

Rural and Appalachian cancer survivors' responses to tobacco use screening and tobacco treatment offer

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ABSTRACT

INTRODUCTION Smoking after a cancer diagnosis is associated with poor outcomes whereas smoking cessation improves survival and other outcomes. Although professional societies and practice guidelines call for equitable tobacco treatment delivery in healthcare, disparities in tobacco-related disease burden persist.

METHODS In the context of an outpatient US cancer center's population-based tobacco treatment program, this study examines associations between cancer survivors' rural and Appalachian residence status and: 1) current tobacco use status, 2) decision to decline tobacco treatment, and 3) reason for declining assistance. A cross-sectional, retrospective analysis was conducted using electronic health record data from 16839 adults: 64.04% female, 88.49% non-Hispanic White, mean age 59.19 ± 14.52 years, 35.97% rural residence, 53.14% Appalachian residence, who sought cancer care in 2019. Descriptive statistics and logistic regression models were applied.

RESULTS The portion of patients that reported current tobacco use was 21.75%. Rural patients had higher odds of tobacco use than urban (OR=1.22; 95% CI: 1.12–1.34), as did Appalachian patients compared to non-Appalachian (OR=1.41; 95% CI: 1.28–1.54). Neither rural nor Appalachian residence status was significantly associated with responses to tobacco treatment offers (76.65% declined the offer) or reason for declining (65.19% declined because they were 'not ready to quit').

CONCLUSIONS Findings highlight continued need for population-level tobacco use screening and proactive tobacco treatment offers, given elevated tobacco use in some minority groups and overall low rates of tobacco treatment acceptance. This large study helps shed light on the association between geographical residence and tobacco-related outcomes among patients with cancer, and underscores room for improvement in tobacco treatment uptake in cancer care.

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INTRODUCTION

Cancer is a major public health concern, with over two million new cases in the United States (US) projected for 2024¹. Among the general US population, the lifetime risk of developing cancer is currently one in three², with the most common disease sites being breast, colorectal, lung, and prostate. Advances in early detection and treatment have led to significant reductions in cancer mortality, with a 33% overall reduction since 1991. Five-year survival rates have increased from 49% in 1975 to 68% in 2018, leading to more and more people living well beyond their cancer diagnosis². Indeed, there are more than 18 million

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US cancer survivors today, a number that could reach 26 million by 2029².

As cancer treatments improve and survival rates rise, secondary disease prevention and health promotion among cancer survivors are paramount. Individuals with a cancer history are at high risk of developing other chronic conditions such as hypertension, pulmonary diseases, and diabetes³. They also tend to experience high rates of chronic or recurring sleep problems, fatigue, distress, and pain⁴. Poor overall health among cancer survivors is influenced by factors such as healthcare access and quality, as well as the side- and late-effects of cancer treatments⁵. Another contributing factor is the increased prevalence of unhealthy behaviors (e.g. heavy alcohol use, cigarette smoking, sedentary behavior) among cancer survivors compared to those without a cancer history⁶. To facilitate disease prevention and health promotion, professional organizations have established and disseminated national guidelines on health behaviors to cancer survivors and their cancer care teams⁷, with one common recommendation being abstinence from tobacco use.

Tobacco use abstinence is critically important for cancer survivors, as it can improve and extend their lives. The 2014 US Surgeon General's Report concluded a causal relationship between cancer survivors' smoking and all-cause mortality, cancer-specific mortality, and second primary cancer⁸. Smoking is also associated with an increased risk of cancer recurrence, poorer response to cancer treatment, and higher cost of cancer care^{8,9}. Additionally, cancer survivors who smoke are more likely to report greater symptom burden during routine care, experience surgical site infection and other complications, and return to the operating room more than their non-smoking counterparts¹⁰. Importantly, there is ample empirical evidence that smoking cessation after cancer diagnosis is associated with reduced overall and cancer-specific mortality^{8,11} plus other health benefits¹². Despite all this, 12–33% of cancer survivors report current cigarette smoking or other tobacco use¹³.

