RESEARCH

Cervical cancer outcome by type of health care facilities: National Cancer Database, 2004-2015

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ABSTRACT

The National Cancer Database from 2004 to 2015 was analyzed to identify cervical cancer outcomes associated with demographic and clinical characteristics measured by types of facility. Chi-Square tests were used to compare proportions and logistic regression to determine factors associated with cervical cancer outcomes. Women treated at Academic/Research Programs (ARPs) were younger at diagnosis, more likely black, less educated and more in Stage 2, lived further away from treatment facilities, had less comorbidities and better 5- year survival, and were more likely to be alive at 30 and 90 days after surgery compared to other programs. Women treated at Community Cancer Programs were more likely 75 and older at diagnosis, more likely to receive radiation treatment and more in Stage 4, more living in rural areas and less than 10 miles from the facility, and had more comorbidities, and lower 5-year survival compared to other programs. Women treated at Comprehensive Community Cancer Programs were more likely white and educated, had more private insurance, and underwent surgery. Women treated at Integrated Network Cancer Programs were more likely to live in urban, south region, and in Stage 1B2, had more surgery and one comorbidity, and died fewer than 30 days after surgery. The type of facility and treatment had varied effects on mortality and 5-year survival. Considering the different cervical cancer outcomes from different health care facilities, further research is needed to identify what factors influence women to choose a health care facility for their treatment and how this choice can affect different health outcomes.

KEYWORDS: Cervical cancer, type of facility, mortality, survival

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Introduction

Cervical cancer is the most common type of gynecological cancer but one of the most preventable and treatable cancers (Fedewa et al., 2012; Ferlay et al., 2015). In the United States, cervical cancer incidence and mortality rates continue to decline since regular cervical cancer screening tests and vaccination were introduced (Akinlotan et al., 2017; CDC, 2018; Scarinci et al., 2010.).

Several studies have investigated risk factors associated with higher cervical cancer incidence and mortality. For example, being black (Arvizo and Mahdi, 2017; Beavis et al., 2017; Furlow, 2018; Powell et al., 2018 ; Scarinci et al., 2010. ; Singh and Jemal, 2017; Weragoda et al., 2016 ; Yoo et al., 2017), getting older (Fedewa et al., 2012; Furlow, 2018; Yosta and Hoekstra, 2018), living in The South (Yoo et al., 2017), less income (Singh and Jemal, 2017), less education (Singh and Jemal, 2017), having comorbidity (Diaz et al., 2018), stages of cancer (Acharya and Grigsby, 2016; Landy et al., 2016), insurance (Acharya and Grigsby, 2016; Churilla et al., 2016 ; Davis et al., 2018; Fedewa et al., 2012) and distance (Barrington et al., 2016) have been reported as risk factors responsible for the incidence and mortality of cervical cancer.

Identifying risk factors for cervical cancer is critical for developing proper prevention and treatment approaches connecting to risk factors, thus reducing racial disparities on the outcomes of cervical cancer, such as higher incidence and mortality rates, as well as lower five-year survival and overall survival among black women (American Cancer Society, 2018).

There were significant differences in the characteristics between white and black women with cervical cancer in the NCDB data. For example, black women were diagnosed with later-stage disease with more comorbidities than white women, which resulted in increased morbidity and mortality in black women. In addition, most black women had treatment in academic/research programs that were close to their residence and higher mortality rates among white women were identified in community cancer programs and Comprehensive Community Cancer Programs.

Considering significant racial disparities in healthcare outcomes, it is essential to understand the impact of the type of health care facility on health outcomes among cervical cancer patients. Several studies have been conducted on the relationship between outcomes in cervical cancer patients based on distance from hospitals (Barrington et al., 2016; Gunderson et al., 2013; Powell et al., 2018; Spees et al., 2018) and the impact of facility volume on quality treatment and survival (Ross et al., 2010; Showalter et al., 2016). In their study on racial disparities in outcomes after surgical procedures, Haider and associates (2013) reported systemic factors such as access to care, hospital volume, and hospital patient population have been shown to contribute to disparities (Haider et al., 2013). Study results report that high volume hospitals have more favorable outcomes than low volume hospitals.

