



Association between health insurance coverage and stage of diagnosis for cervical cancer among females in Indiana from 2011 - 2019

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ABSTRACT

Introduction: Health insurance status is an important determinant of health outcomes for patients with cancer. This study aimed to assess the extent to which health insurance coverage in Indiana is a contributing factor to the stage of cervical cancer diagnosis.

Methods: We examined reported cervical cancer cases among females ($N = 2518$) using cancer registry data from the Indiana Department of Health from 2011 to 2019. Analyses were carried out in SPSS. Using multinomial logistic regression, we examined associations of both insurance status and race/ethnicity with stage of diagnosis after adjusting for age at diagnosis.

Results: The multinomial analysis showed that uninsured females (OR = 2.42, 95 % CI = 1.35–4.35) and those who have Medicaid (OR = 2.36, 95 % CI = 1.62–3.42) were significantly more likely to be diagnosed at the regional stage than the in-situ stage compared to females with private insurance. Additionally, Black (OR = 1.98, 95 % CI = 1.21–3.24) and Hispanic females (OR = 2.19, 95 % CI = 1.04–4.61) were significantly more likely to be diagnosed at the regional stage than the in-situ stage when compared to Non-Hispanic White females. Females who are uninsured (OR = 4.43, 95 % CI = 2.23–8.44) and those who have Medicaid (OR = 3.03, 95 % CI = 1.91–4.80) were significantly more likely to be diagnosed at the distant stage than in-situ, compared to females with private insurance.

Conclusion: Insurance status and race/ethnicity are associated with later stages of cervical cancer diagnosis. Increased coverage for routine cervical cancer screening and preventive care services is recommended, especially for racial/ethnic minority populations, the uninsured and those with public insurance.

1. Introduction

Cervical cancer is the second most common type of cancer among females in the U.S. and almost all cases are caused by infection with human papillomavirus (HPV) (Arbyn et al., 2011; Arbyn et al., 2020). HPV is a common sexually transmitted infection, and it has a high prevalence rate of 16.9 % among females younger than 25 years (Crosbie et al., 2013). Cervical Intraepithelial Neoplasia (CIN) is caused by undetected persistent HPV infection prevailing for more than 6–18 months (Crosbie et al., 2013). Development of cervical cancer (CIN-Grade 3) is observed after a period of 5–10 years of having persistent infection (Lei et al., 2020). Recurrent HPV infection through latent infection can be detected through routine screening and follow-up (Gravitt and Winer, 2017).

Screening for pre-invasive lesions reduces likelihood of cancer

progression and malignancy (Hariri et al., 2012; Saraiya et al., 2015). Females diagnosed at earlier stages of cervical cancer have a better chance of survival over time than those diagnosed at later stages (Wright et al., 2015). Follow-up after abnormal test results and treatment of preinvasive lesions is also necessary to reduce higher incidence rates (Yang et al., 2018; Watson et al., 2008). While various professional and academic organizations have differing recommendations for cervical cancer screening, the United States Preventive Services Task Force (USPSTF) recommendations during the study period (2011–2019) stated that screening was recommended for people who have a cervix and who have been sexually active between the ages of 21 to 65 years with cytology every three years or a combination of cytology and HPV testing every five years for ages 30 to 65 years. In 2018, the updated USPSTF recommendations stated that cervical cancer screening with cervical cytology alone is required every three years for females aged 21 to 29

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years. For females aged 30 to 65 years, three options are recommended: cytology every three years, high-risk HPV testing alone or in combination with cytology (co-testing) every five years (US Preventive Services Task Force et al., 2018).

Evidence shows that screening is successful in preventing cervical cancer mortality but racial, ethnic, and age-based disparities persist in cervical cancer screening and incidence rates (Benard et al., 2014; Sheppard et al., 2016). Previous studies have shown that Hispanic and African American females are less likely to be diagnosed with cervical cancer at a localized stage when compared to Non-Hispanic White females (Rauh-Hain et al., 2013; Yu et al., 2019). Cancer detection at a later stage can be partly attributed to lack of access to and utilization of preventive care and screening services by racial/ethnic minorities (Adams et al., 2009). Cancer incidence and mortality rates related to cervical cancer are higher among racial/ethnic minorities than in Non-Hispanic Whites (Siegel et al., 2011; Yoo et al., 2017). Factors such as education, health insurance, continuity of care and access to providers are associated with lower screening rates among the Hispanic and Black populations (Del Carmen and Avila-Wallace, 2013). Lack of knowledge of screening guidelines for HPV and cervical cancer is also associated with lower screening rates (Del Carmen and Avila-Wallace, 2013).