While quality cancer care should be accessible to, affordable for, and provided to everyone, there are well known inequities in cancer care delivery such that historically marginalized groups often bear the brunt

of adverse outcomes. These inequities are evident across various factors, including race, ethnicity, English proficiency, insurance coverage, sexual and gender identity, and geographical residence¹⁴. Not discounting the multitude of other sociodemographic factors linked to cancer care inequities, the focus of the current study is geographical residence. National surveys indicate that 21% of cancer survivors live in rural areas, amounting to nearly 3 million individuals, a considerable segment of the US population¹⁵. Critically, rural areas have seen slower reductions in cancer incidence and mortality¹⁶. Additionally, significant differences in tobacco use and cessation rates exist between the US rural and urban population, with 26% of rural residents reporting current tobacco use compared to 18% of urban residents¹⁷. Appalachia – a geographically distinct and socioeconomically diverse region that spans parts of 13 US states – faces persistent health disparities and markedly higher rates of smoking than the national average (33%), challenges that extend beyond those seen in other rural areas¹⁸. Given the heightened cancer burden in rural and Appalachian populations and the significance of tobacco use after cancer diagnosis, it is important to determine rural-urban and Appalachian–non Appalachian differences in cancer survivors' responses to proactive, population-based offers of tobacco treatment. This study aims to investigate how rural and Appalachian residence relate to tobacco use and treatment engagement among cancer survivors within a population-level tobacco treatment program.

Current study

Within the context of a newly implemented tobacco treatment program at an outpatient cancer care facility, the current study examined whether geographical residence was independently associated with current tobacco use, declining an offer of tobacco treatment, and reasons for declining tobacco treatment. Based on prior literature we hypothesized that rural and Appalachian residence status would have a significant, negative effect across all outcomes, such that cancer survivors from rural and Appalachian areas (examined separately) would be more likely to report current tobacco use, decline tobacco treatment, and decline treatment specifically because they are not ready to

quit. The rationale for studying Appalachian residence in addition to rural residence is that while the Appalachian region faces similar challenges to rural areas, it is a unique geographical area of historical independence and resilience, with health disparities in Appalachia especially pronounced in part due to its well-documented social disadvantages, history of economic exploitation, and increased environmental exposure¹⁹.

METHOD

Study design, setting, and sample

This cross-sectional, retrospective study was conducted using electronic health record data from a National Cancer Institute (NCI)-designated comprehensive cancer center located centrally within a southeastern US state. The cancer center is in an urban county, but its catchment area is the entire state, with many patients traveling from rural and Appalachian areas to seek care. The study population includes all adults (aged ≥ 18 years) who presented for outpatient care between 1 January 2019, and 31 December 2019. The final analytic sample (n=16839) was restricted to individuals with complete data on residential status (loss of 40 cases) and tobacco use status (loss of 10 cases).

Procedures

As part of standard care, the cancer center's rooming procedures involve clinical service technicians asking standardized tobacco use screening questions and recording patients' responses to these questions in the electronic health record. This study is a retrospective review of patients' responses plus selected demographic and clinical variables extracted from the electronic health record. All data were de-identified and aggregated for the purpose of analysis. Research procedures were ruled exempt by the Institutional Review Board of the University of Kentucky (Protocol 52059).

Measures

Background characteristics

Patients' demographic information pertinent to age, sex, race, ethnicity, marital status, and insurance type were recorded using a fixed set of response options. The clinic where patients were seen is a proxy for disease site, with breast, gynecology, and hematology

as disease-specific clinics and the multidisciplinary clinic being the location where patients with other cancers (e.g. larynx, colorectal, bronchus) were seen. Self-reported level of distress in the past week was reported on a scale from 0=no distress to 10=extreme distress²⁰, and is considered a clinical variable.

Rural and Appalachian residence

Patients' county of residence was used to measure, as separate variables, rural and Appalachian residence status. For rurality, the latest US Rural-Urban Continuum Codes (RUCC) were used, codes which classify counties by population size and proximity to metropolitan areas. RUCC range from 1=counties in metropolitan areas of 1 million or more residents to 9=完全 rural or less than 2500 urban population, not adjacent to a metropolitan area²¹. The continuum was dichotomized such that codes 1–6 represent urban areas and codes 7–9 indicate rural residence, in order to focus the analysis on those who are most likely face geographically driven disparities in health outcomes²². County of residence was also used to create a dichotomy of Appalachian or non-Appalachian residence status according to the US Appalachian Regional Commission²³.