Connecting to the choice of hospitals for treatment, it is also important to understand possible factors affecting the patient's choice of treatment options resulting in the subsequent oncologic outcome and causing significant disparities in survival among minority patients (Luo et al., 2015). For example, black patients and living in rural areas were associated with the choice of surgery to treat other cancers, resulting in less

surgery compared to white patients (Cykert et al., 2010; Steenland et al., 2011).

The purpose of this study was to investigate the impact of different health care facilities on types of treatments and cervical cancer outcomes using the National Cancer Database (NCDB) data. The research question was "How would different types of health care facilities influence the outcomes of patients with cervical cancer and their types of treatment?"

Materials and Methods

To assess cervical cancer outcomes by different facility types, cervical cancer data were drawn from the National Cancer Database (NCDB) for the years 2004 to 2015. NCDB is jointly sponsored by the American College of Surgeons and the American Cancer Society, and it is the largest clinical cancer registry in the world (Steenland et al., 2011). It covers more than 70% of newly diagnosed cancer cases in the United States (Lin et al., 2014).

Each facility reporting cases to the NCDB is assigned to a category classification, i.e., the facility type, by the Commission on Cancer Accreditation program. The NCDB classified all facilities into four types: Academic Cancer Programs, Community Cancer Programs, Comprehensive Community Cancer Programs, and Integrated Network Cancer Programs (Source: http://ncdbpuf.facs.org/content/participant-use-file-facility-type). Academic Comprehensive Cancer Program or Academic/Research programs (ARPs) participate in postgraduate medical education in at least four program areas, including internal medicine and general surgery. The facility accessions more than 500 newly diagnosed cancer cases each year, and offers the full range of diagnostic and treatment services either on-site or by referral. Community Cancer Programs (CCPs) accession more than 100 but fewer than 500 newly diagnosed cancer cases each year and provides a full range of diagnostic and treatment services, but referral for a portion of diagnosis or treatment may occur. Comprehensive Community Cancer Programs (CCCPs) accession 500 or more newly diagnosed cancer cases each year and provide a full range of diagnostic and treatment services either on-site or by referral. Integrated Network Cancer Programs (INCPs) own, operate, lease, or are part of a joint venture with multiple facilities providing integrated cancer care and offer comprehensive services. We used this classification to analyze demographic characteristics, disease status, treatment and cervical cancer outcomes by the type of facility.

For our data analysis, women younger than 40 years old were excluded from this study in addition to women other than white and black (Hispanic origin was not distinguished). Age was categorized into 5 groups: 40-49, 50-59, 60-69, 70-79, and 80+. Regional information was deduced from the location of the reporting facility (suppressed for cases aged 0-39).

There are 6 categories for insurance in NCDB: uninsured, private insurance/managed care, Medicaid, Medicare, other government, and unknown. We further separated the Medicare group into younger Medicare (< 65 years old) and older Medicare (≥ 65 years old) because of the difference in eligibility for these two groups. Cervical cancer stages were identified based on the T, N, and M elements as defined by the American Joint Committee on Cancer (AJCC). To analyze the association between disease status and facility types, "TNM Clin Stage Group" that identifies the anatomic extent of disease based on

the T, N, and M elements known prior to the start of any therapy was re-categorized into 5 groups:1A-1B1 (TNM Clin Stage Group=1,1A,1A1, 1A2,1B,1B1), 1B2 (TNM Clin Stage Group=1B2), 2 (TNM Clin Stage Group=2,2A,2A1,2A2,2B), 3 (TNM Clin Stage Group=3,3A,3B), and 4 (TNM Clin Stage Group=4,4A,4B).