Health insurance status is an important determinant for health outcomes for cancer patients (Institute of Medicine, 2013). Prior studies demonstrate the association between uninsured patients and advanced stage of diagnosis (Halpern et al., 2008; Niu et al., 2013). Research also shows that insurance status is associated with ethnicity, with members of minority populations being more likely to be uninsured than the Non-Hispanic White population (Ward et al., 2010). Earlier studies have shown that females lacking health insurance coverage have a lower likelihood of receiving screening tests for cervical cancer, resulting in later stages of diagnosis (Riley et al., 1994).

The Centers for Disease Control and Prevention (CDC) launched the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) in 1990 to provide screening and other preventive care services to low income, uninsured females (CDPC, 2021). As a part of the NBCCEDP, the Breast and Cervical Cancer Program (BCCP) was established in Indiana, a midwestern US state, to provide free screening services for uninsured females in 1996 (Lee et al., 2014). But in Indiana, the incidence rate of cervical cancer is 8 per 100,000 females for the years 2012–2016, with 43 % of the cases being diagnosed among females between the ages of 45 to 64 years. African American females have the highest incidence and mortality rates for cervical cancer in the state (Indiana Cervical Cancer Strategic Plan, 2018). The incidence rates of cervical cancer have increased in Indiana from 2008 to 2012 to 2013–2017 but the mortality rate has remained constant (Indiana Cancer Consortium, 2021). The up-to-date cervical cancer screening rate among females between the ages of 21 to 65 years in Indiana was 76 % in 2020, compared to the national average of 78 % (Centers for Disease Control and Prevention, 2023). Given the low screening rates and lack of research on the impact of health insurance coverage in Indiana, the objective of this study was to explore the associations between insurance status, race/ethnicity, and stage of diagnosis among females diagnosed with cervical cancer in Indiana between 2011 and 2019 by utilizing data from the Indiana State Cancer Registry (ISCR). The ISCR records all cases of precancerous disease, malignant disease and tumors that are diagnosed or treated in Indiana. Through a state legislation, all healthcare providers who treat or diagnose cancer patients in Indiana are mandated to report confirmed cancer cases to the State Cancer registry. After identifying reportable cancer cases, the hospital retrieves all the medical information from the Electronic Medical Record and reports it to the State Cancer registry. The ISCR is not publicly available, and information is made available to researchers upon request.

The study hypothesis is that females with public insurance or no insurance coverage had a higher likelihood of being diagnosed at later stages of cervical cancer when compared to those with private insurance coverage in the state of Indiana, especially among minority, underserved

populations.

2. Materials and methods

2.1. Study design

This study involved the secondary analysis of ISCR data to assess cervical cancer disparities. This study was classified as “exempt” by the Purdue University Institutional Review Board (IRB-2021-998).

2.2. Study sample

This study utilized de-identified ISCR data from the Indiana Department of Health (IDOH) from the years 2011–2019. The IDOH shared a total of 2555 reported cases of cervical cancer during the study period. After excluding cases with missing values from the race/ethnicity variable ($n = 4$) and females from a racial/ethnic group other than Non-Hispanic White, Non-Hispanic Black, or Hispanic ($n = 33$), 2518 females between the ages of 11 to 96 were included in the study.

2.3. Measures

This sample included demographic information such as age, race/ethnicity (Non-Hispanic White, Black and Hispanic), Insurance status (Private, Medicare, Medicaid, Uninsured, Other-Unknown), county, date of first contact and last contact, poverty level and zip code. The poverty level was recoded from the reported county of the patient and classified into three groups – low (3.9 % to 14.5 %), moderate (14.6 % to 18.3 %) and high (18.4 % to 24.7 %) based on the Small Area Income and Poverty Estimates (SAIPE) program from the US Census Bureau (US Census Bureau, n.d.). The zip codes were recoded based on Rural-Urban Commuting Area (RUCA) codes from the US Department of Agriculture into metropolitan, micropolitan, small town and rural areas (US Department of Agriculture, n.d.).

