

RESEARCH ARTICLE

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Disparities in Human Papillomavirus Vaccination and Cervical Cancer Prevention and Screening Strategies: A Meta-Analysis

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Abstract

Background: Sociodemographic disparities continue to impact access to cervical cancer screening and treatment outcomes. Although advancements in preventive and therapeutic strategies have contributed to reductions in cervical cancer incidence and mortality, inequities in healthcare access remain largely influenced by social gradients and limited health literacy. **Method:** This study aimed to investigate the influence of factors such as age, race, socioeconomic status, educational attainment, and insurance coverage on cervical cancer mortality and participation in preventive measures, including HPV vaccination and cervical cancer screening. A systematic search of the MEDLINE, EMBASE, and Cochrane databases was conducted through January 2024. Eligible studies examined associations between disparities, defined as differences in race, social determinants of health, treatment modalities, and cervical cancer prevention or mortality. Data were synthesized using a random-effects meta-analysis, supplemented by subgroup analyses and multiple meta-regression models. **Results:** A total of 69 studies met the inclusion criteria. Screening participation was higher among individuals who were non-Black, had attained higher education levels, were publicly insured, were married, and had a higher income. In contrast, higher cervical cancer mortality rates were observed among individuals who were Black, uninsured, less educated, unmarried, or those who either did not receive treatment or underwent surgery alone. **Conclusion:** Significant disparities persist in access to cervical cancer prevention services and in mortality outcomes. These findings highlight the urgent need for policy interventions aimed at addressing economic, social, and racial barriers to equitable healthcare access.

Keywords: Cervical cancer- Disparity- Screening- Prevention- Vaccination- Treatment- Mortality

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Introduction

Several studies have shown socioeconomic disparities in preventive healthcare, particularly in cancer screening and treatment outcomes [1-3]. Cervical cancer remains a significant public health concern globally, with a high burden observed in regions such as Sub-Saharan Africa, South America, and Southeast Asia [4]. As of 2022, cervical cancer ranked fourth in terms of both incidence and mortality worldwide, a decline attributed to advances in prevention and treatment strategies. However, these improvements have not been equitably realized across all demographic groups, suggesting that social determinants continue to influence health outcomes. Public awareness of human papillomavirus (HPV) and cervical cancer prevention remains limited in many developing regions [3].

In recent decades, research has increasingly highlighted the role of social inequity in shaping access to preventive measures and mortality outcomes among individuals with cervical cancer [5]. Significant disparities exist in HPV vaccination and cervical cancer screening rates across sociodemographic groups [6]. Despite this, a comprehensive meta-analysis evaluating the individual effects of various determinants on cervical cancer prevention and mortality remains lacking.

Our study aimed to investigate how various sociodemographic factors, such as age, race/ethnicity, socioeconomic status, educational attainment, and insurance status, impact disparities in preventive measures (i.e., HPV vaccination and cervical cancer screening) and mortality rates among cervical cancer patients.

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Materials and Methods

Literature review and search strategy

This systematic review and meta-analysis were registered with PROSPERO (International Prospective Register of Systematic Reviews; no. 42024538245). We conducted a comprehensive search of MEDLINE (via PubMed), Embase (via Scopus), and the Cochrane Database of Systematic Reviews for studies published up to January 2024. The search strategy targeted studies evaluating the effects of race and other sociodemographic factors on cervical cancer prevention (i.e., screening and HPV vaccination) and mortality outcomes.

Two independent reviewers (T.J. and N.S.) performed the literature search using predefined search terms: (“cervical cancer” OR “HPV”) AND (“vaccin*” OR “mortality” OR “screening”) AND (“insurance” OR “disparit*” OR “racial” OR “ethnicity” OR “socioeconomic”). No language restrictions were applied. Additionally, the reference lists of all included articles were manually screened to identify any further relevant studies. The systematic review and meta-analysis followed the Meta-analyses Of Observational Studies in Epidemiology (MOOSE) guidelines and adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The MOOSE checklist is presented in Supplementary Table 2.

