Racial Disparities in Cervical Cancer Survival Over Time

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BACKGROUND: The purpose of this study is to examine changes over time in survival for African American (AA) and white women diagnosed with cervical cancer (CC). METHODS: Surveillance, Epidemiology, and End Results (SEER) Program data from 1985 to 2009 were used for this analysis. Racial differences in survival were evaluated between African American (AA) and white women. Kaplan-Meier and Cox proportional hazards survival methods were used to assess differences in survival by race at 5-year intervals. RESULTS: The study sample included 23,368 women, including 3886 (16.6%) who were AA and 19,482 (83.4%) who were white. AA women were older (51.4 versus 48.9 years; \( P < .001 \)) and had a higher rate of regional (38.3% versus 31.8%; \( P < .001 \)) and distant metastasis (10.7% versus 8.7%; \( P < .001 \)). AA less frequently received cancer-directed surgery (32.4% versus 46%; \( P < .001 \)), and more frequently radiotherapy (36.3% versus 26.4%; \( P < .001 \)). Overall, AA women had a hazard ratio (HR) of 1.41 (95% confidence interval 1.32-1.51) of cervical cancer (CC) mortality compared with whites. Adjusting for SEER registry, marital status, stage, age, treatment, grade, and histology, AA women had an HR of 1.13 (95% confidence interval 1.05-1.22) of CC-related mortality. After adjusting for the same variables, there was a significant difference in CC-specific mortality between 1985 to 1989 and 1990 to 1994, but not after 1995. CONCLUSIONS: After adjusting for race, SEER registry, marital status, stage, age, treatment, grade, and histology, there was a significant difference in CC-specific mortality between 1985 to 1989 and 1990 to 1994, but not after 1995. Cancer 2013;119:3644-52. © 2013 American Cancer Society.

KEYWORDS: cervical cancer, African American, race, disparities, SEER.

INTRODUCTION
In 2013, there will be an estimated 12,170 new cases of cervical cancer (CC) diagnosed and approximately 4030 cancer-related deaths due to the disease,\(^1\) making it the third most common cancer diagnosis and cause of death among gynecological cancers in the United States, and the second leading cause of death in women aged 20 to 39 years.\(^1,2\) Effective cervical cytology screening has resulted in a steady decline in the incidence and mortality of CC in the United States.\(^3\) Although this decline has occurred across all racial and ethnic groups, significant disparities in these rates continue to exist.\(^3,5\) Several factors may account for the observed disparity in CC incidence and mortality among African American (AA) compared to white women. These factors include differences in screening and follow-up rates and practices, treatment, behavioral risk factors, and potentially underlying difference in biological characteristics of the tumor.

Studies have examined long-term trends and disparities in US CC mortality according to race. However, the extent to which disparities in CC mortality rates by race have changed over time has not been studied. Observing changes in mortality over time, rather than statically at a cross-sectional moment, may allow us to track progress toward reducing social and geographic disparities in CC mortality. Temporal analysis may also reveal important insights into the differential impact of cancer prevention and CC screening programs among different racial/ethnic minorities. The objective of this study was to examine if trends in death rates for CC between AA and white women with CC have changed over time, while accounting for both biological and treatment related prognostic factors.

MATERIALS AND METHODS
Data from the National Cancer Institute’s Surveillance, Epidemiology and End Results (SEER) registry from CC cases diagnosed between 1985 and 2009 were the source for this analysis. Because all information from the SEER database is deidentified, informed consent by the study participants and approval of an ethics committee were unnecessary to perform the analyses in this study.

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deidentified, informed consent by the study participants and approval of an ethics committee were unnecessary to perform the analyses in this study. For the current analysis the SEER 9 registries were used, which include Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, and Utah. Eligible women were 18 or older with newly diagnosed, histologically confirmed CC. Women who were not AA or white, women who were diagnosed at autopsy, and women with a previous diagnosis of cancer were excluded.