Clinical information given in the dataset include stage of diagnosis (in-situ – disease with characteristics of malignancy and noninvasive to the neighboring tissues, localized – disease confined entirely to the cervix, regional – disease extending beyond the cervix and involving lymph nodes, and distant – disease spread to the remote parts of the body), primary site (C530-Endocervix, C531-Exocervix, C538-Overlapping lesion of cervix uteri, C539-Cervix uteri, not otherwise specified (NOS)), vital status (recorded at the date of last contact with the patient as alive or dead), cancer status (presence or absence of clinical evidence of tumor at the date of last contact is recorded as no evidence of tumor, evidence of tumor and unknown – indeterminate whether tumor is present), and histology (squamous cell carcinoma and adenocarcinoma).

2.4. Statistical analyses

Preliminary data analyses were carried out using descriptive statistics to assess frequencies and percentages of categorical variables, and chi-square tests to understand the relationship between stage of diagnosis and other categorical variables, and also to examine the association between race/ethnicity and insurance status. We analyzed stage at diagnosis – in-situ, localized, regional and distant - using multinomial logistic regression analyses to examine the associations of both race/ethnicity and insurance status after adjusting for age at diagnosis, SAIPE poverty level and RUCA codes of the sample population. The categorical covariates included in the analyses were recoded to group similar categories together. Cases with missing values were excluded listwise by SPSS and only complete cases scenarios were analyzed. Data analyses were carried out in SPSS version 26.

Data Availability Statement – The data analyzed in this study were obtained from the Indiana Department of Health (IDOH). Data requests can be submitted at <https://www.in.gov/health/cdpc/cancer/cancer-registry/>

3. Results

Of the analytic sample ($n = 2518$) the largest proportions were between 45 and 64 years of age (41.7 %), Non-Hispanic White (85.5 %), had private insurance coverage (41.8 %), had cervix uteri, NOS as the primary site of diagnosis (76.5 %), lived in a metropolitan area (74.5 %) and had squamous cell carcinoma (73.4 %).

In chi-square analyses, there were significant differences in stage of diagnosis by age ($p < 0.001$) and of those diagnosed in the in-situ and localized stages, the largest percentage were 30–44 years old (47.1 %

and 41.3 %, respectively), while in the regional and distant stages the largest percentages were 45–64 years old (46.3 % and 53.3 %, respectively). The results of the chi-square tests are given in Table 1.

Fig. 1 showed there were significant differences in stage of diagnosis by insurance status ($p < 0.001$). Of those with private insurance, the largest percentage were diagnosed in the earliest two stages (16.1 % had private insurance in the in-situ stage and 46.9 % had private insurance in the localized stage), while females with Medicare were diagnosed in the two latest stages (regional stage had 44.3 % and distant stage had 21.9 %, respectively).

Table 1

– Differences between stages of diagnosis for females diagnosed with cervical cancer in Indiana from 2011 to 2019 with the percentages reported by stage of diagnosis.