Tobacco use and related outcomes

Patients were asked if they have ever used tobacco (yes/no), and those who reported lifetime tobacco use were asked about the types of tobacco products used (e.g. cigarettes, cigars/pipes), and the last time they used tobacco (e.g. today, more than one year ago), both of which have fixed response options. Standard clinical protocol dictates that all patients who report current tobacco use (i.e. past 30 days) are then asked if they would like help quitting (yes/no) consistent with a proactive offer of tobacco treatment. Patients who decline the offer of tobacco treatment (which would have begun with an individual meeting with a certified tobacco treatment specialist to develop a personalized, evidence-based treatment plan) were asked the reason for their referral decline, again with fixed response options (specifically, 'already in treatment', 'want to quit on my own', or 'not ready to quit'). The three outcome variables are: 1) current tobacco use status, 2) tobacco treatment engagement response, and 3) reasons for declining treatment.

Data analysis

Descriptive statistics (e.g. percentages, frequencies) were used to describe the sample's background characteristics, residential status, and tobacco use and related outcomes. Binomial (current tobacco use and tobacco treatment response) and ordinal logistic regression (reasons for declining) were conducted to assess the independent influence of residential status across all outcomes, with rural and Appalachian residence tested in separate models. A prior, similar study found multiple background demographic and clinical variables were associated with one or more of the outcomes of interest¹³, so sex, age, race and ethnicity, marital status, insurance status, clinic and distress level were all treated as covariates in the

models tested here. Statistical significance was set at $p<0.05$ in all analyses and the assumptions for all models, including proportional odds, were checked. Adjusted odds ratios (AORs) and corresponding 95% confidence intervals (CIs) were calculated for all model estimates. Model goodness of fit for binary logistic regressions was assessed using the Hosmer-Lemeshow (H-L) test. All hypothesis tests were two-tailed, and all statistical analyses were conducted in SAS version 15.2 (SAS Institute, Cary, NC) and SPSS version 28.0 (SPSS Inc., Chicago, IL).

RESULTS

Sample characteristics

Tables 1 and 2 provide for full details on the sample's

Table 1. Demographic and clinical characteristics of US cancer survivors seeking care at a cancer center, by residence status, a cross-sectional analysis, 2019 (N=16839)

Characteristics	Total (N=16839) % (n)	Rural ^a (N=5905) % (n)	Urban (N=10934) % (n)	p
Sex				0.387
Female	64.04 (10783)	64.47 (3807)	63.80 (6976)	
Male	35.96 (6056)	35.53 (2098)	36.20 (3958)	
Race and ethnicity				<0.001
Racial and/or ethnic minority	8.20 (1381)	1.78 (105)	11.67 (1276)	
White, non-Hispanic	88.49 (14901)	94.65 (5589)	85.17 (9312)	
Missing	3.31 (557)	3.57 (211)	3.16 (346)	
Marital status				<0.001
Married	55.87 (9408)	57.14 (3374)	55.19 (6034)	
Single/never married	17.77 (2992)	14.77 (872)	19.39 (2120)	
Widowed/separated/divorced	23.26 (3916)	24.52 (1448)	22.57 (2468)	
Missing	3.11 (523)	3.57 (211)	2.85 (312)	
Insurance status				<0.001
Managed care organizations	34.95 (5885)	28.02 (1708)	38.20 (4177)	
Medicaid	18.05 (3040)	21.68 (1280)	16.10 (1760)	
Medicare	44.27 (7454)	47.52 (2806)	42.51 (4648)	
Self-pay or other	2.73 (460)	1.88 (111)	3.19 (349)	
Age (years), mean \pm SD	59.19 \pm 14.52	59.35 \pm 13.95	59.10 \pm 14.82	0.029
Clinic				<0.001
Breast	17.03 (2868)	14.77 (872)	18.25 (1996)	
Gynecology	16.94 (2853)	21.12 (1247)	14.69 (1606)	
Hematology	17.99 (3029)	13.84 (817)	20.23 (2212)	
Multidisciplinary	48.04 (8089)	50.28 (2969)	46.83 (5120)	
Distress (0–10), mean \pm SD	3.27 \pm 3.12	3.45 \pm 3.16	3.17 \pm 3.09	<0.001 ^b

^a Rural refers to a definition of 'rural' as inclusive of RUCC 7-9. ^b Mann-Whitney test used due to non-normal distribution of variable.

background. Patients had a mean age of 59.19 ± 14.52 years. There were more female (64.04%) than male patients and most patients were White, non-Hispanic (88.49%). Most patients were either currently married (55.87%) or widowed, separated or divorced (23.26%). Nearly all patients had insurance coverage, with most having Medicare (44.27%) or Medicaid (18.05%). Patients were seen in these outpatient clinics: multidisciplinary (48.04%), hematology (17.99%), breast (17.03%), and gynecological (16.94%). Patients reported mild distress levels (range: 0–10), on average (3.27 ± 3.12). Regarding geographical area of residence, 35.97% of patients were categorized as having rural residence, and just over half lived in Appalachia (53.14%).