Variables were coded according to SEER Program criteria. The exposure variable, race, was designated as white and AA. Marital status was categorized as: married, not married and unknown. Geographic location was divided into the 9 SEER locations. Tumor grade was classified as well differentiated, moderately differentiated, poorly differentiated, undifferentiated, or unknown. We used SEER Summary Staging (localized, regional, distant, and unstaged) to categorize the extent of the disease. Histology was categorized as squamous cell carcinoma, adenocarcinoma, adenosquamous or other histologies. The primary treatment modality (radiation, surgery or no treatment) was recorded. The outcome variables included vital status and the time-to-event from the date of diagnosis until death, censoring, or last follow-up, as verified by the SEER program vital status determination. Among deceased persons listed in the SEER Registry, death may have occurred from CC or any other cause of death.

Statistical Analysis
Racial differences in the distribution of demographic, clinical, and treatment characteristics were compared using chi-square tests. Student t tests and analysis of variance (ANOVA) were used to assess the significance of differences in the mean values of continuous variables. We used the Kaplan-Meier method to estimate survival curves in order to compare observed survival between AA and white women for a given period of diagnosis. Survival curves were constructed to show all-cause mortality within the first 5 years of diagnosis for each race within each cohort, although the hazard ratios (HR) and resulting P values were calculated using all available data through last date of follow-up at the end of 2009, not only the first 5 years after diagnosis. Unadjusted all-cause mortality and disease-specific mortality analyses were performed to assess the survival of AA compared with whites within diagnosis years 1985-1989, 1990-1994, 1995-1999, 2000-2004, and 2005-2009, and then for all cohorts combined. Cox proportional hazards models were used to calculate adjusted racial group HRs and their 95% confidence intervals (CI) to assess the importance of race as an independent predictor of survival after adjusting for the following prognostic factors: SEER site, age, marital status, stage, treatment, histology, grade. Five-year diagnosis cohort was also included as a categorical variable when the entire population was analyzed.

All statistical tests were 2-sided and differences were considered statistically significant at P < .05. We used R software, version 2.15.2, and the package survival version 2.36-14 for all statistical analyses.

RESULTS
The SEER data set included 129,070 women who were diagnosed with reproductive cancer within the SEER 9 registries from 1985 to 2009, of whom 28,346 were diagnosed with invasive CC. A total of 4978 patients were excluded from the final analysis: 3175 cases because of race (not white or AA), 22 cases because of age, 1397 cases who had a prior malignancy, 372 cases that were not microscopically confirmed, and 12 cases were excluded because diagnosis was made at autopsy. The final study group consisted of 23,368 women, including 19,482 (83.4%) whites and 3886 (16.6%) AA.

Table 1 summarizes the demographic and clinical characteristics of the study population. The mean age at diagnosis was 51.4 years for AA and 48.9 years for whites (P < .001). AA were less frequently married at the time of diagnosis (25.8% versus 48.8%; P < .001). AA had a higher rate of regional (38.2% versus 31.9%; P < .001) and distant metastasis (10.7% versus 8.7; P < .001); and a lower rate of well-differentiated cancers (4.8% versus 8.6%; P < .001). AA had a higher rate of squamous cell carcinoma (77.1% versus 69.0%; P < .001), and a lower rate of adenocarcinoma (9.3% versus 18.2%; P < .001). AA had surgery less frequently (53.3% versus 66.3%; P < .001), and radiotherapy more frequently (57.2% versus 46.7%; P < .001).

In the crude models for both all-cause mortality and cancer-specific mortality, AA had a significantly increased overall and disease-specific hazard of death compared with white women (Table 2). The overall HR for AA women was 1.53 (95% CI = 1.46-1.61), and the disease-specific HR was 1.41 (95% CI = 1.32-1.51). Figure 1 shows Kaplan-Meier survival curves for disease-specific mortality for whites and AA women diagnosed with CC by 5-year diagnosis cohort and overall. Table 2 presents the risk of mortality for AA compared with whites, stratified by 5-year diagnosis cohorts. AA women had a higher HR of all cause mortality and CC related mortality for all the 5-year diagnosis cohorts. Over the entire study period,
after adjusting for race, SEER registry, marital status, stage, age, treatment (surgery versus radiotherapy versus surgery and radiotherapy versus none), grade, histology, and 5-year diagnosis cohort, AA race remained significantly associated with an increased overall hazard of death (HR = 1.17; 95% CI = 1.11-1.23), and CC-related mortality compared to whites (HR = 1.13, 95% CI = 1.05-1.22). After adjusting for the same variables there was a significant difference in CC-specific mortality between AA and whites between 1985-1989 and 1990-1994, but not after 1995.