Variables	Total ($N = 2441$) n (%)	In-situ ($n = 367$) n (%)	Localized ($n = 923$) n (%)	Regional ($n = 832$) n (%)	Distant ($n = 319$) n (%)	P-value ^e
Age						<0.001
29 and younger	196 (8)	99 (27)	66 (7.2)	26 (3.1)	5 (1.6)	
30 to 44	858 (35.1)	173 (47.1)	381 (41.3)	246 (29.6)	58 (18.2)	
45 to 64	1018 (41.7)	89 (24.3)	374 (40.5)	385 (46.3)	170 (53.3)	
65 and older	369 (15.1)	6 (1.6)	102 (11.1)	175 (21)	86 (27)	
Race/Ethnicity						0.05
Non-Hispanic White	2087 (85.5)	330 (89.9)	791 (85.7)	689 (82.8)	277 (86.8)	
Black	249 (10.2)	27 (7.4)	91 (9.9)	104 (12.5)	27 (8.5)	
Hispanic	105 (4.3)	10 (2.7)	41 (4.4)	39 (4.7)	15 (4.7)	
Insurance status^d						<0.001
Private	1014 (41.8)	164 (44.8)	474 (51.5)	286 (34.7)	90 (28.3)	
Medicare	412 (17)	18 (4.9)	121 (13.2)	183 (22.2)	90 (28.3)	
Medicaid	479 (19.7)	60 (16.4)	156 (17)	193 (23.4)	70 (22)	
Uninsured	163 (6.7)	19 (5.2)	46 (5)	64 (7.8)	34 (10.7)	
Other-Unknown ^a	360 (14.8)	105 (28.7)	123 (13.4)	98 (11.9)	34 (10.7)	
Primary site						<0.001
C530 - Endocervix	436 (17.9)	74 (20.2)	200 (21.7)	125 (15)	37 (11.6)	
C531 - Exocervix	68 (2.8)	16 (4.4)	21 (2.3)	24 (2.9)	7 (2.2)	
C538 – Overlapping lesion of cervix uteri	70 (2.9)	4 (1.1)	21 (2.3)	31 (3.7)	14 (4.4)	
C539 – Cervix uteri, NOS	1867 (76.5)	273 (74.4)	681 (73.8)	652 (78.4)	261 (81.8)	
RUCA codes^b						0.03
Metropolitan	1818 (74.5)	301 (82)	693 (75.1)	596 (71.6)	228 (71.5)	
Micropolitan	381 (15.6)	39 (10.6)	139 (15.1)	147 (17.7)	56 (17.6)	
Small town	147 (6)	16 (4.4)	56 (6.1)	51 (6.1)	24 (7.5)	
Rural	95 (3.9)	11 (3)	35 (3.8)	38 (4.6)	11 (3.4)	
Histology^d						<0.001
Squamous Cell Carcinoma	1535 (73.4)	106 (49.1)	564 (66.7)	650 (85.3)	215 (80.2)	
Adenocarcinoma	557 (26.6)	110 (50.9)	282 (33.3)	112 (14.7)	53 (19.8)	
Vital status						<0.001
Alive	1695 (69.4)	357 (97.3)	817 (88.5)	457 (54.9)	64 (20.1)	
Dead	746 (30.6)	10 (2.7)	106 (11.5)	375 (45.1)	255 (79.9)	
SAIPE Poverty level^c						0.03
Low	1670 (68.4)	256 (69.8)	653 (70.7)	562 (67.5)	199 (62.4)	
Moderate	583 (23.9)	94 (25.6)	200 (21.7)	201 (24.2)	88 (27.6)	
High	188 (7.7)	17 (4.6)	70 (7.6)	69 (8.3)	32 (10)	
Cancer status						<0.001
No evidence of tumor	1351 (55.3)	288 (78.5)	708 (76.7)	328 (39.4)	27 (8.5)	
Evidence of tumor	885 (36.3)	45 (12.3)	145 (15.7)	416 (50)	279 (87.5)	
Unknown, indeterminate whether tumor is present	205 (8.4)	34 (9.3)	70 (7.6)	88 (10.6)	13 (4.1)	

^a Other-Unknown for insurance status constitutes Insurance – NOS- not otherwise specified ($n = 278$), TRICARE- Department of Defense program providing supplementary civilian-sector hospital and medical services beyond a military treatment facility to military dependents, retirees, and their dependents ($n = 11$), Military ($n = 3$), Veterans Affairs ($n = 2$), Indian/Public Health Service($n = 2$), and Insurance status unknown (101).

^b RUCA - Rural-Urban Commuting Area codes obtained from US Department of Agriculture.

^c SAIPE – Small Area Income and Poverty Estimates obtained from US Census Bureau.

^d Certain demographic variables might have missing values.

^e Statistical significance was determined using chi-square tests.