Descriptive analyses were done to explore if patients' background differed by rural and Appalachian residence status (Tables 1 and 2, respectively). To summarize the main differences, patients from rural areas were more likely to be White, non-Hispanic (94.65% vs 85.17%) and insured through Medicare and Medicaid (47.52% and 21.68% vs 42.51% and 16.10%, respectively) than urban patients. Similarly, Appalachian patients were more likely to be White, non-Hispanic (94.60% vs 81.56%) and insured through Medicare and Medicaid (47.38% and 20.37% vs 40.73% and 15.42%, respectively) than non-Appalachian patients. Finally, rural patients were more likely to be seen in the gynecology and multidisciplinary clinics than urban patients (21.12% vs 12.50%, respectively).

Table 2. Demographic and clinical characteristics of US cancer survivors seeking care at a cancer center, by Appalachian residence status, a cross-sectional analysis, 2019 (N=16839)

Characteristics	Total (N=16839) % (n)	Appalachian (N=8948) % (n)	Non-Appalachian (N=7891) % (n)	p
Sex				0.605
Female	64.04 (10783)	64.22 (5746)	63.83 (5037)	
Male	35.96 (6056)	35.78 (3202)	36.17 (2854)	
Race and ethnicity				<0.001
Racial and/or ethnic minority	8.20 (1381)	1.94 (174)	15.30 (1207)	
White, non-Hispanic	88.49 (14901)	94.60 (8465)	81.56 (6436)	
Missing	3.31 (557)	3.45 (309)	3.14 (248)	
Marital status				<0.001
Married	55.87 (9408)	57.66 (5159)	53.85 (4249)	
Single/never married	17.77 (2992)	14.54 (1301)	21.43 (1691)	
Widowed/separated/divorced	23.26 (3916)	24.42 (2185)	21.94 (1731)	
Missing	3.11 (523)	3.39 (303)	2.79 (220)	
Insurance status				<0.001
Managed care organizations	34.95 (5885)	30.17 (2700)	40.36 (3185)	
Medicaid	18.05 (3040)	20.37 (1823)	15.42 (1217)	
Medicare	44.27 (7454)	47.38 (4240)	40.73 (3214)	
Self-pay or other	2.73 (460)	2.07 (185)	3.48 (275)	
Age (years), mean \pm SD	59.19 ± 14.52	59.51 ± 14.05	58.83 ± 15.03	
Clinic				<0.001
Breast	17.03 (2868)	14.87 (1331)	19.48 (1537)	
Gynecology	16.94 (2853)	19.90 (1781)	13.59 (1072)	
Hematology	17.99 (3029)	13.92 (1246)	22.60 (1783)	
Multidisciplinary	48.04 (8089)	51.30 (4590)	44.34 (3499)	
Distress (0–10), mean \pm SD	3.27 ± 3.12	3.38 ± 3.15	3.15 ± 3.01	<0.001 ^a

^a Mann-Whitney test used due to non-normal distribution of variable.

Table 3. Association of tobacco use status and response to tobacco treatment offer among US cancer survivors seeking care at a cancer center, with rural residence status, a cross-sectional analysis, 2019 (N=16839)

