

# Examining Urban and Rural Differences in How Distance to Care Influences the Initiation and Completion of Treatment among Insured Cervical Cancer Patients



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## Abstract

**Background:** Although rural cancer patients encounter substantial barriers to care, they more often report receiving timely care than urban patients. We examined whether geographic distance, a contributor to urban–rural health disparities, differentially influences treatment initiation and completion among insured urban and rural cervical cancer patients.

**Methods:** We identified women diagnosed with cervical cancer from 2004 to 2013 from a statewide cancer registry linked to multipayer, insurance claims. Primary outcomes were initiation of guideline-concordant care within 6 weeks of diagnosis and, among stage IB2-IVA cancer patients, completion of concurrent chemoradiotherapy (CCRT) in 56 days. We estimated risk ratios using modified Poisson regressions, stratified by urban/rural status, to examine the association between distance and treatment timing (initiation or completion).

**Results:** Among 999 stage IA-IVA patients, 48% initiated guideline-concordant care within 6 weeks of diagnosis, and 37% of 492 stage IB2-IVA cancer patients completed CCRT in 56 days. In urban areas, stage IA-IVA patients who lived  $\geq 15$  miles from the nearest treatment facility were less likely to initiate timely treatment compared with those  $< 5$  miles [risk ratio (RR): 0.72; 95% confidence intervals (CI), 0.54–0.95]. Among IB2-IVA stage cancer patients, rural women residing  $\geq 15$  miles from the nearest radiation facility were more likely to complete CCRT in 56 days (RR: 2.49; 95% CI, 1.12–5.51).

**Conclusions:** Geographic distance differentially influences the initiation and completion of treatment among urban and rural cervical cancer patients.

**Impact:** Distance was an access barrier for insured cervical cancer patients in urban areas whereas rural patients may require more intensive outreach, support, and resources, even among those living closer to treatment.

## Introduction

Women with cervical cancer experience substantial treatment disparities. Even among privately insured patients, only 44% of women diagnosed with advanced cervical cancer receive guideline-concordant care (1). In comparison, 65% and 80% of patients with breast cancer and prostate cancer, respectively, receive guideline-concordant care (2, 3). Underserved popula-

tions such as minority, low socioeconomic status (SES), and rural residents comprise a significant proportion of patients with cervical cancer in the United States (4–6). These patients are particularly susceptible to access barriers to care; they often do not have a usual source of medical care, travel long distances to receive care, have low health literacy, and experience financial strain (7). The persistent burden of cervical cancer among these vulnerable populations (5, 8, 9) makes it essential to target resources that decrease access barriers to care.

Distance to care, often used as a proxy for geographic access, is one specific measure of access (10). However, recent evidence suggests the relationship between distance to care and urban/rural status in predicting cancer care receipt is complex. A recent study among patients with breast cancer observed a paradoxical relationship between distance to care and urban/rural status: in rural areas, women living farther from radiation facilities were "more likely" to receive guideline-concordant radiotherapy; however, in urban areas, women living farther from care were "less likely" to receive guideline-concordant radiotherapy than those who lived closer to treatment (11). Although recent evidence suggests that rural cancer patients are more likely to report receiving timely care than urban patients (12), it is unclear exactly how distance and urban/rural residence interact to predict receipt of timely cancer care, and to our knowledge, no studies have explored this relationship in cervical cancer.

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**Note:** Supplementary data for this article are available at Cancer Epidemiology, Biomarkers & Prevention Online (<http://cebp.aacrjournals.org/>).

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The National Comprehensive Cancer Network (NCCN) and the Institute of Medicine cite timely treatment as a critical dimension of quality cancer care. Among patients with cervical cancer, the timely completion of concurrent chemoradiotherapy (CCRT) has been prioritized by the American Brachytherapy Society, Radiation Therapy Oncology Group, and Gynecologic Oncology Group (13–15). As a predominately medically underserved population, both rural and urban patients with cervical cancer may be at greater risk of experiencing treatment delays. Access to timely cancer treatment, however, may be exacerbated by geographic barriers. This study examines the differential effects of distance on the timing of cervical cancer treatment among women residing in urban and rural settings.

## Materials and Methods

### Data and study population

We used data from the Cancer Information and Population Health Resource (CIPHR), which links the North Carolina Central Cancer Registry (NCCCR) to claims data from Medicare, Medicaid, and private insurance files. This population-based dataset included patient demographics, tumor information, utilization of health care services, physician identifiers, and geocoded patient and physician locations, making it well-suited for evaluating distance to care. In addition, we linked county-specific contextual data (e.g., sociodemographic and health care workforce information) from the Area Health Resource File (AHRF). This study was approved by the University of North Carolina Institutional Review Board.