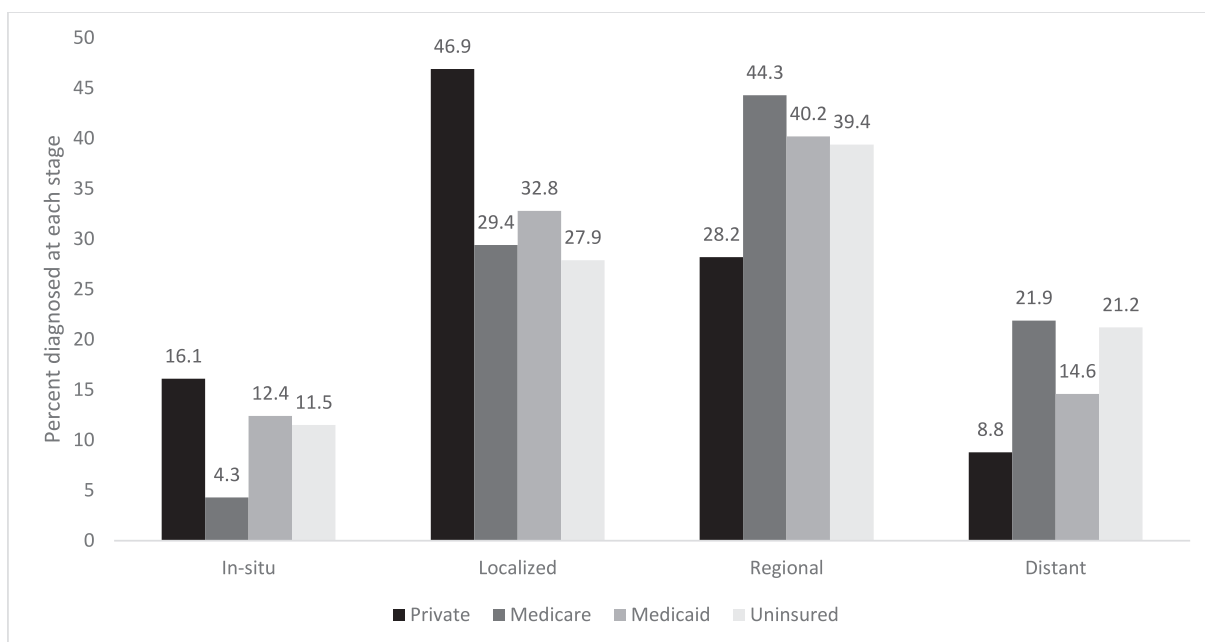


Fig. 1. – Differences in insurance status by stage of diagnosis for females diagnosed with cervical cancer in Indiana from 2011 to 2019 (percentages reported by insurance status).

In the chi-square analysis between race/ethnicity and stage of diagnosis (Fig. 2), there were no significant differences ($p = 0.05$) but among Non-Hispanic White females, the largest percentage was diagnosed in the in-situ stage (15.8 %), while Black females had the largest percentage in the regional stage (41.8 %) and Hispanic females had the largest percentages in the localized and distant stages (39.6 % and 14.2 %, respectively).

While there were significant differences in the chi-square analysis between race/ethnicity and insurance status ($p < 0.001$), the largest percentage of non-Hispanic White females had private insurance (50.9 %), while the largest percentage of Black females had Medicaid (39.3 %). Our chi-square analysis showed that 20.7 % of Hispanic females

were uninsured, compared to 7.7 % Non-Hispanic White and 3.6 % Black females (Fig. 3).

The multinomial logistic regression analysis shows that females in this sample were less likely to be diagnosed in the localized stage (vs in-situ) if they had other-unknown insurance status (OR = 0.42, 95 % CI = 0.30–0.59), compared to females with private insurance. Similarly, females in this sample were less likely to be diagnosed in the localized stage (vs in-situ) if they were living in a moderate poverty level county (OR = 0.53, 95 % CI = 0.29–0.97), compared to females living in a high poverty level county. Females in this sample were more likely to be diagnosed in the regional stage (vs. in situ) if they were uninsured (OR = 2.42, 95 % CI = 1.35–4.35) or had Medicaid (OR = 2.36, 95 % CI =