Variables	Current tobacco use OR (95% CI)	Treatment referral decline OR (95% CI)	Reason for treatment referral decline	
			Logit 1 ^a	Logit 2 ^a
			OR (95% CI)	OR (95% CI)
Residence status				
Urban ®	1	1	1	1
Rural	1.22 (1.12–1.34)*	0.87 (0.71–1.06)	1.01 (0.84–1.21)	0.94 (0.67–1.32)
p ^b	<0.0001	0.1754	0.9151	
Clinic/disease site				
Hematology ®	1	1	1	1
Breast	0.90 (0.76–1.07)	1.15 (0.77–1.70)	0.84 (0.59–1.20)	0.83 (0.42–1.63)
Gynecology	1.18 (1.01–1.38)*	1.30 (0.91–1.86)	1.38 (0.99–1.92)	0.63 (0.35–1.11)
Other	1.72 (1.52–1.94)*	0.87 (0.66–1.16)	0.69 (0.53–0.88)*	0.83 (0.49–1.39)
p	<0.0001	0.0620	<0.0001	
Sex				
Female ®	1	1	1	1
Male	1.73 (1.55–1.92)*	1.55 (1.23–1.96)*	1.23 (1.00–1.52)	2.07 (1.34–3.19)*
p	<0.0001	0.0002	0.0030	
Race and ethnicity				
White, non-Hispanic ®	1	1	1	1
Minority	0.81 (0.69–0.95)*	0.71 (0.50–1.00)	1.02 (0.72–1.43)	1.21 (0.62–2.39)
p	0.0104	0.0522	0.8492	
Marital status				
Married ®	1	1	1	1
Divorced/separated/ widowed	1.66 (1.49–1.85)*	1.05 (0.83–1.33)	0.87 (0.71–1.08)	0.99 (0.66–1.48)
Single	1.41 (1.26–1.59)*	1.08 (0.84–1.39)	0.87 (0.69–1.09)	0.85 (0.56–1.28)
p	<0.0001	0.8268	0.6038	
Insurance status				
Self-pay/other ®	1	1	1	1
Managed care organization	0.67 (0.51–0.89)*	1.01 (0.52–1.96)	0.74 (0.41–1.34)	0.22 (0.03–1.60)
Medicare	1.27 (0.96–1.69)	1.00 (0.51–1.93)	0.90 (0.50–1.61)	0.31 (0.04–2.28)
Medicaid	1.94 (1.46–2.57)*	0.87 (0.45–1.67)	1.06 (0.59–1.89)	0.19 (0.03–1.39)
p	<0.0001	0.6690	0.3240	
Age tertiles (years)				
<55 ®	1	1	1	1
55–67	0.80 (0.72–0.88)*	0.86 (0.68–1.08)	1.14 (0.93–1.41)	0.72 (0.50–1.05)
>67	0.30 (0.26–0.35)*	0.82 (0.59–1.15)	1.34 (0.98–1.81)	1.06 (0.55–2.05)
p	<0.0001	0.3541	0.0876	
Distress tertiles				
<1 ®	1	1	1	1
1–5	1.09 (0.97–1.22)	0.88 (0.66–1.17)	1.15 (0.91–1.46)	0.49 (0.30–0.80)*
>5	1.81 (1.63–2.02)*	0.62 (0.48–0.79)*	0.90 (0.73–1.12)	0.60 (0.38–0.96)*
p	<0.0001	0.0001	0.0010	
Model goodness of fit (H-L test)	0.3463	0.4316		

*Statistically significant. ^a A proportional odds model was initially fit and a test of proportional odds was made. This test revealed that the proportional odds assumption did not hold for this cumulative logits model. Therefore, two separate sets of logits were formed by fitting a cumulative logits model where the first logit corresponds to the 'log odds' of not yet ready to quit versus want to quit on my own or already in treatment, and the second logit corresponds to the 'log odds' of not yet ready to quit or want to quit on my own versus already in treatment. These log odds 'accumulate' probability of 'least desired to most desired outcome'. The model reported is the non-proportional odds/cumulative logits model. ^b p-values from Type 3 Analysis of Effects Wald chi-squared statistic. H-L: Hosmer-Lemeshow. ® Reference categories.

Table 4. Association of tobacco use status and response to tobacco treatment offer among US cancer survivors seeking care at a cancer center, with Appalachian residence status, a cross-sectional analysis, 2019 (N=16839)