Survival analysis using the Cox proportional hazards model identified an independent association of race, time period of diagnosis, older age, SEER registry site, advanced stage, grade, and type of treatment, with higher mortality (Table 3). The strongest quantitative predictor of death was stage at the time of diagnosis, with more advanced stages having higher mortality rates. Surgical therapy, radiation therapy, and combination therapy were all protective compared with patients who did not receive therapy. Marriage was protective against all-cause mortality, but not CC-specific mortality. Histology was not a significant factor. The hazard of disease-specific mortality decreased over time in the periods of 2000-2004 and 2005-2009 compared to 1985-1989. Table 4 summarizes the effect of the same factors on mortality in patients with CC by period of diagnosis.

Changes in disease characteristics and patterns of care over time were analyzed (Table 5). Among white women, there was a shift toward a more advanced stage at diagnosis (8.2% in 1985-1989 versus 11.3% in 2005-2009; $P < .001$), and lower rate of localized disease (53.3% in 1985-1989 versus 50.6% in 2005-2009; $P = .01$). Among AA, there was not a significant
difference in the rate of advanced stage at diagnosis (13.7% in 1985-1989 versus 12.8% in 2005-2009; \(P = .6\)). However, there was a shift toward a more localized disease at diagnosis (38.0% in 1985-1989 versus 44.3% in 2005-2009; \(P = .01\)). Squamous cell carcinoma was the most common histologic variant, although the rate of cervical adenocarcinoma increased more in whites (14.9% in 1985-1999 versus 23.5% in 2005-2009; \(P < .001\)) compared to AA (7.6% in 1985-1999 versus 11.0% in 2005-2009; \(P = .029\)). In whites, the rates of surgery remained relatively constant over time (60.6% in 1985-1989 versus 62.1% in 2005-2009; \(P = .195\)), in contrast to AA, were the rate of surgery appeared to increased over time (45.8% in 1985-1989 versus 49.2% in 2005-2009; \(P = .214\)), although not statistically significant.

Conclusions
In the present analysis, AA women presented overall with higher disease stage and had a higher prevalence of adverse prognostic indicators compared with white women. Although we found that after adjusting for standard treatment and other confounders, there were no differences in CC-specific survival for AA compared with whites after 1995, when looking at the survival for the whole group, AA women had worse overall and disease-specific survival. Prior studies have shown that CC incidence and death rates vary considerably among racial and ethnic groups. Siegel et al. showed that the CC death rate in the United States during the years of 2003 to 2007 was higher for AA (4.4 per 100,000) compared to whites (2.2 per 100,000). Patel et al., while evaluating the racial/ethnic differences in survival after diagnosis with invasive CC, after adjusting for tumor characteristics and treatment reported that AA were at 19% increased risk of death (HR = 1.19, 95% CI = 1.06-1.33). In a study from the South Carolina Central Cancer Registry from 1996-2006, the authors noted significant differences in survival rates for AA and white patients after matching on several factors and adjusting for lifestyle confounders.