The cohort included insured women diagnosed with cervical cancer between January 1, 2004, and June 30, 2013 (Fig. 1). We identified women ages 18 years or older with cervical cancer who had no additional primary cancer diagnosis within 1 year of the index diagnosis ( $N = 4013$ ). We excluded patients who were diagnosed at death ( $N = 51$ ), died of any cause in the same month as being diagnosed ( $N = 25$ ), had a non-epithelial cervical cancer histology ( $N = 44$ ), or were missing stage of cancer at diagnosis or were stage IVB or stage 0 carcinoma *in situ* ( $N = 373$ ). We excluded stage IVB patients because treatment focuses on a palliative rather than curative strategy, and we excluded stage 0 patients since diagnosis and treatment are often determined simultaneously. Finally, patients had to be continuously enrolled in private, Medicare, or Medicaid insurance 3 months before diagnosis through 6 months after diagnosis to fully capture treatment detail around the time of diagnosis. We considered requiring patients to be continuously enrolled for at least 12 months postdiagnosis. However, because over 99% initiated treatment within 6 months of diagnosis, we used 6 months to define continuous enrollment. Our final cohort included 999 patients with stage IA to IVA cervical cancer and 492 patients with stage IB2 to IVA cancer.

### Dependent variables

**Initiation of treatment.** We measured the number of days between diagnosis and initiation of guideline-concordant treatment. Using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes, we defined guideline-concordant treatment using stage-specific NCCN guidelines:

- Stage IA1: Days to conization, loop electrosurgical excision procedure (LEEP), radical hysterectomy, simple hysterectomy, or trachelectomy.

- Stage IA2: Days to radical hysterectomy, simple hysterectomy, or trachelectomy.
- Stage IB: Days to radical hysterectomy or external beam radiation therapy (EBRT).
- Stage IIA–IVA: Days to initiating concurrent chemotherapy and EBRT.

We created a binary variable to indicate if guideline-concordant treatment had been initiated within 6 weeks of diagnosis. The decision to use 6 weeks was based on expert opinion as well as previous gynecological cancer studies suggesting this to be an appropriate interval between diagnosis and treatment (16).

**Completion of guideline-concordant CCRT.** We determined completion of CCRT indicated by ICD-9-CM codes. For patients with stage IB2–IVA cervical cancer, we measured the number of days between the first and last day of CCRT. Patients with stage IIA–IVB cancer were only considered as having completed treatment if they had also finished brachytherapy in accordance with NCCN guidelines (Fig. 2). We then created a binary outcome reflecting whether CCRT had been completed in 56 days since prolonged CCRT treatment has been shown to harm survival (13).