Variables	Current tobacco use OR (95% CI)	Treatment referral decline OR (95% CI)	Reason for treatment referral decline	
			Logit 1 ^a	Logit 2 ^a
			OR (95% CI)	OR (95% CI)
Appalachian residence status				
Non-Appalachian ®	1	1	1	1
Appalachian	1.41 (1.28–1.54)*	0.99 (0.80–1.22)	0.96 (0.80–1.16)	0.95 (0.66–1.37)
p ^b	<0.0001	0.909	0.912	
Clinic/disease site				
Hematology ®	1	1	1	1
Breast	0.89 (0.75–1.06)	1.13 (0.76–1.67)	0.84 (0.59–1.20)	0.83 (0.42–1.62)
Gynecology	1.16 (0.97–1.35)	1.27 (0.89–1.82)	1.39 (0.99–1.93)	0.62 (0.35–1.11)*
Other	1.68 (1.49–1.90)*	0.87 (0.65–1.15)	0.69 (0.53–0.89)*	0.83 (0.49–1.39)
p	<0.0001	0.071	<0.0001	
Sex				
Female ®	1	1	1	1
Male	1.73 (1.56–1.93)*	1.55 (1.23–1.95)*	1.23 (1.00–1.52)	2.06 (1.34–3.18)*
p	<0.0001	0.0002	0.003	
Race and ethnicity				
White, non-Hispanic ®	1	1	1	1
Minority	0.88 (0.75–1.04)	0.74 (0.52–1.05)	0.99 (0.70–1.40)	1.21 (0.60–2.44)
p	0.137	0.091	0.838	
Marital status				
Married ®	1	1	1	1
Divorced/separated/widowed	1.67 (1.50–1.86)*	1.05 (0.83–1.33)	0.87 (0.70–1.08)	0.98 (0.66–1.47)
Single	1.44 (1.29–1.62)*	1.09 (0.85–1.41)	0.86 (0.69–1.08)	0.84 (0.56–1.27)
p	<0.0001	0.783	0.585	
Insurance status				
Self-pay/other ®	1	1	1	1
Managed care organization	0.68 (0.51–0.90)*	1.01 (0.52–1.96)	0.74 (0.41–1.34)	0.22 (0.03–1.58)
Medicare	1.25 (0.94–1.66)	0.99 (0.51–1.91)	0.90 (0.50–1.61)	0.31 (0.04–2.25)
Medicaid	1.90 (1.43–2.52)*	0.86 (0.45–1.66)	1.06 (0.59–1.90)	0.19 (0.03–1.38)
p	<0.0001	0.647	0.325	
Age tertiles (years)				
<55 ®	1	1	1	1
55–67	0.80 (0.72–0.89)*	0.86 (0.68–1.08)	1.14 (0.93–1.41)	0.72 (0.49–1.05)
>67	0.30 (0.26–0.35)*	0.82 (0.59–1.15)	1.33 (0.98–1.81)	1.06 (0.55–2.06)
p	<0.0001	0.359	0.046	
Distress tertiles				
<1 ®	1	1	1	1
1–5	1.09 (0.97–1.23)	0.88 (0.66–1.17)	1.15 (0.91–1.46)	0.49 (0.30–0.80)*
>5	1.82 (1.63–2.02)*	0.61 (0.48–0.79)*	0.90 (0.73–1.12)	0.60 (0.38–0.96)*
p	<0.0001	0.0001	0.001	
Model goodness of fit (H-L test)	0.346	0.432		

*Statistically significant. ^a A proportional odds model was initially fit and a test of proportional odds was made. This test revealed that the proportional odds assumption did not hold. Therefore, a fully non-proportional odds model was fit using two separate sets of logits where the first logit corresponds to the 'log odds' of not yet ready to quit versus want to quit on my own or already in treatment and the second logit corresponds to the 'log odds' of not yet ready to quit or want to quit on my own versus already in treatment. These log odds 'accumulate' probability of 'least desired to most desired outcome'. The model reported is the non-proportional odds/cumulative logits model.

^b p-values from Type 3 Analysis of Effects Wald chi-squared statistic. H-L: Hosmer-Lemeshow. ® Reference categories.

and 50.28% vs 14.69% and 46.83%, respectively), a pattern also seen for Appalachian compared to non-Appalachian patients.

Responses to tobacco use screening and tobacco treatment offers

A history of tobacco use (i.e. current or former) was reported by 44.69% of patients, of which 21.75% reported current use. Among those with a history of tobacco use, 91.77% reported use of cigarettes, with smokeless tobacco being the second most common product (4.50%). Amid patients who reported current use, 76.65% declined the offer of tobacco treatment that would have triggered a referral to the 'in-house' tobacco treatment program. Of those who declined, 65.19% did so because they were not ready to quit, 27.29% because they desired to quit without assistance, and 6.73% because they were currently in treatment.