Comorbidity was measured by Charlson score, which is a weighted score derived from the sum of the scores for each of the comorbid conditions listed in the Charlson Comorbidity Score Mapping Table.

Household income was categorized as quartiles based on equally proportioned income ranges among all US zip codes. Education was estimated by matching the zip code of the patient recorded at the time of diagnosis against files derived from the 2012 American Community Survey data, spanning years 2008-2012. This item provides a measure of the number of adults in the patient's zip code who did not graduate from high school, and is categorized as equally proportioned quartiles among all US zip codes.

Residence, which represents the area-based measure of rurality and urban influence, was estimated by matching the state and county FIPS code of the patient recorded at the time of diagnosis against 2013 files published by the United States Department of Agriculture Economic Research Service. Metro counties and urban counties (as defined in the 2014 NCDB Participant Use Data File (PUF) Data Dictionary) were combined together as "Urban", and compared with rural counties.

SAS version 9.4, a software package for statistical analysis, was used to compute descriptive statistics. Chi-Square tests were used to compare the differences in demographic characteristics, disease status (cervical cancer stage at diagnosis), treatment, and cervical cancer outcomes among programs. Multivariable analysis was performed using stepwise modeling for variables associated with the outcomes of cervical cancer including vital status and 5 year survival. Odds ratio with 95% confidence intervals were calculated.

Results

Table 1 presents the association between demographic information and facility types. About forty-four percent of women used ARPs, followed by CCCPs (37.4%), INCPs (11.4%), and CCPs (6.8%).

ARPs had more black women and younger women aged 40-59 years at diagnosis compared to CCPs and CCCPs, had less income and education (more women from the area who did not graduate from high school) compared to CCCPs and INCPs, more income compared to CCPs, more living far from hospitals, more uninsured, more lived in Midwest and Northeast compared to all other programs.

CCPs had more women aged 75 and older when diagnosed compared to ARPs and INCPs, income with $38,000-47,999, education with 13-20.9% who did not graduate from high school, more living in rural areas and less than 10 miles away from the facility compared to all other programs.

CCCPs had more white women compared to ARPs and INCPs, more women aged 65-74 years when diagnosed compared to ARPs, more education with less than 7% and with 7-12.9% who did not graduate from high school compared to ARPs and CCPs, more living in 21-50 miles away from the facility compared to all other programs, more private and other government insurance program

compared to ARPs and CCPs, and more living in West region compared to all other programs.

INCPs had more income with $48,000-$62,999 compared to ARPs and CCPs, and more living in urban, 11-20 miles from the facility and in South region compared to all other programs.

Table 1. The demographic information by facility types (NCDB, 2004-2015).