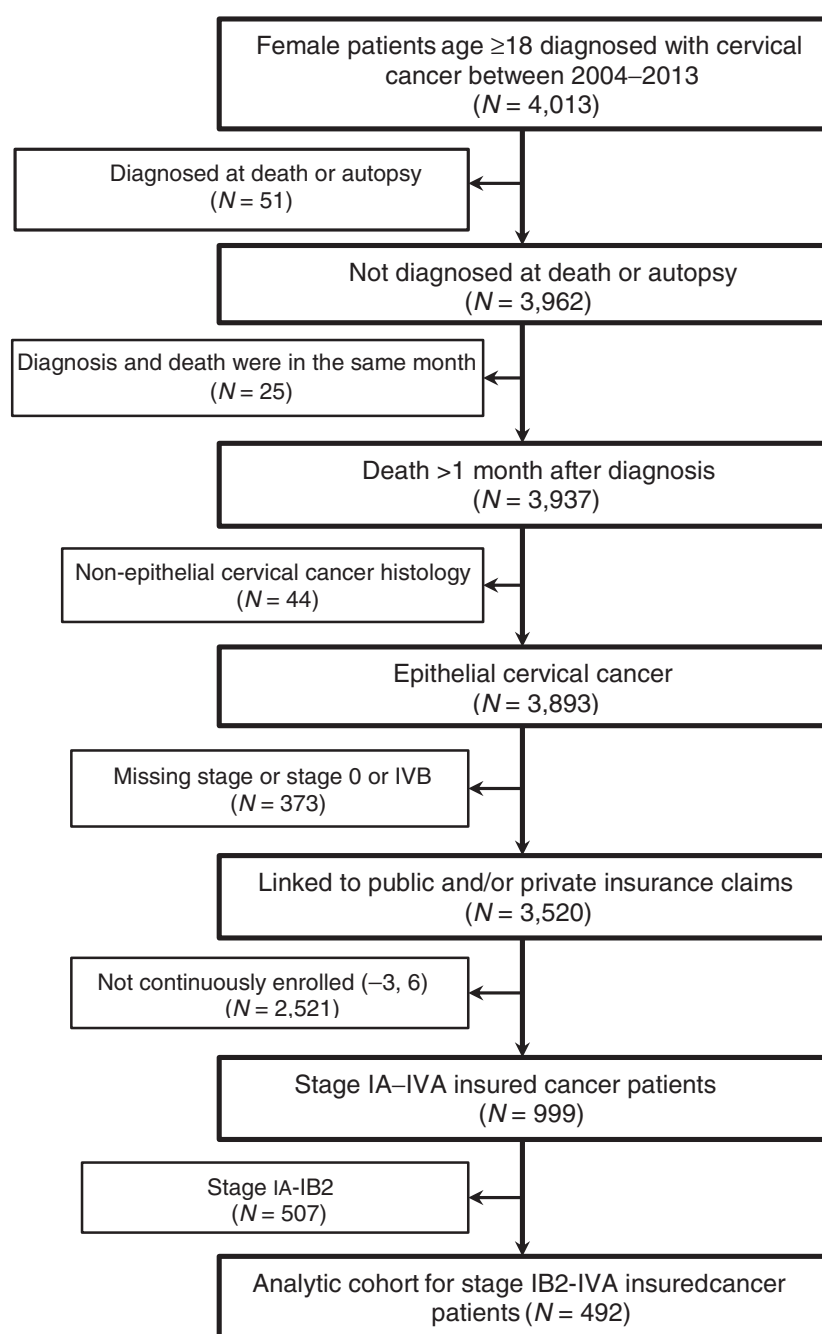
### Independent variables

The key independent variable was distance to "nearest" treatment facility providing cervical surgery, chemotherapy, or radiotherapy. Using the straight-line method (11), we measured the distance between the geographic centroid of patients' residential zip code at diagnosis and the treatment centers' physical address. Patient addresses were geocoded by the NCCCR using North American Association of Central Cancer Registries guidelines (17). To determine treatment facilities' locations, we used insurance claims to identify all surgical, medical, and gynecological oncologists who provided either cervical surgery or chemotherapy to patients with cervical cancer in the CIPHR database. Similarly, we identified all radiation oncologists who provided radiotherapy. For analyses where the outcome was initiation of treatment, distance to nearest treatment center was based on patient's stage of cancer:

- Stage IA: Nearest facility providing primary operative management.
- Stage IB1: Nearest facility providing either radiotherapy or radical hysterectomy.
- Stage IB2–IVA: Nearest facility providing radiotherapy or chemotherapy. Since both treatments are required, we then used the further of the two distances.

For analyses where the outcome was completion of CCRT, we used distance to nearest radiation treatment facility. In all analyses, distance measures were categorized as: <5 miles, 5 to <15 miles, and  $\geq 15$  miles (18).

We also examined patient- and tumor-level characteristics shown to influence timeliness of treatment including: year of diagnosis, American Joint Commission on Cancer stage (stage I; stage II; stage III; stage IV), age at diagnosis (<60 years; 60–70 years; >70 years), race (nonwhite; white), insurance status at diagnosis (Medicaid only; Medicare only; any private; dual-Medicare and Medicaid), and residence status (urban; rural). We defined race as a binary variable since over 90% of nonwhite



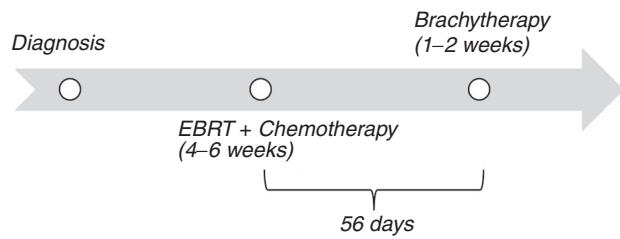
**Figure 1.** This figure describes the analytic cohorts using the Consolidated Standard of Reporting Trials (CONSORT) diagram.

patients in the study population were black ( $N = 285$ ). Specifically, the nonwhite category included black, Hispanic, Asian, Native American, and other race patients. We defined residence status using the rural–urban continuum codes (RUCC) and delineated urban/rural status based on the United States Department of Agriculture's (USDA) classification scheme. We used RUCC because it takes both population levels and proximity to an urban area into consideration when determining urban/rural status. We measured comorbid conditions during the study period (3 months prior to diagnosis to 6 months after diagnosis) using a modified Charlson Comorbidity Index. Finally, we included county-level sociodemographic characteristics previously

shown to influence receipt of guideline-concordant care, such as number of generalist physicians, percent unemployed, and median household income (1, 11).

#### Statistical methods

We used  $\chi^2$  tests and  $t$  tests to evaluate whether differences in patient, tumor, and county-level characteristics were associated with women of all stages initiating guideline-concordant treatment within 6 weeks of diagnosis; for women with stage IB2–IVA cervical cancer, we also examined factors associated with completing CCRT in 56 days. In multivariable analyses, we used modified Poisson regression to estimate risk ratios (RR) and



**Figure 2.** Timeline of guideline-concordant care. Figure describes guideline-concordant care for patients with stage IIA-IVA cervical cancer.

95% confidence intervals (CI). We used this approach since our outcomes occurred in more than 10% of our study populations; using logistic regression to estimate odds ratios would have upwardly biased our results. Models included full and urban/rural stratified samples. Only patients with stage IB2-IVA cervical cancer were included in model where the outcome was comple-

tion of CCRT in 56 days. In a sensitivity analysis, we also examined initiation of guideline-concordant treatment within 8 weeks since some gynecological cancer studies have suggested this as a target interval between diagnosis and treatment (19). All analyses were conducted using SAS version 9.4 software (SAS Institute, Inc.).