Preliminary analyses of current tobacco use and response to tobacco treatment offers by residence

Descriptive analyses examined differences in key tobacco-related outcomes by rural and Appalachian residence. Patients from rural areas reported current tobacco use at a rate that was approximately six points higher than urban patients (25.74% vs 19.59%). In contrast, tobacco treatment referral decline was similarly high among rural and urban patients (77.37% vs 76.14%). The reason for declining was also similar across rural and urban patients: already in treatment (6.89% vs 6.62%), desire to quit without assistance (26.19% vs 28.08%), not ready to quit (66.33% vs 64.38%), and missing (0.60% vs 0.92%). Patients from rural areas reported current tobacco use at a higher rate (24.90% vs 16.86%), but there were similar rates of tobacco treatment referral decline (76.92% vs 76.03%) in rural and urban patients. The reason for declining was also similar across these groups of rural and urban patients: already in treatment (6.94% vs 6.26%), desire to quit without assistance (26.43% vs 28.28%), not ready to quit (65.87% vs 63.64%), and missing (0.77% vs 0.83%).

Appalachian patients also reported current tobacco use at a higher rate than non-Appalachian patients (25.50% vs 17.49%). In contrast, Appalachian patients

declined tobacco treatment at similar rates as non-Appalachian patients (77.34% vs 75.51%) and the reason for treatment decline was also similar across groups: already in treatment (6.97% vs 6.33%), desire to quit without assistance (26.80% vs 28.12%), not ready to quit (65.50% vs 64.48%), and missing (0.74% vs 0.86%).

Regression analyses of associations between key tobacco-related outcomes for both rural and Appalachian residence status

For the primary analyses, univariate and multivariable logistic regressions were completed (Tables 3 and 4). Adjusting for covariates, patients from rural areas were more likely to report current tobacco use than those from urban areas (OR=1.22; 95% CI: 1.12–1.34). The same was true for Appalachian residence, such that patients from Appalachian counties were more likely to report current tobacco use than non-Appalachian patients (OR=1.41; 95% CI: 1.28–1.54). Model goodness of fit for both binary logistic regressions were acceptable, as indicated by non-significant Hosmer–Lemeshow tests ($p=0.346$ and 0.432).

However, in separate models, neither rural nor Appalachian residence status were significantly associated with the decision to decline tobacco treatment (rural: OR=0.87; 95% CI: 0.71–1.06; Appalachian: OR=0.99; 95% CI: 0.80–1.22). For the ordinal outcome of reason to decline, a proportional odds model was initially tested, but the assumption of proportional odds was not met. Consequently, a nonproportional odds cumulative logits model was used, specifying two sets of logits: the first comparing 'not yet ready to quit' with 'want to quit on my own' and 'already in treatment,' and the second comparing 'not yet ready to quit' and 'want to quit on my own' with 'already in treatment.' These logits reflect the progression from least to most desired outcome. In separately tested models, neither rural (OR=0.94–1.01; 95% CI: 0.67–1.32) nor Appalachian (OR=0.95–0.96; 95% CI: 0.66–1.37) residence status was significantly associated with the preferred response.

DISCUSSION

This study of electronic health record data from >16000 adult cancer patients examines the association between cancer survivors' geographical

residence and their report of current tobacco use and response to tobacco treatment offers. This study was done in the context of cancer care delivery, where identifying all individuals who use tobacco and providing evidence-based tobacco treatment can be considered the 4th pillar of care alongside surgery, radiation and chemotherapy²⁴. Here, rural and Appalachian cancer survivors were found to report significantly higher levels of tobacco use than their urban and non-Appalachian counterparts, which is especially concerning because the overall rate of tobacco use in this sample (22%) is relatively high⁶. This mirrors national trends in clinical and non-clinical populations, underscoring the heightened vulnerability of rural and Appalachian residents for tobacco use and tobacco-related disease burden²⁵. The persistence of tobacco use and related disparities tied to geographical residence may be attributed to a variety of demographic, socioeconomic, and cultural and societal factors, such as lower income, lower level of education, limited healthcare access, pro-tobacco social norms, and economic reliance on tobacco agriculture coupled with insufficient investment in tobacco prevention and control by regulatory agencies^{18,19}. Notably, this study was conducted in a tobacco nation state – a region with a history of high smoking rates and significant tobacco industry interference in public health policies – further emphasizing the importance of addressing these disparities. The geographical isolation that is inherent to most rural and Appalachian areas and reduced preventive healthcare access, make it essential for cancer care and other specialty and tertiary care providers to take advantage of every clinical encounter by screening for tobacco use and providing tobacco treatment to all who report current use²⁶.