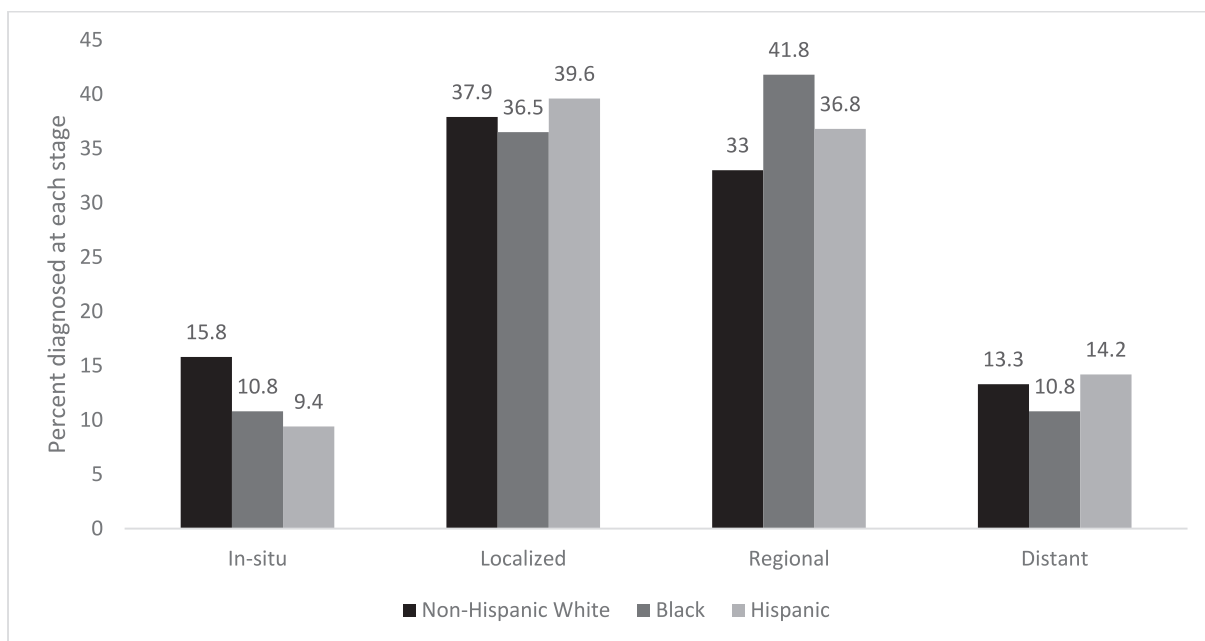


Fig. 2. – Differences between race/ethnicity by stage of diagnosis for females diagnosed with cervical cancer in Indiana from 2011 to 2019 (percentages reported by race/ethnicity).

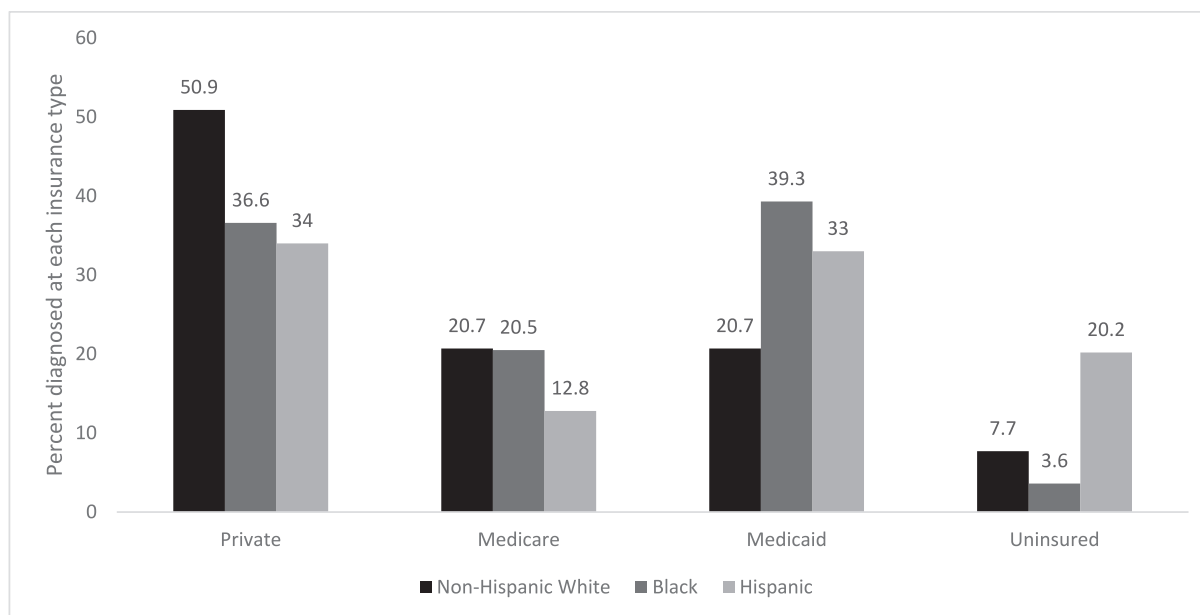


Fig. 3. – Differences between race/ethnicity by insurance status for females diagnosed with cervical cancer in Indiana from 2011 to 2019 (percentages reported by race/ethnicity).