**Results**

Among 999 women with stage IA-IVA disease at diagnosis, 48% initiated stage-specific guideline-concordant treatment regimens within 6 weeks of diagnosis. These patients were more likely to be younger than 60 years, enrolled in private insurance, have zero comorbidities, and diagnosed at a later cancer stage (Table 1). No significant differences in initiating guideline-concordant care within 6 weeks were found by race, urban/rural residence, tumor-, or county-level characteristics. Among patients with stage IB2-IVA cancer, 37% completed guideline-recommended CCRT in 56 days. These patients were more likely to be younger, on Medicaid only or private insurance, and

**Table 1.** Characteristics of insured women with cervical cancer

	Full sample (N = 999) N (%) or mean (SD)	GC care ≤6 weeks from diagnosis (N = 478) N (%) or mean (SD)	No GC care ≤6 weeks from diagnosis (N = 521) N (%) or mean (SD)	P
<b>Patient characteristics</b>				
Age at diagnosis				
<60	475 (47.55)	269 (56.28)	206 (39.54)	<0.0001
60-70	240 (24.02)	113 (23.64)	127 (24.38)	
>70	284 (28.43)	96 (20.08)	188 (36.08)	
Race				
White	683 (68.37)	334 (69.87)	349 (66.99)	0.33
Nonwhite	316 (31.63)	144 (30.13)	172 (33.01)	
Insurance				
Medicare only	374 (37.44)	153 (32.01)	221 (42.42)	<0.0001
Medicaid only	128 (12.81)	68 (14.23)	60 (11.52)	
Any private	298 (29.83)	184 (38.49)	114 (21.88)	
Medicare and Medicaid	199 (19.92)	73 (15.27)	126 (24.18)	
Comorbidity index				
0	661 (66.17)	331 (69.25)	330 (63.34)	0.01
1	198 (19.82)	90 (18.83)	108 (20.73)	
2+	140 (14.01)	57 (11.92)	83 (15.93)	
Residence location				
Urban	633 (63.36)	309 (64.64)	324 (62.19)	0.43
Rural	366 (36.64)	169 (35.36)	197 (37.81)	
<b>Tumor characteristics</b>				
AJCC stage at diagnosis				
I	572 (57.26)	244 (51.05)	328 (62.96)	0.01
II	176 (17.62)	97 (20.29)	79 (15.16)	
III	227 (22.72)	127 (26.57)	100 (19.19)	
IV	24 (2.40)	aa	14 (2.69)	
Histology				
Squamous	688 (68.87)	331 (69.25)	357 (68.52)	0.24
Adenocarcinoma	212 (21.22)	107 (22.38)	105 (20.15)	
Unknown	99 (9.91)	40 (8.37)	59 (11.32)	
Tumor grade				
Well differentiated	123 (12.31)	56 (11.72)	67 (12.86)	0.39
Moderately differentiated	289 (28.93)	144 (30.13)	145 (27.83)	
Poorly differentiated	319 (31.93)	160 (33.47)	159 (30.52)	
Unknown/anaplastic	268 (26.83)	118 (24.69)	150 (28.79)	
<b>County characteristics</b>				
Median household income	\$40487 (7434)	\$40994 (7775)	\$40120 (7162)	0.07
Mean % unemployed	5 (1.27)	5 (1.24)	6 (1.30)	0.16
Mean number of generalists	8 (9.11)	7 (8.68)	8 (9.50)	0.31

NOTE: GC, guideline-concordant; AJCC, American Joint Committee on Cancer.  
<sup>a</sup>Indicates cell values less than 11 and is suppressed to protect patients' confidentiality.

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**Table 2.** Risk ratios from multivariate models for receiving treatment within 6 weeks of diagnosis among insured cervical cancer patients and stratified by urban/rural status

	Full sample RR (95% CI)	P	Rural RR (95% CI)	P	Urban RR (95% CI)	P
Age at diagnosis						
<60	1.00 (ref.)		1.00 (ref.)		1.00 (ref.)	
60–70	0.88 (0.70–1.09)	0.24	0.98 (0.68–1.41)	0.91	0.83 (0.63–1.10)	0.19
>70	0.64 (0.48–0.85)	<0.001	0.64 (0.40–1.00)	0.05	0.58 (0.40–0.85)	<0.001
Race						
White	1.00 (ref.)		1.00 (ref.)		1.00 (ref.)	
Nonwhite	0.96 (0.81–1.13)	0.60	0.95 (0.71–1.25)	0.70	0.99 (0.80–1.21)	0.90
Insurance at diagnosis						
Medicare only	1.00 (ref.)		1.00 (ref.)		1.00 (ref.)	
Medicaid only	1.12 (0.83–1.50)	0.46	1.09 (0.67–1.78)	0.74	1.19 (0.82–1.72)	0.35
Any private	1.47 (1.14–1.89)	<0.001	1.33 (0.88–2.01)	0.17	1.66 (1.21–2.28)	<0.001
Medicare and Medicaid	0.93 (0.72–1.21)	0.59	1.02 (0.69–1.50)	0.92	0.83 (0.58–1.18)	0.30
Comorbidity index						
0	1.00 (ref.)		1.00 (ref.)		1.00 (ref.)	
1	1.22 (1.01–1.49)	0.04	1.13 (0.83–1.53)	0.43	1.23 (0.96–1.57)	0.10
2+	1.06 (0.80–1.39)	0.69	0.79 (0.51–1.23)	0.30	1.15 (0.82–1.62)	0.42
Residence location						
Urban	1.00 (ref.)		–		–	
Rural	1.06 (0.89–1.27)	0.52	–		–	
Distance to care						
<5 miles	1.00 (ref.)		1.00 (ref.)		1.00 (ref.)	
5–<15 miles	1.01 (0.86–1.19)	0.90	1.10 (0.77–1.59)	0.60	0.93 (0.77–1.13)	0.46
≥15 miles	0.78 (0.64–0.95)	0.01	0.73 (0.51–1.04)	0.08	0.72 (0.54–0.95)	0.02