In this investigation, AAs were less likely than whites to be diagnosed with a cancer at a localized stage. This finding is consistent with findings from previously published studies. The reason for the higher
Several studies have reported that medically unin-
diminished, race was not an independent predictor of sur-

where the impact of sociodemographic biases should be
treated in an equal access, military health care system,

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ethnic minorities.10 In fact, in a study of women with CC
result of the underutilization of screening among racial/
racial/ethnic differences in disease stage at diagnosis are a
proportion of advanced stage disease we observed among
AA women is not clear. Studies have shown that, in part,
racial/ethnic minorities in the receipt of CC treat-
treatment affecting the assignment of clinical staging, and the
receipt of surgical treatment, intracavitary radiation ther-
apy (ICRT), and definitive treatment.13,21-23 Based on
SEER data, AA when compared to whites, were less likely
to be treated with surgery alone, more likely to receive no
treatment or to have radiation therapy alone for their CC.
This difference was seen after adjusting for age and stage
of disease.15 Patel et al.19 found that more AA patients had
radiation therapy of any type as part of the first course of
cancer-directed treatment compared with the other racial/
ethnic groups. In a study using SEER data, del Carmen
et al.24 reported racial differences in the management of
women with Stage IA2 CC with older minority women
less likely treated by hysteroscopy and more likely to be
treated by fertility-sparing, less definitive procedures. Pro-
posed explanations for these disparities in treatment
include structural barriers, the existence of other medical
comorbidities, patient’s choice to decline recommended
treatment, and physician’s bias in making treatment
recommendations.20,22,23

The temporal trend analysis in the present study
showed that after adjusting for SEER registry, marital sta-
tus, stage, age, treatment, grade and histology, there was a
significant difference in CC-specific mortality between
AA and whites between 1985-1989 and 1990-1994, but
after 1995 there was not a difference in CC-specific mor-
tality. The findings that AA were older, less likely to pre-
sent with localized stage, and also less likely to receive
surgical treatment in the earlier cohorts, may be a reflec-
tion of more aggressive targeting by screening programs
among white women when compared to AA women in
the cohorts before 1995. These findings also suggest that
screening programs in minorities probably improved in
the 1990s, when AA women were more often diagnosed
with localized disease and receive more frequently surgical
treatment, compared to earlier cohorts. However, despite
these efforts, the significant difference in the rate of early

| Characteristic                        | All-Cause Mortality, HR | Cervical Cancer Mortality, HR |
|--------------------------------------|-------------------------|-----------------------------|
| Year of diagnosis                    |                         |                             |
| 1985-1989                            | Ref.                    | Ref.                        |
| 1990-1994                            | 1.07 (1.01-1.13)        | 1.08 (1.00-1.17)            |
| 1995-1999                            | 1.04 (0.98-1.11)        | 1.02 (0.94-1.11)            |
| 2000-2004                            | 0.95 (0.89-1.02)        | 0.89 (0.82-0.97)            |
| 2005-2009                            | 0.93 (0.86-1.01)        | 0.88 (0.79-0.97)            |
| Race                                 |                         |                             |
| White                                | Ref.                    | Ref.                        |
| African American                     | 1.17 (1.11-1.23)        | 1.13 (1.05-1.22)            |
| Age at diagnosis                     |                         |                             |
| 1-year increase                      | 1.03 (1.03-1.03)        | 1.01 (1.00-1.01)            |
| Marital status at diagnosis          |                         |                             |
| Unmarried                            | 0.86 (0.82-0.90)        | 0.94 (0.89-1.00)            |
| Married                              | 0.82 (0.74-0.90)        | 0.77 (0.67-0.89)            |
| SEER registry                        |                         |                             |
| Metropolitan Atlanta                 | Ref.                    | Ref.                        |
| Connecticut                          | 1.02 (0.94-1.10)        | 0.98 (0.88-1.10)            |
| Metropolitan Detroit                 | 1.09 (1.02-1.17)        | 1.04 (0.94-1.16)            |
| Hawaii                               | 1.40 (1.18-1.66)        | 1.46 (1.16-1.84)            |
| Iowa                                 | 0.99 (0.91-1.08)        | 1.04 (0.92-1.16)            |
| New Mexico                           | 1.09 (0.99-1.20)        | 1.05 (0.92-1.20)            |
| San-Francisco-Oakland                | 1.03 (0.94-1.11)        | 1.06 (0.94-1.18)            |
| Seattle (Puget Sound)                | 0.98 (0.90-1.07)        | 1.04 (0.92-1.17)            |
| Utah                                 | 1.11 (1.00-1.24)        | 1.08 (0.93-1.26)            |
| Stage                                |                         |                             |
| Localized                            | Ref.                    | Ref.                        |
| Regional                             | 1.96 (1.85-2.08)        | 3.21 (2.93-3.52)            |
| Distant                              | 6.29 (5.84-6.71)        | 10.79 (9.75-11.95)          |
| Unstaged                             | 1.35 (1.23-1.49)        | 1.67 (1.43-1.94)            |
| Grade                                |                         |                             |
| I                                    | Ref.                    | Ref.                        |
| II                                   | 1.17 (1.06-1.29)        | 1.36 (1.17-1.58)            |
| III                                  | 1.37 (1.24-1.50)        | 1.69 (1.46-1.96)            |
| IV                                   | 1.58 (1.37-1.83)        | 1.73 (1.41-2.12)            |
| Unknown                              | 1.03 (0.93-1.13)        | 1.08 (0.93-1.25)            |
| Histology                            |                         |                             |
| Adenocarcinoma                       | Ref.                    | Ref.                        |
| Adenosquamous                        | 1.04 (0.93-1.16)        | 1.13 (0.98-1.30)            |
| Squamous                             | 0.97 (0.91-1.03)        | 0.95 (0.87-1.03)            |
| Other                                | 1.03 (0.94-1.12)        | 0.98 (0.87-1.11)            |
| Treatment                            |                         |                             |
| None                                 | Ref.                    | Ref.                        |
| Surgery                              | 0.23 (0.21-0.25)        | 0.14 (0.12-0.16)            |
| Radiation                            | 0.64 (0.59-0.69)        | 0.61 (0.55-0.67)            |
| Surgery and radiation                | 0.40 (0.36-0.43)        | 0.33 (0.29-0.36)            |