Demo \ Type of facility		Facility Type				Total N (%)
		ARPs	CCPs	CCCPs	INCPs	
Facility		35719(44.43)	5447(6.78)	30050(37.38)	9169(11.41)	80385
Race*	White	28096(78.66)	4670(85.74)	25911(86.23)	7328(79.92)	66005
	Black	7623(21.34)	777(14.26)	4139(13.77)	1841(20.08)	14380
Age*†	40-44	6489(18.17)	914(16.78)	5088(16.93)	1636(17.84)	14127
	45-49	6466(18.10)	883(16.21)	4937(16.43)	1567(17.09)	13853
	50-54	5690(15.93)	818(15.02)	4416(14.70)	1406(15.33)	12330
	55-59	4970(13.91)	699(12.83)	4016(13.36)	1262(13.76)	10947
	60-64	3956(11.08)	609(11.18)	3257(10.84)	1026(11.19)	8848
	65-69	2912(8.15)	472(8.67)	2779(9.25)	782(8.53)	6945
	70-74	2026(5.67)	354(6.50)	1987(6.61)	551(6.01)	4918
	75+	3210(8.99)	698(12.81)	3570(11.88)	939(10.24)	8417
Income*	<$38,000	9807(27.46)	1452(26.66)	6756(22.48)	2172(23.69)	20187
	$38,000-47,999	8356(23.39)	1669(30.64)	7961(26.49)	2245(24.48)	20231
	$48,000-62,999	8450(23.66)	1322(24.27)	7841(26.09)	2444(26.66)	20057
	>=$63,000	8733(24.45)	942(17.29)	7095(23.61)	2183(23.81)	18953
	Unknown	373(1.04)	62(1.14)	397(1.32)	125(1.36)	957
Education*††	<7%	5646(15.81)	606(11.13)	5236(17.42)	1561(17.02)	13049
	7-12.9%	9094(25.46)	1530(28.09)	9099(30.28)	2752(30.01)	22475
	13-20.9%	9928(27.79)	1709(31.38)	8763(29.16)	2761(30.11)	23161
	>=21%	10694(29.94)	1542(28.31)	6574(21.88)	1971(21.50)	20781
	Missing	357(1.00)	60(1.10)	378(1.26)	124(1.35)	919
Residence*	Urban	34135(95.57)	5125(94.09)	28463(94.72)	8819(96.18)	76542
	Rural	489(1.37)	195(3.58)	656(2.18)	61(0.67)	1401
	Missing	1095(3.07)	127(2.33)	931(3.10)	289(3.15)	2442
Distance*	<=10	15743(45.65)	3301(62.80)	14379(49.80)	4757(53.80)	38180
	11-20	5578(16.18)	981(18.66)	5250(18.18)	1702(19.25)	13511
	21-50	6742(19.55)	742(14.12)	5758(19.94)	1585(17.93)	14827
	>50	6421(18.62)	232(4.41)	3486(12.07)	798(9.03)	10937
Insurance*	Uninsured	3829(10.78)	424(7.83)	2113(7.06)	800(8.77)	7166
	Medicaid	7373(20.76)	1273(23.50)	4320(14.44)	1601(17.55)	14567
	Younger Medicare	1579(4.45)	312(5.76)	1343(4.49)	368(4.03)	3602
	Older Medicare	6039(17.00)	1265(23.35)	6815(22.79)	1863(20.42)	15982
	Private	14866(41.85)	1979(36.53)	14443(48.29)	4262(46.71)	35550
	Other	301(0.85)	41(0.76)	371(1.24)	109(1.19)	822

	Government					
	Missing	1536(4.32)	123(2.27)	504(1.69)	121(1.33)	2284
Region*	Midwest	9076(25.41)	1777(32.62)	6209(20.66)	1867(20.36)	18929
	Northeast	9083(25.43)	900(16.52)	4534(15.09)	873(9.52)	15390
	South	12833(35.93)	1928(35.40)	13429(44.69)	5421(59.12)	33611
	West	4727(13.23)	842(15.46)	5878(19.56)	1008(10.99)	12455

* P<.0001

† All women whose age were less than 40 years were missing in this facility analysis (26,927, 25.1%).

†† Education was measured using the number of adults in the patient's zip code who did not graduate from high school and is categorized as equally proportioned quartiles among all US zip codes.

TNM Clin Stage Group presented that ARPs had more women in Stage 2, CCPs in Stage 4, and INCPs in Stage 1B2 compared to all other programs. ARPs had more women with no comorbidity while INCPs had more women with 1 comorbidity compared to all other programs (Table 2).

Table 2. Disease status by facility types (NCDB, 2004-2015).