1.62–3.42) and less likely to be diagnosed in the regional stage (vs. in-situ) if they had other-unknown insurance status (OR = 0.56, 95 % CI = 0.39–0.81), compared to females with private insurance. When compared to Non-Hispanic White females, Black (OR = 1.98, 95 % CI = 1.21–3.24) and Hispanic females (OR = 2.19, 95 % CI = 1.04–4.61) were significantly more likely to be diagnosed in the regional stage (vs. in-situ). In addition, females in this sample were significantly more likely to be diagnosed in the distant stage (vs. in situ) if they were uninsured (OR = 4.33, 95 % CI = 2.23–8.44) or had Medicaid (OR = 3.03, 95 % CI = 1.91–4.80), compared to those with private insurance. The results of the multinomial logistic regression analysis are given in [Table 2](#).

4. Discussion

This study aimed to assess the association between insurance status and race/ethnicity with stage of diagnosis for cervical cancer among females in Indiana from 2011 to 2019. The main findings show that insurance status is strongly associated with the stage of diagnosis for cervical cancer. Females with public insurance such as Medicaid or those who are uninsured, had higher odds of being diagnosed at a later stage. While our chi-square analyses showed that a higher proportion of Black and Hispanic females were either uninsured or had Medicaid, race/ethnicity was significantly associated with the regional stage of diagnosis for cervical cancer in the regression model while controlling for insurance status and age at diagnosis.

Previous studies have established similar associations between insurance status, race/ethnicity, and stage of diagnosis with cancer using national databases. Uninsured patients and patients with Medicaid were more likely to be diagnosed with late-stage cancer, when compared to patients with private insurance ([Halpern et al., 2008](#)). Another study found that health insurance had a mediating effect on the stage of diagnosis among racial/ethnic minorities, by reducing the risk of late-stage diagnosis ([Ko et al., 2020](#)).

Our study built upon existing research with a focus on cervical cancer cases reported in Indiana. Consequently, the Healthy People 2020 cervical cancer screening objective, to increase the proportion of females receiving a Pap smear within the past three years, fell short of its target of 93 % coverage ([Cancer | Healthy People, 2020](#)). During the COVID-19 pandemic, most cancer diagnostic and screening services

were scaled back ([Star et al., 2023](#)). Therefore, many of the cancer screening resources and personnel were reallocated to meet the pandemic response ([Puricelli Perin et al., 2021](#)). This led to disruptions in continuity of care, as preventive care services for cancer were classified as non-emergency medical procedures. From 2018 to 2021, the screening rates dropped from 80.5 % to 73.9 % ([Increase the proportion of females who get screened for cervical cancer — C-09 - Healthy People 2030, n.d.](#)). Studies from other countries have also shown that the number of patients diagnosed with cervical cancer was significantly reduced during the pandemic ([Qi et al., 2023](#)). Since the number of patients diagnosed with cervical cancer at the earlier stages decreased, the study forecasts show that there would be extra cases of patients diagnosed at the later stages in the coming years ([Davies et al., 2022](#)). Timely diagnosis and treatment of cervical cancer will reduce mortality rates and improve health outcomes for cervical cancer patients, especially for uninsured and Medicaid patients.

In Denmark, mass cervical cancer screening programs have helped decrease cervical cancer incidence rates by detecting cervical cancer precursors that can be easily treatable ([About the National Breast and Cervical Cancer Early Detection Program | CDC. Published September 15, 2023](#)). Similarly in the US, the implementation of universal health insurance coverage for cervical cancer screening in Massachusetts led to a 6 to 7 % increase relative to pre-reform screening rates in Pap tests ([Bchtawi et al., 2019](#)). Increased awareness and enrollment in free screening programs through the NBCCEDP, and improved outreach to at-risk populations in Indiana by the BCCP could greatly reduce late-stage diagnosis rates among uninsured females in Indiana. Addressing lack of coverage for treatment after cancer diagnosis through the BCCP program is a major deterrent for women to avail this screening program. While the Affordable Care Act does account for Medicaid expansion to cover preventive health care services such as cancer screenings, females face other barriers such as transportation and socio-economic status ([Sabik and Bradley, 2016](#); [Spada et al., 2021](#)). Other barriers such as education, age, and level of awareness contribute to the poor uptake of Pap smears, especially among rural women ([Pirani et al., 2023](#)).

While this study has numerous strengths, including comprehensive diagnostic information about reported cervical cancer cases from Indiana and analysis based on the different stages of diagnosis, results should be interpreted in the context of several limitations. First, it is limited in its scope because only age at diagnosis, SAIPE poverty level

Table 2
– Multinomial logistic regression model using in-situ as the reference group for females diagnosed with cervical cancer in Indiana from 2011 to 2019.