Abbreviations: HR, hazard ratio; Ref, reference; SEER, Surveillance, Epidemiology, and End Results.
stage and surgical management between the groups persists, even in the last 10 years of this analysis. In addition, we also found that the rate of cervical adenocarcinoma increased more in whites compared to AA. Prior studies suggest that cytologic screening has been shown to effectively detect squamous cell carcinoma in early stages, whereas adenocarcinomas have been reported to be less detectable by screening. These differences in trends with regards histology could also reflect differences in screening or biological characteristics of the tumor. Targeted screening has been shown to be successful for minority women. In cooperation with the NCI-funded community-based Cancer Control Programs, the Indian Health Service sponsored screening programs more aggressively targeting American Indian women older than 60 years. Through these efforts, the incidence rate of CC decreased by 66% among American Indian women in New Mexico, with a significant concomitant shift also seen toward earlier diagnosis of CC. In an era where immigrants and ethnic minorities increasingly comprise a growing segment of the CC burden in the United States, it is incumbent upon the medical and public health community to overcome socioeconomic and cultural barriers to provide adequate care for patients with CC, and develop effective programs for prevention and early detection of CC.28,29

We found that mortality declined in the cohorts of 2000-2004 and 2005-2009 compared to earlier cohorts.

### TABLE 4. Effect of Various Factors on Mortality in Patients With Cervical Cancer by Period of Diagnosis. SEER Program, 1985-2009.