Disease status \ Type of facility		Facility Type				Total N (%)
		ARPs	CCPs	CCCPs	INCPs	
TNM Clin Stage Group*	1A-1B1	9357(32.92)	1293(30.71)	7702(33.67)	2324(33.71)	20676
	1B2	1516(5.33)	176(4.18)	1186(5.18)	405(5.87)	3283
	2	5806(20.42)	784(18.62)	4270(18.67)	1313(19.04)	12173
	3	6885(24.22)	989(23.49)	5456(23.85)	1692(24.54)	15022
	4	4862(17.10)	968(22.99)	4262(18.63)	1161(16.84)	11253
Comorbidity*	0	29874(84.61)	4507(83.66)	24861(83.59)	7434(82.19)	66676
	1	4521(12.81)	722(13.40)	4031(13.55)	1361(15.05)	10635
	2	911(2.58)	158(2.93)	849(2.85)	250(2.76)	2168

* P<.0001

The association between treatment types and race by the types of facility was analyzed. Black women had more surgery, radiation, and chemotherapy in ARPs compared to all other programs, while white women had more surgery and chemo in CCCPs compared to ARPs and INCPs and more radiation in CCPs compared to ARPs and INCPs.

Women who did not have surgery were about five times as likely to die of cervical cancer (Odds ratio 4.90, 95%CI: 4.74-5.06), while women who did not have radiation or chemotherapy were less likely to die of cervical cancer (Odds ratio 0.84, 95%CI: 0.81-0.87; Odd ratio 0.86, 95%CI:0.82-0.89) (data not shown).

INCPs had more women with surgery compared to all other programs.

Table 3. Treatment status by race and facility types (NCDB, 2004-2015).

Treatment	Type of facility	Facility Type				Total N (%)
		ARPs	CCPs	CCCPs	INCPs	
Surgery*	Yes		16432(46.10)	2293(42.40)	14818(49.51)	4682(51.22)
	White	13597(82.75)	2013(87.79)	13126(88.58)	3910(83.51)	32646
	Black	2835(17.25)	280(12.21)	1692(11.42)	772(16.49)	5579
	No	19210(53.90)	3115(57.60)	15113(50.49)	4459(48.78)	41897
Chemo*	Yes	22110(62.43)	3328(62.03)	18034(60.73)	5641(62.13)	49113
	White	17165(77.63)	2836(85.22)	15487(85.88)	4479(79.40)	39967
	Black	4945(22.37)	492(14.78)	2547(14.12)	1162(20.60)	9146
	No	13308(37.57)	2037(37.97)	11663(39.27)	3439(37.87)	30447
Radiation*	Yes	22470(63.31)	3425(63.50)	18547(62.26)	5612(61.51)	50054
	White	17409(77.48)	2940(85.84)	15832(85.36)	4453(79.35)	40634
	Black	5061(22.52)	485(14.16)	2715(14.64)	1159(20.65)	9420
	No	13024(36.69)	1969(36.50)	11242(37.74)	3511(38.49)	29746

* P<.0001

Five outcomes were analyzed to identify their association with facility types. ARPs had more women alive at 30 and 90 days after surgery compared to CCPs, while INCPs had more cases died less than 30 days after surgery compared to ARPs and CCCPs. CCPS had more cases that died fewer than 90 days after surgery, more cases with no surgery or alive cases that had fewer than 30 and 90 days of follow up and more deceased cases compared to all other programs.

CCCPs had more cases with no surgery or alive cases that had fewer than 30 days of follow up compared to all other programs.

Regarding the outcome of readmission within 30 days of surgical discharge, overall 94.6% was either no surgical procedure of the primary site was performed, or patient was not readmitted.

INCPs had more cases with unplanned readmission within 30 days of discharge compared to all other programs.

ARPs presented more five-year survival compared to CCPs and less comorbidity compared to INCPs, while CCPs had less five year survival compared to all other programs. Regarding the outcome of vital status (mortality), ARPs had more cases who were alive compared to CCPs and CCCPs, while CCPs had more cases who were deceased compared to all other programs (Table 4).

Table 4. Survival outcomes by facility types (NCDB, 2004-2015).