NOTE: Models also included diagnosis year, stage of diagnosis, and county-level characteristics (median household income, % unemployed, number of generalists).

resided in counties with lower median household incomes (Supplementary Table S1). No differences were found between those who did and did not complete CCRT in 56 days by race, comorbidity, urban/rural residence, or tumor characteristics.

In multivariable analyses among patients with stage IA–IVA cervical cancer, living ≥15 miles from the nearest treatment center was associated with a lower likelihood of initiating guideline-concordant care within 6 weeks of diagnosis (RR: 0.78; 95% CI, 0.64–0.95; Table 2). In analyses stratified by rural/urban residence, urban patients living ≥15 miles from nearest treatment facility had a lower likelihood of initiating treatment within 6 weeks of diagnosis compared with those living <5 miles from the nearest facility (RR: 0.72; 95% CI, 0.54–0.95). In contrast, among rural residents, distance from the nearest treatment center was not associated with initiation of treatment within 6 weeks.

Across the full and urban/rural stratified samples, being older than 70 years was associated with a lower likelihood of initiating timely guideline-concordant treatment compared to patients younger than 60 years (full sample RR: 0.64; 95% CI, 0.48–0.85; rural RR: 0.64; 95% CI, 0.40–1.00; urban RR: 0.58; 95% CI, 0.40–0.85). Urban residents with private insurance were more likely to initiate care within 6 weeks compared with urban residents enrolled only in Medicare (RR: 1.66; 95% CI, 1.21–2.28). Rural patients diagnosed with stage II cervical cancer were more likely to receive care within 6 weeks compared with rural patients with stage I cervical cancer (RR: 1.75; 95% CI, 1.32–2.33). Results were similar when the outcome indicated receipt of care within 8 weeks of diagnosis (Supplementary Table S2).

Among women with stage IB2–IVA cervical cancer, living 5 to <15 miles from the nearest radiotherapy facility was significantly associated with completing CCRT in 56 days compared with patients residing <5 miles from the closest radiotherapy facility (RR: 1.42; 95% CI, 1.02–1.98; Table 3). These findings became more pronounced among rural residents; specifically, compared

with rural patients living within 5 miles of a radiotherapy facility, those living 5 to <15 miles (RR: 2.43; 95% CI, 1.10–5.35) or ≥15 miles (RR: 2.49; 95% CI, 1.12–5.51) were more likely to complete CCRT. In contrast, among urban residents, distance to radiotherapy facility did not influence timely completion of CCRT; however, urban residents >70 years old were less likely to complete CCRT in 56 days (RR: 0.55; 95% CI, 0.34–0.90) compared with those <60 years old. Among rural residents, those between 60 and 70 years old (RR: 0.54; 95% CI, 0.34–0.84) and >70 years old (RR: 0.32; 95% CI, 0.18–0.54) had a lower likelihood of completing CCRT in 56 days.

## Discussion

Distance to care is one measure of an individual's access to guideline-concordant cancer treatment. We examined the influence of distance on the timely initiation and completion of treatment in women with cervical cancer. Less than half of this population-based cohort of patients with cervical cancer received timely guideline-concordant care, indicating significant quality concerns. The influence of distance on timely treatment varied between urban and rural residents. Interestingly, in urban areas, living further away from care was associated with being less likely to initiate timely guideline concordant treatment. Women with stage IB2–IVA cervical cancer living in rural areas residing farther from care were "more" likely to complete CCRT in a timely manner. However, distance was not associated with timely completion of CCRT among these patients in urban areas.