| Characteristic | 1985-1989 | 1990-1994 | 1995-1999 | 2000-2004 | 2005-2009 |
|---------------|-----------|-----------|-----------|-----------|-----------|
| **Race**      |           |           |           |           |           |
| White        | Ref.      | Ref.      | Ref.      | Ref.      | Ref.      |
| African American | 1.16 (1.00-1.35) | 1.24 (1.06-1.45) | 1.06 (0.89-1.25) | 1.01 (0.85-1.21) | 1.15 (0.92-1.43) |
| Age at diagnosis |           |           |           |           |           |
| 1-year increase  | 1.00 (1.00-1.01) | 1.01 (1.00-1.01) | 1.01 (1.00-1.01) | 1.01 (1.01-1.01) | 1.01 (1.01-1.02) |
| Marital status at diagnosis |           |           |           |           |           |
| Married | 0.94 (0.83-1.06) | 1.04 (0.92-1.17) | 0.90 (0.79-1.02) | 0.87 (0.75-0.99) | 0.86 (0.72-1.02) |
| Unknown | 0.85 (0.66-1.10) | 0.69 (0.51-0.93) | 0.72 (0.51-1.02) | 0.89 (0.64-1.24) | 0.61 (0.40-0.92) |
| **SEER registry** |           |           |           |           |           |
| Metropolitan Atlanta | 0.95 (0.76-1.20) | 1.23 (0.97-1.56) | 0.90 (0.71-1.14) | 0.95 (0.74-1.21) | 0.92 (0.66-1.29) |
| Connecticut | 1.00 (0.81-1.23) | 1.38 (1.12-1.72) | 0.91 (0.73-1.19) | 0.98 (0.78-1.22) | 0.98 (0.74-1.30) |
| Iowa | 1.27 (0.82-1.96) | 2.04 (1.34-3.12) | 1.51 (0.87-2.64) | 1.39 (0.82-2.35) | 1.14 (0.46-2.85) |
| New Mexico | 0.98 (0.77-1.25) | 1.27 (1.00-1.62) | 1.04 (0.81-1.33) | 0.97 (0.75-1.26) | 0.92 (0.65-1.30) |
| San Francisco-Oakland | 1.13 (0.90-1.42) | 1.33 (1.05-1.67) | 0.97 (0.76-1.24) | 1.00 (0.77-1.30) | 0.76 (0.53-1.09) |
| Seattle (Puget Sound) | 1.02 (0.80-1.30) | 1.24 (0.97-1.59) | 1.09 (0.85-1.40) | 0.94 (0.72-1.22) | 0.95 (0.69-1.33) |
| Utah | 1.34 (0.97-1.87) | 1.26 (0.92-1.73) | 1.00 (0.73-1.37) | 0.79 (0.55-1.12) | 0.94 (0.61-1.43) |
| **Stage** |           |           |           |           |           |
| Localized | 3.24 (2.72-3.87) | 3.10 (2.59-3.71) | 3.50 (2.87-4.27) | 3.09 (2.46-3.89) | 2.72 (1.99-3.72) |
| Distant | 11.06 (9.07-13.49) | 9.48 (7.70-11.88) | 11.59 (9.23-14.54) | 10.13 (7.94-12.93) | 10.99 (7.98-15.11) |
| Unstaged | 1.75 (1.33-2.31) | 1.52 (1.14-2.03) | 2.22 (1.62-3.05) | 1.61 (1.04-2.51) | 2.22 (1.30-3.78) |
| **Grade** |           |           |           |           |           |
| I | 1.32 (0.97-1.79) | 1.01 (0.76-1.33) | 2.11 (1.47-3.04) | 1.42 (1.01-1.99) | 1.34 (0.86-2.09) |
| II | 1.58 (1.17-2.14) | 1.42 (1.08-1.86) | 2.28 (1.59-2.83) | 1.69 (1.21-2.38) | 1.93 (1.24-2.98) |
| IV | 2.19 (1.43-3.37) | 1.17 (0.79-1.74) | 2.80 (1.77-4.43) | 2.15 (1.37-3.38) | 1.22 (0.60-2.47) |
| Unknown | 1.08 (0.80-1.46) | 0.80 (0.61-1.06) | 1.51 (1.04-2.18) | 1.15 (0.81-1.63) | 1.10 (0.70-1.72) |
| **Histology** |           |           |           |           |           |
| Adenocarcinoma | Ref. | Ref. | Ref. | Ref. | Ref. |
| Adenosquamous | 1.18 (0.87-1.61) | 0.98 (0.73-1.33) | 1.39 (1.02-1.89) | 0.92 (0.66-1.29) | 1.10 (0.74-1.64) |
| Squamous | 0.94 (0.79-1.13) | 0.94 (0.79-1.12) | 0.96 (0.79-1.17) | 0.89 (0.74-1.07) | 0.90 (0.72-1.14) |
| Other | 0.72 (0.54-0.96) | 1.03 (0.79-1.34) | 0.96 (0.73-1.26) | 1.03 (0.79-1.33) | 0.92 (0.66-1.27) |
| **Treatment** |           |           |           |           |           |
| None | Ref. | Ref. | Ref. | Ref. | Ref. |
| Surgery | 0.66 (0.54-0.81) | 0.63 (0.51-0.78) | 0.93 (0.73-1.20) | 0.52 (0.42-0.65) | 0.46 (0.37-0.58) |
| Radiation | 0.15 (0.11-0.20) | 0.14 (0.11-0.19) | 0.20 (0.15-0.27) | 0.11 (0.08-0.16) | 0.12 (0.08-0.18) |
| Surgery and Radiation | 0.42 (0.33-0.53) | 0.35 (0.27-0.44) | 0.47 (0.36-0.61) | 0.23 (0.18-0.29) | 0.25 (0.19-0.34) |