Outcomes	Type of facility	Facility Type				Total N (%)
		ARPs	CCPs	CCCPs	INCPs	
30 Day Mortality*	Alive at 30 days after surgery	14681(98.38)	1988(96.18)	13102(97.81)	4127(98.10)	33898
	Died < 30 days after surgery	56(0.38)	11(0.53)	56(0.42)	25(0.59)	148
	No surgery, or alive cases have < 30 days of follow up	186(1.25)	68(3.29)	237(1.77)	55(1.31)	546
90 Day Mortality*	Alive at 90 days after surgery	14461(96.90)	1949(94.29)	12902(96.32)	4052(96.32)	33364
	Died < 90 days after surgery	168(1.13)	34(1.64)	173(1.29)	62(1.47)	437
	No surgery, or alive cases have < 90 days of follow up	294(1.97)	84(4.06)	320(2.39)	93(2.21)	791

Readmission Within 30 Days of Surgical Discharge*	No surgical procedure	33713(94.38)	5111(93.83)	28519(94.91)	8675(94.61)	76018
	Unplanned readmission	690(1.93)	87(1.60)	454(1.51)	190(2.07)	1421
	Planned readmission	417(1.17)	66(1.21)	278(0.93)	102 (1.11)	863
	Planned and unplanned readmission	33(0.09)	2(0.04)	23 (0.08)	5(0.05)	63
	Unknown	866(2.42)	181(3.32)	776(2.58)	197(2.15)	2020
5 Year survival*	Yes	10895(33.27)	1471(29.53)	8918(32.49)	2684(32.28)	23968
	No	21855(66.73)	3511(70.47)	18531(67.51)	5630(67.72)	49527
Vital status (Mortality) *	Dead	12456(38.03)	2225(44.63)	11480(41.82)	3219(38.72)	29380
	Alive	20299(61.97)	2760(55.37)	15971(58.18)	5095(61.28)	44125

* P<.0001

Table 5 presents the result of multivariate logistic regression on vital status (mortality) and 5-year survival in cervical cancer. There were slight differences in predicting vital status and 5-year survival.

Black women, insurances other than private insurance, less income, more education, more comorbidity, more advanced stages, older women, treatment in CCPS and CCCPs, and not having surgery and chemo were more likely to die of cervical cancer compared to the reference groups.

Black women, insurances other than private insurance, more education, more comorbidity, more advanced stages, living far from facilities, older women, treatment in CCCPs and INCPs, and not having surgery and radiation were less likely to survive for five years compared to the reference groups.

Although distance in predicting vital status and income in predicting 5-year mortality were not significant from stepwise, we added them to the model to adjust confounding effects.

Table 5. Predictors of the outcomes of cervical cancer (NCDB, 2004-2015).

	Vital status (Mortality)		5 year survival	
	Adjusted Odds Ratio	95% confidence interval	Adjusted Odds Ratio	95% confidence interval
Race				
White	1.00	-	1.00	-
Black	1.10	1.04-1.16	0.94	0.89-0.99
Region				
South	1.00	-	1.00	-
Midwest	1.03	0.98-1.09	1.03	0.97-1.08
Northeast	0.94	0.88-1.00	1.01	0.95-1.07
West	0.94	0.89-1.01	1.10	1.04-1.17
Insurance				
Private	1.00	-	1.00	-
Uninsured	1.03	0.96-1.11	0.80	0.74-0.86
Medicaid	1.24	1.17-1.31	0.75	0.71-0.79
Younger Medicare	1.49	1.35-1.64	0.70	0.63-0.78
Older Medicare	1.54	1.40-1.70	0.84	0.75-0.93
Other Government	0.85	0.69-1.05	0.85	0.70-1.03
Missing	1.05	0.94-1.19	0.92	0.82-1.03