Geographic access is only one of myriad factors that influence access to cancer care (20, 21). Our findings suggest that factors other than distance may present greater access barriers to care for rural women. We find that rural, elderly patients were less likely to receive timely care, a population that is already at risk of receiving guideline-discordant care and generally benefits less from

**Table 3.** Risk ratios from multivariate models for completing CCRT within 56 days among stage IB2-IVA insured cervical cancer patients and stratified by urban/rural status

	Full sample RR (95% CI)	P	Rural RR (95% CI)	P	Urban RR (95% CI)	P
Age at diagnosis						
<60	1.00 (ref.)	–	1.00 (ref.)	–	1.00 (ref.)	
60–70	0.61 (0.43–0.85)	0.00	0.54 (0.34–0.84)	0.01	0.65 (0.41–1.03)	0.07
>70	0.44 (0.30–0.63)	0.00	0.32 (0.18–0.54)	0.00	0.55 (0.34–0.90)	0.02
Race						
White	1.00 (ref.)		1.00 (ref.)		1.00 (ref.)	
Nonwhite	1.09 (0.85–1.39)	0.50	0.95 (0.63–1.46)	0.83	1.27 (0.92–1.77)	0.15
Insurance at diagnosis						
Medicare only	1.00 (ref.)		1.00 (ref.)		1.00 (ref.)	
Medicaid only	0.86 (0.58–1.28)	0.45	0.61 (0.33–1.14)	0.12	1.13 (0.66–1.93)	0.65
Any private	0.82 (0.57–1.19)	0.30	0.69 (0.44–1.09)	0.11	1.00 (0.59–1.69)	0.99
Medicare and Medicaid	0.87 (0.62–1.22)	0.41	0.90 (0.55–1.48)	0.68	0.83 (0.52–1.32)	0.43
Comorbidity index						
0	1.00 (ref.)		1.00 (ref.)		1.00 (ref.)	
1	1.10 (0.83–1.47)	0.50	0.78 (0.44–1.39)	0.40	1.41 (0.99–2.00)	0.06
2+	0.88 (0.61–1.27)	0.50	0.67 (0.36–1.23)	0.19	1.22 (0.75–1.97)	0.43
Residence location						
Urban	1.00 (ref.)		–		–	
Rural	1.10 (0.82–1.46)	0.52	–		–	
Distance to care						
>5 miles	1.00 (ref.)		1.00 (ref.)		1.00 (ref.)	–
5–<15 miles	1.42 (1.02–1.98)	0.04	2.43 (1.10–5.35)	0.03	1.17 (0.80–1.69)	0.42
≥15 miles	1.35 (0.94–1.93)	0.10	2.49 (1.12–5.51)	0.02	0.99 (0.63–1.57)	0.97

NOTE: Models also included diagnosis year, stage of diagnosis, and county-level characteristics (median household income, % unemployed, number of generalists).

advances in cancer treatment (22, 23). We speculate this may be due to the additional burden of traveling out of town to access specialty care and the high cost of health care services (24). Interventions such as telemedicine may be able to address these barriers. A recent study among complex cancer cases showed that telecommunication visits with a surgical oncologist reduced patient travel by 80% and decreased travel-related costs on average by \$525 per patient (25). Vulnerable cancer populations such as the elderly may require more intensive outreach, support, and resources to help ensure timely treatment, even among those living closer to treatment. Further evidence is needed to determine precisely what factors contribute to disparities in care for this population to ensure interventions are meaningful and effective (26).

Interestingly, among urban and rural women with stage IB2–IVA cervical cancer, distance did not appear to be a barrier to timely completion of CCRT. We suspect this is occurring for two reasons. First, rural patients may be more accustomed to traveling further distances (27) and are also more likely to rely on private transportation to access health care services (28). Subsequently, rural patients in the most remote (i.e., farthest distances from care) areas are potentially the most willing to drive further to receive cancer treatments because they already do so to access other goods and services. Second, rural patients who live far from treatment centers and urban patients who lack access to private transportation or face daily, heavy driving congestion may utilize temporary housing in close proximity to their radiation treatment center. For example, health-related organizations such as the American Cancer Society will provide cancer patients with discounted or free extended-stay housing through programs such as the Hope Lodge. However, these patients may still face significant barriers to treatment. Living in temporary accommodations while undergoing treatment or having to travel long distances to receive treatment may lead to additional financial stress for cancer

patients (29). This financial toxicity from cancer-related costs negatively affects both survival and quality of life (30, 31). Future research should identify and examine the added financial concerns encountered by these patients, and whether these challenges influence patients' health outcomes.

This study has several limitations. First, our ability to detect relationships between certain factors and outcomes was limited by our relatively small sample size. For example, while we did not find evidence of white versus nonwhite disparities, we had too few individuals within specific minority groups to allow for a more detailed examination of racial/ethnic disparities; this should be explored in future research with greater representation of these patients. Second, we used the straight-line method instead of road distance or travel time to measure distance. Nonetheless, this method has been shown to be an acceptable proxy for evaluating distance (32). Third, both analytic cohorts only include insured patients. Thus, we cannot generalize to the uninsured cancer population who often encounter the greatest challenges overcoming access barriers to care. Finally, our findings may not be generalizable outside North Carolina.