Abbreviations: Ref, reference; SEER: Surveillance, Epidemiology, and End Results.
### TABLE 5. Patients With Cervical Cancer Stratified by Race and Date of Diagnosis, SEER Program, 1985-2009.

| Characteristic | 1985-1989 | 1990-1994 | 1995-1999 | 2000-2004 | 2005-2009 |
|---------------|-----------|-----------|-----------|-----------|-----------|
| **Race**      | N = 5027 (21.5%) | N = 5156 (22%) | N = 4902 (20.9%) | N = 4290 (18.3%) | N = 3993 (17%) |
| Mean age, y   | 4182 (83.1%) | 4354 (84.4%) | 4058 (82.7%) | 3552 (82.8%) | 3336 (83.6%) |
|               | 49.5 | 48.8 | 48.1 | 48.1 | 49.0 |
| Marital status | White | White | White | White | White |
| Unmarried     | 1768 (42.3%) | 1941 (44.6%) | 1878 (46.3%) | 1682 (47.4%) | 1567 (47.0%) |
|               | 521 (61.7%) | 527 (65.7%) | 588 (69.7%) | 505 (68.4%) | 470 (71.5%) |
| Married       | 2201 (52.6%) | 2149 (49.4%) | 1962 (48.3%) | 1651 (46.5%) | 1549 (46.4%) |
|               | 246 (29.1%) | 207 (25.8%) | 207 (24.5%) | 198 (26.8%) | 143 (21.8%) |
| Unknown       | 213 (5.1%) | 264 (6.1%) | 218 (5.4%) | 219 (6.2%) | 220 (6.6%) |
| Stage (%)     | 2230 (53.3%) | 2429 (55.8%) | 2330 (57.4%) | 1880 (52.9%) | 1687 (50.6%) |
| Localized     | 310 (7.1%) | 72 (9.0%) | 87 (10.8%) | 78 (9.2%) | 91 (2.7%) |
| Regional      | 2067 (49.4%) | 348 (43.4%) | 1572 (37.6%) | 252 (34.1%) | 947 (28.4%) |
| Unstaged      | 287 (6.6%) | 113 (2.6%) | 104 (2.6%) | 20 (2.7%) | 1180 (33.2%) |
| Grade (%)     | 77 (1.8%) | 61 (3.0%) | 91 (2.6%) | 85 (2.5%) | 91 (1.4%) |
| I             | 233 (6.8%) | 71 (2.1%) | 30 (1.0%) | 35 (1.1%) | 92 (2.8%) |
| II            | 848 (20.3%) | 961 (22.1%) | 1025 (25.3%) | 1029 (29.0%) | 1040 (31.2%) |
| III           | 107 (21.7%) | 1069 (24.6%) | 1019 (25.1%) | 905 (25.5%) | 906 (27.2%) |
| IV            | 2067 (49.4%) | 348 (43.4%) | 363 (43.0%) | 252 (34.1%) | 947 (28.4%) |
| Unknown       | 283 (6.8%) | 61 (3.0%) | 40 (1.3%) | 42 (1.3%) | 92 (2.8%) |
| Histology (%) | 624 (14.9%) | 671 (15.4%) | 736 (18.1%) | 739 (20.8%) | 785 (23.5%) |
| Adenocarcinoma| 140 (3.3%) | 202 (4.6%) | 177 (4.4%) | 152 (4.3%) | 122 (3.7%) |
| Adenosquamous | 3072 (73.5%) | 3120 (71.7%) | 2781 (68.5%) | 2344 (66.0%) | 2126 (63.7%) |
| Squamous      | 346 (8.3%) | 361 (8.3%) | 364 (9.0%) | 317 (9.8%) | 303 (9.1%) |
| Treatment (%) | 312 (7.5%) | 304 (7.0%) | 252 (6.2%) | 249 (7.0%) | 281 (8.4%) |
| None          | 1821 (43.5%) | 2095 (48.1%) | 2062 (50.8%) | 1577 (44.4%) | 1414 (42.4%) |
| Surgery       | 3335 (31.9%) | 1052 (24.2%) | 861 (21.2%) | 921 (25.9%) | 983 (29.5%) |
| Radiation     | 714 (17.1%) | 903 (20.7%) | 883 (21.8%) | 805 (22.7%) | 658 (19.7%) |
| Surgery and   | 163 (19.3%) | 165 (20.6%) | 205 (24.3%) | 168 (22.8%) | 111 (16.9%) |
| Other         | 883 (21.8%) | 205 (24.3%) | 805 (22.7%) | 658 (19.7%) | 111 (16.9%) |