Income				
<$38,000	1.00	-	1.00	-
$38,000-47,999	0.90	0.84-0.95	1.03	0.97-1.09
$48,000-62,999	0.86	0.80-0.92	1.03	0.96-1.10
>=$63,000	0.78	0.72-0.84	1.05	0.96-1.13
Unknown	1.02	0.40-2.58	1.03	0.41-2.62
Education†				
>=21%	1.00	-	1.00	-
<7%	1.12	1.03-1.23	0.94	0.86-1.02
7-12.9%	1.16	1.08-1.24	0.93	0.87-0.99
13-20.9%	1.13	1.07-1.20	0.98	0.92-1.03
Missing	2.60	1.01-6.68	0.30	0.11-0.78
Comorbidity				
0	1.00	-	1.00	-
1	1.37	1.29-1.45	0.79	0.74-0.84
2	1.98	1.75-2.24	0.60	0.52-0.69
Stage				
1A-1B1	1.00	-	1.00	-
1B2	1.34	1.21-1.49	0.64	0.59-0.71
2	1.84	1.72-1.97	0.76	0.71-0.81
3	3.62	3.38-3.87	0.42	0.39-0.45
4	11.52	10.68-12.43	0.12	0.10-0.13
Distance(miles)				
<=10	1.00	-	1.00	-
11-20	0.99	0.94-1.05	0.94	0.89-0.99
21-50	1.00	0.95-1.06	0.91	0.86-0.96
>50	1.05	0.98-1.11	0.82	0.77-0.87
Age				
40-44	1.00	-	1.00	-
45-49	1.20	1.12-1.29	0.99	0.93-1.06
50-54	1.27	1.18-1.36	0.95	0.89-1.02
55-59	1.38	1.28-1.49	0.88	0.82-0.95
60-64	1.52	1.41-1.65	0.85	0.79-0.92
65-69	1.51	1.36-1.69	0.84	0.75-0.94
70-74	1.91	1.69-2.15	0.71	0.63-0.81
75+	3.53	3.15-3.96	0.46	0.40-0.51
Facility				
Academic/Research Program	1.00	-	1.00	-
Community Cancer Program	1.16	1.07-1.27	0.93	0.86-1.02
Comprehensive Community Cancer Program	1.19	1.14-1.25	0.94	0.90-0.99
Integrated Network Cancer Program	1.04	0.97-1.11	0.87	0.81-0.93
Surgery				
Yes	1.00	-	1.00	-
No	1.90	1.80-2.01	0.77	0.73-0.82
Radiation				
Yes	1.00	-	1.00	-

No	0.90	0.85-0.96	0.70	0.66-0.75
Chemo				
Yes	1.00	-	1.00	-
No	1.16	1.09-1.22	1.09	1.03-1.15

[†] Education was measured using the number of adults in the patient's zip code who did not graduate from high school and is categorized as equally proportioned quartiles among all US zip codes.

Discussion

To prevent and treat cervical cancer effectively, it is critical to understand risk factors and how they impact the disease. While assessing the differences in risk factors and outcomes of cervical cancer between races in our previous study, we found there were differences in using health care facilities between black and white women. Therefore, we further analyzed the NCDB data to identify differences in demographics, disease status, treatment status and health outcomes by facility type.

ARPs had more black women, women younger at diagnosis with less education, more living far from treatment facilities, more in Stage 2, less comorbidity and more 5-year survival, and more cases alive at 30 and 90 days after surgery compared to other programs. CCPs had more women aged 75 and older at diagnosis, living in rural areas and fewer than 10 miles from hospitals, more Stage 4 and comorbidity, less 5 year survival, and more radiation compared to other programs. CCCPs had more white women, more education and more private insurance, and more surgery. INCPs had more women living in urban and south region, more Stage 1B2 and more surgery, more 1 comorbidity, and more women who died less than 30 days after surgery.

Previous studies reported having treatment at high-volume hospitals was associated with lower mortality rates and better survival (Haider et al., 2013; Lin et al., 2014). However, when assessing the impact of the type and volume of facility on health care outcome, it is critical to consider patients' disease status. ARPs that would be classified as high volume centers presented better outcomes in being alive at 30 and 90 days after surgery, 5-year survival and, vital status, compared to CCPs that would be classified as low volume centers. However, it was noted that CCPs had more women diagnosed at Stage 4 while ARPs had more women diagnosed at Stage 2, so the result should be interpreted carefully.