Selection criteria

Eligible studies included randomized controlled trials, cross-sectional studies, case-control studies, and cohort studies that investigated associations between sociodemographic variables (e.g., race/ethnicity, socioeconomic indicators, and treatment modalities) and outcomes related to cervical cancer prevention or mortality. Case reports and case series were excluded.

Outcomes

(1) Identify any disparities in the odds of cervical cancer screening associated with race, level of education, health coverage, marital status, and income.

(2) Identify any disparities in the odds of HPV vaccination associated with race, level of education, health coverage, marital status, and income.

(3) Identify any disparities in mortality rates in terms of the hazards of mortality associated with race, level of education, health coverage, marital status, and income.

The selected studies were required to report outcome as the mean $\pm$ standard deviation (SD) or as the median (interquartile range Q1–Q3) along with corresponding p values indicating statistical significance. Odds ratios (ORs) and hazard ratios (HRs), along with their 95% confidence intervals (95% CIs), were calculated to pool the estimated effects. There were no restrictions regarding the sample size or ethnicity of the population. The quality of the included studies was assessed using the Newcastle–Ottawa Scale (NOS) for case-control studies and a modified version for cohort and cross-sectional studies. This assessment covered three domains: four items assessed in study group selection (S); two items assessed group comparability (C); and three items assessed exposure and

outcome (O). Each domain received maximum scores of 4, 2, and 3, respectively, with the bias assessment results reported as numerical values.

Data abstraction

The following data were extracted from the included studies and entered into a structured data form:

1. Basic article information, including article title, first author’s name, year of publication, study period, and the country where the study was conducted

2. Patient baseline characteristics, demographic data, underlying diseases and the included population

3. ORs and HRs with 95% CIs of the outcomes of interest

Statistical analysis

All statistical analyses were conducted using R software version 4.3.1 (College Station, TX). Adjusted point estimates from each included study were calculated using the generic inverse variance method. Between-study heterogeneity was assessed using Cochran’s Q test, and both fixed-effects and random-effects models were applied, with the latter based on the Paule–Mandel estimator. Disparities in the outcomes (i.e., cervical cancer screening, HPV vaccination, and mortality rates) were analyzed with respect to each potential influencing factor, including race, education level, health coverage, marital status, and income. Pooled effect sizes were categorized as either multivariable (adjusted for other covariates within individual studies) or univariable (unadjusted) and analyzed separately. Associations between these factors and the outcomes of interest were expressed as hazard ratios (HRs) or odds ratios (ORs) with 95% confidence intervals (CIs). For each sociodemographic factor, subgroup analyses were performed using individual categories as reference groups. In the case of race and insurance status, both comprising more than two categories, pairwise subgroup comparisons were conducted to evaluate differences across groups. Given that healthcare policies differ across countries and may evolve over time, we hypothesized that the degree of disparity might vary accordingly. To account for this, multiple meta-regression analyses were conducted to assess associations between study-level effect sizes and contextual factors, including the study’s geographic setting (U.S. vs. non-U.S.) and the starting year of the study period. When the study period was not reported, the year of publication was used as a proxy. To ensure robustness of the regression models, permutation tests were applied. Statistical significance was defined as a two-tailed p-value of <0.05 . Publication bias was evaluated using Egger’s test and visually assessed through funnel plots.

Results

A total of 4,059 records were identified through database searches. After removal of duplicates, 2,679 unique studies remained for title and abstract screening. Based on the inclusion and exclusion criteria, 270 studies were selected for full-text review, resulting in 69 studies being included in the final meta-analysis. Among the

included studies, 3 focused on HPV vaccination, [6-8] 28 addressed cervical cancer screening, [9-36] and 38 examined mortality outcomes [37-74]. (Figure 1). Potential publication bias was assessed using Egger's test, with the results presented in Supplementary Tables 3–5. Cervical cancer screening (Figure 2 and Table 1).