Abbreviations: AA, African American; SEER, Surveillance, Epidemiology, and End Results. Asterisk (*) indicates P values not statistically significant.
improvement in both disease-free survival (DFS) and overall survival (OS) when cisplatin-based chemotherapy was administered during radiation for various stages of cervical cancer. The mortality declined in the cohorts of 2000-2004 and 2005-2009 suggests an impact of chemoradiation in survival in a population-based analysis. The effect of the addition of cisplatin when used as a radiation sensitizer may be of higher magnitude, as observed in this study, for women presenting with more advanced stage disease that will necessitate radiation therapy as opposed to curative extirpative treatment. However, whether the superior survival observed in earlier cohorts is a direct function of chemoradiation itself or due to other factors cannot be answered from these data.

This study includes a large population-based cohort of patients with up to 25 years of follow-up, selected from SEER 9 areas that account for approximately 9.4% of the US population. However, there are several limitations to this current study that must be considered in interpreting the data. First, our results could be biased if the accuracy of assessments of cause of death varies by race or across the 5-year cohorts. In addition, this data set was only able to capture race based on classification by a health care provider; therefore, we are limited by an imperfect assessment of race. Additionally, data collected by SEER represent a nonhomogeneous population and, thus, outcomes may be affected by differences in treatment protocols, health care access, health behavior attitudes, regional customs, socioeconomic status, or environmental exposures. Finally, our study may have benefited from adjustment for comorbid conditions, health insurance, or socioeconomic status.

In conclusion, analysis of population-based SEER data indicates significant survival differences by race for women with invasive CC, even after adjusting for SEER registry, marital status, stage, age, treatment, grade and histology. The difference in survival is likely the end result of multiple complex factors including screening, diagnosis, access to care, quality of that care, and treatment disparities, as well as other cultural and social issues. The existence of racial differences in CC demands attention, and the persistence of those disparities over the past 3 decades underscores the charge to dissipate these disparities a priority. The dissolution of health care disparities in the CC spectrum, from screening to treatment and subsequent follow-up, will require the implementation of accessible, culturally competent screening, vaccination, and treatment programs, as well as further research efforts to better understand the factors that contribute to the access and delivery of equitable care across all racial and ethnic groups.

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