Cervical cancer patients persistently suffer from delayed initiation and completion of guideline-concordant care, potentially due to these patients often being of low socioeconomic status and minority backgrounds. Consequently, this cancer population would greatly benefit from targeted access to care interventions. This study is novel in that it examines how distance and urban/rural location influences both the initiation and completion of treatment in a population based-sample of cervical cancer patients and highlights sometimes paradoxical relationships between geographic access and timeliness of cancer treatment in rural versus urban populations. This is a critical step for developing effective interventions since, as our findings illustrate, urban and rural cancer patients face different barriers to initiating and completing treatment. Our findings imply that interventions

that reduce travel such as telemedicine should be targeted at older patients, particularly those in rural areas, while interventions that make transportation more accessible and reliable may be most effective among urban residents. However, pinpointing the diverse and particular barriers encountered during treatment will most likely require the use of qualitative research methods, potentially in the form of interviews or focus groups, among rural and urban patients with cancer (33, 34). Recognizing the importance of urban/rural differences in the context of significant variation in treatment timing may help policymakers, clinicians, and other stakeholders to better identify and treat women at risk for suboptimal care and reduce observed outcome disparities.

### Disclosure of Potential Conflicts of Interest

S.B. Wheeler reports receiving commercial research funding from Pfizer. No potential conflicts of interest were disclosed by the other authors.

### Authors' Contributions

**Conception and design:** L.P. Spees, W.R. Brewster, M.A. Varia, M. Weinberger, C. Baggett, S.B. Wheeler

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### References

- Smith GL, Jiang J, Giordano SH, Meyer LA, Eifel PJ. Trends in the quality of treatment for patients with intact cervical cancer in the United States, 1999 through 2011. *Int J Radiat Oncol Biol Phys* 2015;92:260–7.
- Hamilton AS, Fleming ST, Wang D, Goodman M, Wu XC, Owen JB, et al. Clinical and demographic factors associated with receipt of non guideline-concordant initial therapy for nonmetastatic prostate cancer. *Am J Clin Oncol* 2016;39:55–63.
- Wu XC, Lund MJ, Kimmick GG, Richardson LC, Sabatino SA, Chen VW, et al. Influence of race, insurance, socioeconomic status, and hospital type on receipt of guideline-concordant adjuvant systemic therapy for locoregional breast cancers. *J Clin Oncol* 2012;30:142–50.
- Singh GK. Rural-urban trends and patterns in cervical cancer mortality, incidence, stage, and survival in the United States, 1950–2008. *J Community Health* 2012;37:217–223.
- Singh GK, Miller BA, Hankey BF, Edwards BK. Persistent area socioeconomic disparities in US incidence of cervical cancer, mortality, stage, and survival, 1975–2000. *Cancer* 2004;101:1051–7.
- Freeman HP, Wingrove BK. Excess cervical cancer mortality: a marker for low access to health care in poor communities. National Cancer Institute, 2005. <https://www.cancer.gov/about-nci/organization/crhd/about-health-disparities/resources/excess-cervical-cancer-mortality.pdf>. Accessed May 6, 2018.
- Ramondetta LM, Sun C, Hollier L, Jarrett L, Folloder J, Tortolero-Luna G, et al. Advanced cervical cancer treatment in Harris county: pilot evaluation of factors that prevent optimal therapy. *Gynecol Oncol* 2006;103:547–53.
- Simard EP, Fedewa S, Ma J, Siegel R, Jemal A. Widening socioeconomic disparities in cervical cancer mortality among women in 26 states, 1993–2007. *Cancer* 2012;118:5110–6.
- Yabroff KR, Lawrence WF, King JC, Mangan P, Washington KS, Yi B, et al. Geographic disparities in cervical cancer mortality: what are the roles of risk factor prevalence, screening, and use of recommended treatment? *J Rural Health* 2005;21:149–57.
- Meilleur A, Subramanian SV, Plascak JJ, Fisher JL, Paskett ED, Issamont EB. Rural residence and cancer outcomes in the United States: lessons and challenges. *Cancer Epidemiol Biomarkers Prev* 2013;22:1657–67.
- Wheeler SB, Kuo T, Durham D, Frizzelle B, Reeder-Hayes K, Meyer AM. Effects of distance to care and rural or urban residence on receipt of radiation therapy among North Carolina Medicare enrollees with breast cancer. *NC Med J* 2014;75:239–46.
- Mollica MA, Weaver KE, McNeel TS, Kent KE. Examining urban and rural differences in perceived timeliness of care among cancer patients: a SEER-CAHPS study. *Cancer* 2018;124:3257–65.
- Song S, Rudra S, Hasselle MD, Dorn PL, Mell LK, Mundt AJ, et al. The effect of treatment time in locally advanced cervical cancer in the era of concurrent chemoradiotherapy. *Cancer* 2013;119:325–31.
- Viswanathan A, Thomadsen B. American Brachytherapy Society Cervical Cancer Brachytherapy Task Group [cited 2018 Jul 11]. [https://www.americanbrachytherapy.org/ABS/document-server/?cfp=ABS/assets/file/public/guidelines/cervical\\_cancer\\_taskgroup.pdf](https://www.americanbrachytherapy.org/ABS/document-server/?cfp=ABS/assets/file/public/guidelines/cervical_cancer_taskgroup.pdf).
- DiSilvestro PA, Ali S, Craighead PS, Lucci JA, Lee YC, Cohn DE, et al. Phase III randomized trial of weekly cisplatin and irradiation versus cisplatin and tirapazamine and irradiation in stages IB2, IIA, IIB, IIIB, and IVA cervical carcinoma limited to the pelvis: a Gynecologic Oncology Group study. *J Clin Oncol* 2014;32:458–64.
- Strohl AE, Feinglass JM, Shahabi S, Simon MA. Surgical wait time: a new health indicator in women with endometrial cancer. *Gynecol Oncol* 2016;141:511–5.
- Goldberg DW. A geocoding best practices guide. Springfield, IL: North American Association of Central Cancer Registries; 2008 [cited 2017 Feb 1]. [https://20tqx36s1la18rvn82wcmnpn-wpengine.netdna-ssl.com/wp-content/uploads/2016/11/Geocoding\\_Best\\_Practices.pdf](https://20tqx36s1la18rvn82wcmnpn-wpengine.netdna-ssl.com/wp-content/uploads/2016/11/Geocoding_Best_Practices.pdf).
- Wheeler SB, Kuo T, Goyal R, Meyer AM, Hassmiller Lich K, Gillen EM, et al. Regional variation in colorectal cancer testing and geographic availability of care in a public insured population. *Health Place* 2014;29:114–23.
- Shalowitz D, Epstein AJ, Buckingham L, Ko EM, Giuntoli RL 2nd. Survival implications of time to surgical treatment of endometrial cancers. *Am J Obstet Gynecol* 2017;216:268.e1–268.e18.
- Zapka J, Taplin SH, Price RA, Cranos C, Yabroff R. Factors in quality care—the case of follow-up to abnormal cancer screening tests—problems in the steps and interfaces of care. *J Natl Cancer Inst Monogr* 2010;2010:58–71.
- Zapka JG, Taplin SH, Solberg LI, Manos MM. A framework for improving the quality of cancer care: the case of breast and cervical cancer screening. *Cancer Epidemiol Biomarkers Prev* 2003;12:4–13.
- Sharma C, Deutsch I, Horowitz DP, Hershman DL, Lewin SN, Lu YS, et al. Patterns of care and treatment outcomes for elderly women with cervical cancer. *Cancer* 2012;118:3618–26.