Race

In the univariable analysis, non-Black individuals were significantly more likely to have undergone cervical cancer screening than Black individuals (OR 3.24; 95% CI, 1.23–8.49; $I^2 = 98\%$). However, subgroup analyses did not find statistically significant differences between Black individuals and Asians (OR 3.00; 95% CI, 0.69–12.96; $I^2 = 76\%$) or Caucasians (OR 3.42; 95% CI, 0.39–30.28; $I^2 = 99\%$).

Multivariable analysis showed that non-Black individuals had higher odds of screening compared to Black individuals (OR 1.85; 95% CI, 0.98–3.46; $I^2 = 96\%$). Subgroup analysis revealed that Asians were significantly more likely than Black individuals to have undergone screening (OR 1.83; 95% CI, 1.28–2.60; $I^2 = 0\%$). Additionally, non-Caucasians had higher odds of screening compared to Caucasians (OR 0.59; 95% CI, 0.34–1.04; $I^2 = 99\%$). Among racial groups, Hispanics were more likely to be screened than Caucasians (OR 1.27; 95% CI, 1.05–1.54; $I^2 = 37\%$). No statistically significant differences were observed when comparing Black

individuals to Caucasians (OR 0.53; 95% CI, 0.16–1.77; $I^2 = 97\%$) or Asians to Caucasians (OR 0.35; 95% CI, 0.07–1.72; $I^2 = 99\%$).

In addition to comparing screening rates among specific racial groups, multiple meta-regression analyses were conducted to evaluate the influence of study initiation year and study location on the odds of screening for each race. Overall, neither factor significantly impacted screening likelihood across any racial group. Specifically, in the multivariable analysis, the year of study initiation and study location were not associated with differences in screening odds among Black individuals ($p = 0.367$ and $p = 0.094$, respectively) or Caucasians ($p = 0.230$ and $p = 0.071$, respectively).

Education

Higher education was associated with increased screening in both univariate (OR 2.90, 95% CI 1.45–5.78; $I^2 = 94\%$) and multivariate analyses (OR 1.62, 95% CI 1.20–2.20; $I^2 = 99\%$).

Insurance

Multivariable analysis revealed no significant difference in screening odds between insured and uninsured individuals (OR 1.61; 95% CI, 0.90–2.91; $I^2 = 43\%$). However, subgroup analysis showed individuals with public insurance alone had significantly higher odds of screening compared to the uninsured (OR 1.99; 95% CI,