Summary stages	Covariates	Odds Ratio	95 % CI
Localized	Race/Ethnicity		
	Non-Hispanic White	1.00	
	Black	1.59	0.98–2.57
	Hispanic	1.99	0.96–4.09
	Insurance Status		
	Private insurance	1.00	
	Uninsured	0.98	0.54–1.75
	Medicaid	1.06	0.74–1.52
	Medicare	0.69	0.39–1.24
	Other-Unknown	0.42***	0.30–0.59
	RUCA Codes ^a		
	Rural	1.00	
	Small town	1.01	0.40–2.54
	Micropolitan	1.03	0.46–2.32
	Metropolitan	0.70	0.34–1.47
	SAIPE Poverty Level ^b		
High	1.00		
Moderate	0.53*	0.29–0.97	
Low	0.71	0.40–1.25	
Age at Diagnosis	1.07***	1.06–1.08	
Regional	Race/Ethnicity		
	Non-Hispanic White	1.00	
	Black	1.98**	1.21–3.24
	Hispanic	2.19*	1.04–4.61
	Insurance Status		
	Private insurance	1.00	
	Uninsured	2.42**	1.35–4.35
	Medicaid	2.36***	1.62–3.42
	Medicare	0.89	0.49–1.61
	Other-Unknown	0.56**	0.39–0.81
	RUCA Codes ^a		
	Rural	1.00	
	Small town	0.97	0.37–2.54
	Micropolitan	1.19	0.52–2.74
	Metropolitan	0.61	0.28–1.31
	SAIPE Poverty Level ^b		
High	1.00		
Moderate	0.57	0.30–1.07	
Low	0.68	0.38–1.23	
Age at diagnosis	1.10***	1.09–1.12	
Distant	Race/ethnicity		
	Non-Hispanic White	1.00	
	Black	1.10	0.59–2.04
	Hispanic	2.10	0.88–5.02
	Insurance Status		
	Private insurance	1.00	
	Uninsured	4.33***	2.23–8.44
	Medicaid	3.03***	1.91–4.80
	Medicare	0.88	0.45–1.70
	Other-Unknown	0.62	0.38–1.01
	RUCA Codes ^a		
	Rural	1.00	
	Small town	1.67	0.53–5.25
	Micropolitan	1.66	0.60–4.60
	Metropolitan	0.91	0.36–2.32
	SAIPE Poverty Level ^b		
High	1.00		
Moderate	0.61	0.30–1.24	
Low	0.54	0.28–1.05	
Age at diagnosis	1.13***	1.11–1.15	

*Significance at the 0.05 level **Significance at the 0.01 level ***Significance at the 0.001 level.

^a RUCA – Rural Urban Commuting Area codes obtained from US Department of Agriculture; ^bSAIPE – Small Area Income and Poverty Estimates obtained from US Census Bureau.

and RUCA codes are controlled in the multinomial regression model and additional demographic variables such as income, education and employment were not included in our data source and therefore could not be included as covariates. Second, there is a potential for selection bias due to our data sources. Third, data from the IDOH registry could be subject to underreporting or even missing data. Furthermore, the

insurance status variable was collected during the time of diagnosis and does not account for potential changes in insurance coverage, screening guidelines and healthcare policies during the period of diagnosis and treatment. Finally, this study focuses on a single state, thus, the findings may not be generalizable to other geographic locations. Future studies must examine the screening coverage of BCCP and assess screening uptake by race/ethnicity, insurance status and other demographic factors.

5. Conclusion

The study findings show that insurance status and race/ethnicity are associated with the stage of diagnosis for cervical cancer, and this highlights the imperative need for increased coverage for routine cervical cancer screening and preventive care services, especially for Black and Hispanic females who are disproportionately diagnosed at later stages of disease. It is also important to consider improving awareness of programs such as BCCP among uninsured females to increase screening and detection of cervical cancer cases at earlier stages.

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CRedit authorship contribution statement

Mrithula Suresh Babu: Writing – original draft, Methodology, Formal analysis. **Monica L. Kasting:** Writing – review & editing, Supervision, Methodology. **Natalia M. Rodriguez:** Writing – review & editing, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: MLK has served as a consultant to Merck and has received investigator-initiated research funding for a separate project from Merck Sharp & Dohme LLC, administered through Purdue University.

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Data availability

Data will be made available on request.

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