23. Zeng C, Wen W, Morgans AK, Pao W, Shu XO, Zheng W. Disparities by race, age, and sex in the improvement of survival for major cancers: Results from the National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) program in the United States, 1990 to 2010. *JAMA Oncol* 2015;1: 88–96.
24. Goins RT, Williams KA, Carter MW, Spencer M, Solovieva T. Perceived barriers to health care access among rural older adults: a qualitative study. *J Rural Health* 2005;21:206–13.
25. Jue JS, Spector SA, Spector SA. Telemedicine broadening access to care to complex cases. *J Surg Res* 2017;220:164–70.
26. Subramanian SV, Jones K, Kaddour A, Krieger N. Revisiting Robinson: the perils of individualistic and ecologic fallacy. *Int J Epidemiol* 2009;38: 342–60. (author reply 370–3).
27. Probst JC, Ladtika SB, Wang J, Johnson AO. Effects of residence and race on burden of travel for care: cross sectional analysis of the 2001 US National Household Travel Survey. *BMC Health Serv Res* 2007;7:40.
28. Arcury TA, Preisser JS, Gesler WM, Powers JM. Access to transportation and health care utilization in a rural region. *J Rural Health* 2005;21:31–8.
29. Martin-McDonald K, Rogers-Clark C, Hegney D, McCarthy A, Pearce S. Experiences of regional and rural people with cancer being treated with radiotherapy in a metropolitan centre. *Int J Nurs Pract* 2003;9:176–82.
30. Ramsey SD, Bansal A, Fedorenko CR, Blough DK, Overstreet KA, Shankaran V, et al. Financial insolvency as a risk factor for early mortality among patients with cancer. *J Clin Oncol* 2016;34:980–6.
31. Zafar SY, McNeil RB, Thomas CM, Lathan CS, Ayanian JZ, Provenzale D. Population-based assessment of cancer survivors' financial burden and quality of life: a prospective cohort study. *J Oncol Pract* 2015;11:145–50.
32. Fortney J, Rost K, Warren J. Comparing alternative methods of measuring geographic access to health services. *Health Serv Outcomes Res Methodol* 2000;1:173–84.
33. Miedema B, Easley JK, Robinson LM. Comparing urban and rural young adult cancer survivors' experiences: a qualitative study. *Rural Remote Health* 2013;13:2324.
34. Wittrock S, Ono S, Stewart K, Reisinger HS, Charlton M. Unclaimed health care benefits: a mixed-method analysis of rural veterans. *J Rural Health* 2015;31:35–46.