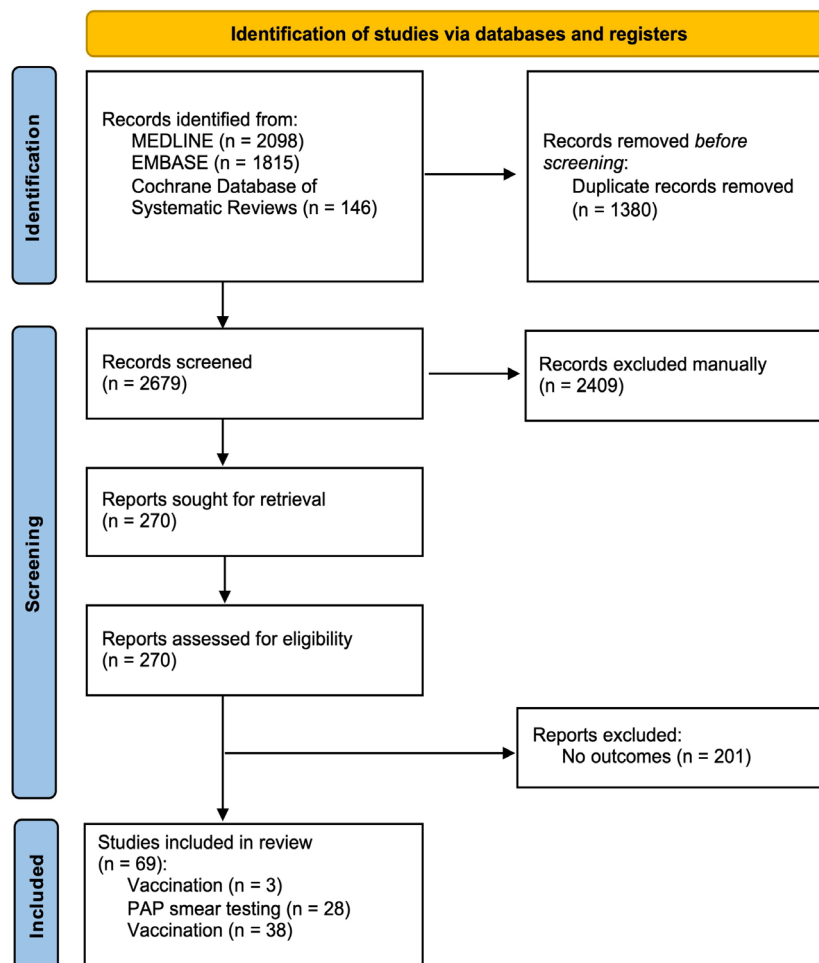


Figure 1. The PRISMA Flow Diagram

Table 1. Multiple Meta-Regression for Cervical Cancer Screening

Outcome	Reference Group	Model	k	I ²	H ²	R ²	Test for Residual Heterogeneity	Test of Moderators	Degrees of Freedom	Coefficient	Log Odds Ratio [95% CI]	P-value (estimator)
Income	High	Year + Location	8	96.95%	32.82	0.00%	p < 0.001	p = 0.812	5	Intercept	-28.07 [-299.57, 243.42]	p = 0.764
										Location (U.S.)	-0.49 [-2.25, 1.26]	p = 0.532
										Year	0.01 [-0.12, 0.15]	p = 0.765
Insurance	Private	Insurance + Year + Location	9	0.00%	1	0.00%	p = 0.712	p = 0.556	4	Insurance (None)	-0.14 [-1.09, 0.81]	p = 0.773
										Insurance (Public)	0.30 [-0.89, 1.49]	p = 0.613
										Intercept	132.21 [-116.27, 380.70]	p = 0.265
Marital Status	Married	Year + Location	27	98.27%	57.87	0.00%	p < 0.001	p = 0.550	24	Location (U.S.)	0.74 [-0.48, 1.96]	p = 0.196
										Year	-0.07 [-0.19, 0.06]	p = 0.263
										Intercept	-24.55 [-83.45, 34.34]	p = 0.410
Race	African	Race + Year + Location	8	4.73%	1.05	98.00%	p = 0.370	p = 0.077	4	Location (U.S.)	0.07 [-0.41, 0.55]	p = 0.768
										Race (Caucasian)	0.01 [-0.02, 0.04]	p = 0.415
										Year	-61.36 [-227.08, 104.35]	p = 0.371
Caucasian	Race + Year + Location	11	92.57%	13.45	61.29%	p < 0.001	p = 0.077	6	Location (U.S.)	-1.39 [-2.66, -0.12]	p = 0.094	
									Race (Hispanic)	0.46 [-0.46, 1.39]	p = 0.268	
									Year	0.03 [-0.05, 0.11]	p = 0.367	
										Intercept	57.05 [-45.21, 159.32]	p = 0.236
										Location (U.S.)	1.11 [-0.12, 2.34]	p = 0.071
										Race (Asian)	-1.20 [-2.56, 0.16]	p = 0.079
										Race (Hispanic)	0.17 [-1.04, 1.39]	p = 0.763
										Year	-0.03 [-0.08, 0.02]	p = 0.230

Multiple meta-regression for odds of cervical cancer screening based on year of study initiation and study location (U.S. or non-U.S.). For insurance and race, which include more than one comparison group, the effect of each group is also included in the model. k is the number of studies. I² represents the Higgins & Thompson's I² Statistic. H² represents the H² statistic. R² represents the R² statistic.