This study also aimed to determine how cancer survivors from rural and Appalachian areas respond to offers of tobacco treatment. While the overall acceptance rate was low (18%), no differences were indicated based on rural or Appalachian residence status. The lack of group difference in this study contrasts with some prior literature, which has found that rural and Appalachian populations often experience lower levels of care utilization and help-seeking²⁷. Prior observed discrepancies may, in part, be due to intrapersonal factors like cancer fatalism

and cancer information overload, which are prevalent among rural residents²⁸. In contrast, the current results align with a prior study's finding that implementing an 'opt-out' tobacco treatment program increased treatment engagement among rural cancer survivors, which supports the broader conclusion that proactive, population-level interventions can effectively reach rural populations²⁵. Another recent study highlighted how proactive, population-level offers of tobacco treatment can improve treatment access across diverse populations, specifically across Black and Hispanic cancer survivors²⁹. Proactive outreach and population-level or universal offers of tobacco treatment may mitigate some of rural (and Appalachian) residents' foremost barriers to engaging in treatment, as challenges with asking for help with a sensitive or stigmatized problem, scheduling appointments and finding suitable providers are inherently addressed at the system-level and the importance of cessation is clearly communicated by healthcare providers³⁰.

The low overall acceptance rate of tobacco treatment observed in this study parallels relatively low utilization of such services in similar clinical populations³¹. Nearly two-thirds of the patients who declined reportedly did so because they were not ready to quit. Readiness to quit varies over time, and while most US adults who use tobacco would like to quit eventually¹², at any given moment, most are not ready to do so^{32,33}. In this way, study results converge with prior literature. However, contrary to hypotheses, there were no group differences by residential status regarding reasons for declining tobacco treatment. While unexpected because of multilevel barriers to cessation in rural and Appalachian regions, this could be viewed as a novel and encouraging result. It again highlights the need for cancer center system-level interventions that ensure everyone receives an offer of tobacco treatment, rather than relying on provider-level interventions that are subject to biases and assumptions tied to sociodemographic factors like geographical area of residence. At the same time, this study result also underscores the need to bolster readiness to quit among individuals receiving cancer care, potentially by implementing clinical strategies that have proven effective in other populations and care settings, such as tailored health education, nicotine replacement therapy sampling,

and practice quit attempts³⁴. These findings highlight the importance of comprehensive, system-wide approaches that offer cessation support to all cancer survivors while also addressing strategies to increase readiness to quit.

Strengths and limitations

The study's strengths include focusing on vulnerable populations and offering insights into a newly implemented tobacco treatment program. Importantly, tobacco treatment was equitably offered across patients from different sociodemographic backgrounds, and results demonstrated the potential to reach a high-risk population. This study's large sample size enhances the reliability of the findings, particularly in evaluating the impact of factors such as geographical area of residence on tobacco use and tobacco treatment engagement outcomes.

However, a few methodological limitations of this study merit consideration for future research. First, the study was conducted at a single NCI-designated comprehensive cancer center in the United States, which may limit the generalizability of the findings to other cancer care settings, regions, or countries with different healthcare systems or population characteristics. Second, the cross-sectional, observational design precludes causal inferences about the relationships observed. Third, tobacco use and readiness to quit were assessed through self-reported measures, which are subject to bias. Fourth, despite adjusting for several covariates, residual confounding by unmeasured factors cannot be ruled out. Fifth, patients might have misrepresented their tobacco use or reasons for declining tobacco treatment due to social desirability. Finally, the study relies on quantitative measures and does not explore the nuances of patients' experiences and motivations through qualitative data, which could provide more insight into the unique barriers faced by rural and/or Appalachian cancer survivors.

CONCLUSIONS

Tobacco treatment is a vital component of cancer care, and this study ultimately serves as a reminder that cancer survivors from rural and Appalachian regions stand to benefit from evidence-based care in the same manner as those from urban areas. Cancer

care systems should continue quality improvement endeavors that increase accessibility to tobacco treatment and mitigate longstanding tobacco-related disease burden^{35,36}.

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CONFLICTS OF INTEREST

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ETHICAL APPROVAL AND INFORMED CONSENT

Research procedures were ruled exempt from ethical approval by the Institutional Review Board of the University of Kentucky (Protocol 52059).

DATA AVAILABILITY

The data supporting this research are available from the authors on reasonable request.

PROVENANCE AND PEER REVIEW

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