It is also interesting that younger age groups had more treatment in ARPs while older age groups had more treatment in CCPs and CCCPs. That may explain the possible association with a better survival outcome in cervical cancer in ARPs, which is consistent with prior works (Fedewa et al., 2012; Furlow, 2018; Yosta and Hoekstra, 2018).

From multivariate analysis results, under-insured women were more likely to die of cervical cancer and, uninsured and under-insured women were less likely to survive for five years compared to privately insured women. It is interesting that the uninsured women were not more likely to die of cervical cancer compared to private patients. Although women without health insurance are less likely to receive cervical cancer treatment and survive (Acharya and Grigsby, 2016; Fedewa et al., 2012), our analysis shows over 53% of uninsured patients were treated in ARPs and had better health outcomes in 30 day and 90 day mortality

and vital status, which proves promising in developing cervical cancer centers that may improve healthcare access and provide a high quality of care to those with under- or no insurance.

However, when the population was stratified by race within ARPs, black women had more deaths less than 30 days and 90 days after surgery (respectively $p<.05$) and had more deaths (Vital status: $p<.0001$) compared to white women. Further analyses showed black women in ARPs were older, less income, more living in urban area and close to treatment facilities, more uninsured and underinsured, more advanced stages (Stage 3 & 4), more comorbidities, less surgery, and more chemo and radiation therapy compared to white women (data not shown). Considering the proportion of black women (21%) and still overall better outcomes for women with cervical cancer in ARPs, it addresses clear cervical cancer outcome disparities between black and white women (Arvizo and Mahdi, 2017; Dalton & Farley, 2017; Fleming and et al., 2014).

Therefore, it is needed to assess the effectiveness of cervical cancer treatment/programs according to the facility type, especially, to explore how to manage patients without insurance and with less income and how to reduce outcome disparities by targeting barriers identified.

As another interesting result, we found there was an interaction between education and income (Data not shown) that women from higher education areas had less survival, which is contradicting to previous study results (Franceschi et al., 2009; Singh and Jemal, 2017). This might be associated with the fact that education was measured using the number of adults in the patient's zip code who did not graduate from high school, not based on an individual's educational attainment.

Therefore, further study is necessary to investigate how the level of education and income are related to cervical cancer risk and mortality.

Our study has some limitations especially in assessing the outcomes of cervical cancer in each facility. We compared the association between cervical cancer outcomes and facility type based on responses from a large national sample of cancer patients, so our results should not be interpreted as actual evaluation of cervical cancer treatment in each facility classified by NCDB. Also, considering a disproportionate number of women treated at each facility, for example, 44.4% patients at ARPs compared with about 6.8% at CCPs, the generalizability of this study may be limited. More importantly, a significant number of patients had missing data on facility at each stage of their diagnosis (e.g., 34.99% did not have facility information in Stage 1A-1B1).

As another limitation, our analysis was limited by the variables collected in the NCDB. For example, there was no data to assess factors contributing to choosing a facility and treatment, so the reason for racial differences in using different facilities could not be explored.

Considering a complex situation that patients with cervical cancer may confront, it is imperative to understand what factors contribute to choosing their treatment option including health care facility. For example, possible reasons resulting from limited access to high-volume/quality hospitals, such as geographic location and under- or no insurance among minorities leading to outcome disparities, should be considered and reflected when developing cervical cancer centers and

programs (Beavis et al., 2017; Haider et al., 2013; Singh and Jemal, 2017).

Our study results include some contradicting outcomes, which may encourage further research on understanding treatment choices and outcomes better. This will help identify critical factors that make cancer care programs successful and effective.

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Conflict of interest

The authors declare that there are no conflicts of interest or financial disclosures.

Authors' contributions

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