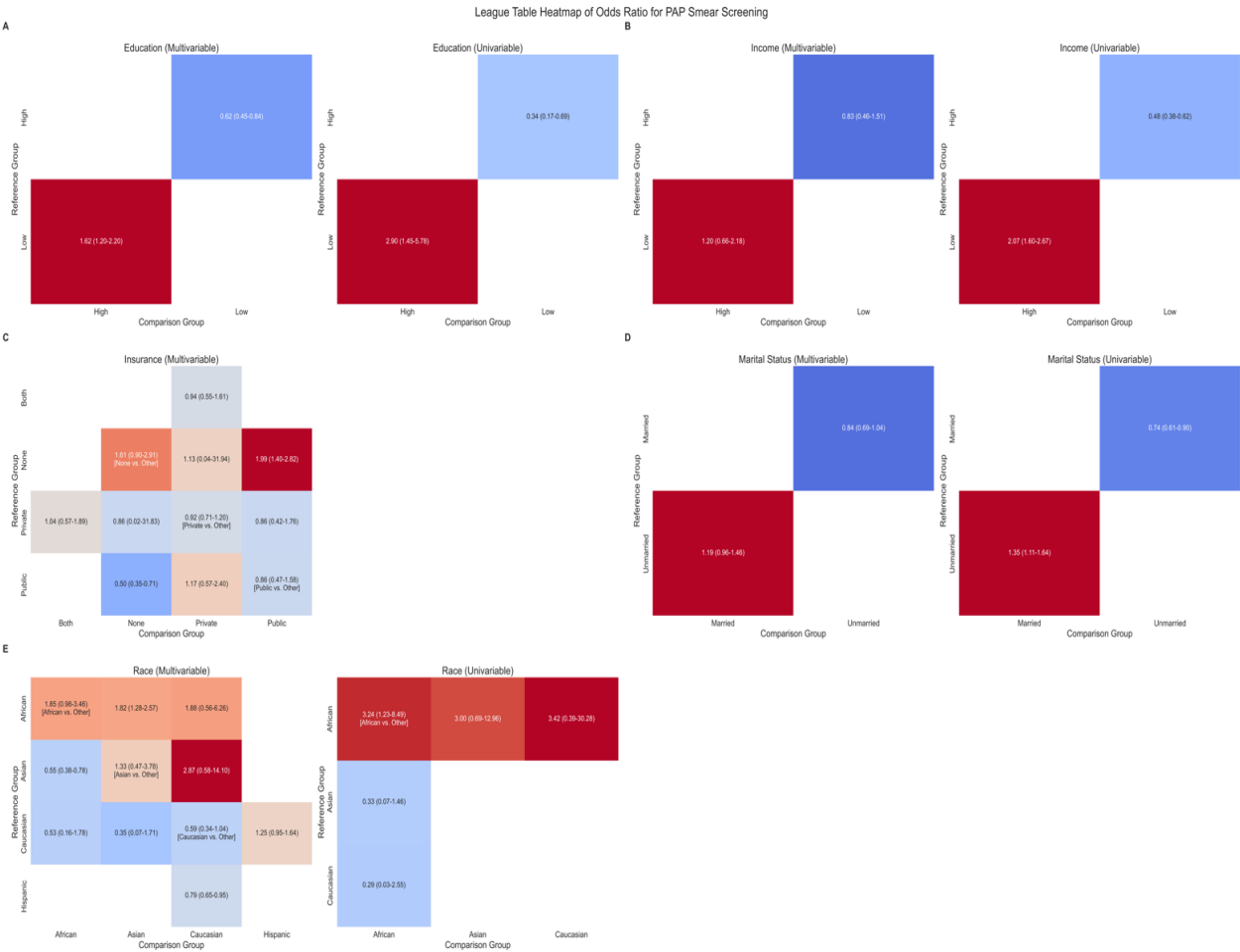


Figure 2. Odds Ratio for Cervical Cancer Screening. League table heatmap for cervical cancer screening from pairwise comparison of multivariable (left) and univariable analysis (right). Comparison groups (columns) are compared to reference groups (rows). When comparison and reference groups are the same, the odds ratio represents the overall odds ratio of the other groups compared to the reference group. A. Education. B. Income. C. Insurance. D. Marital Status. E. Race.

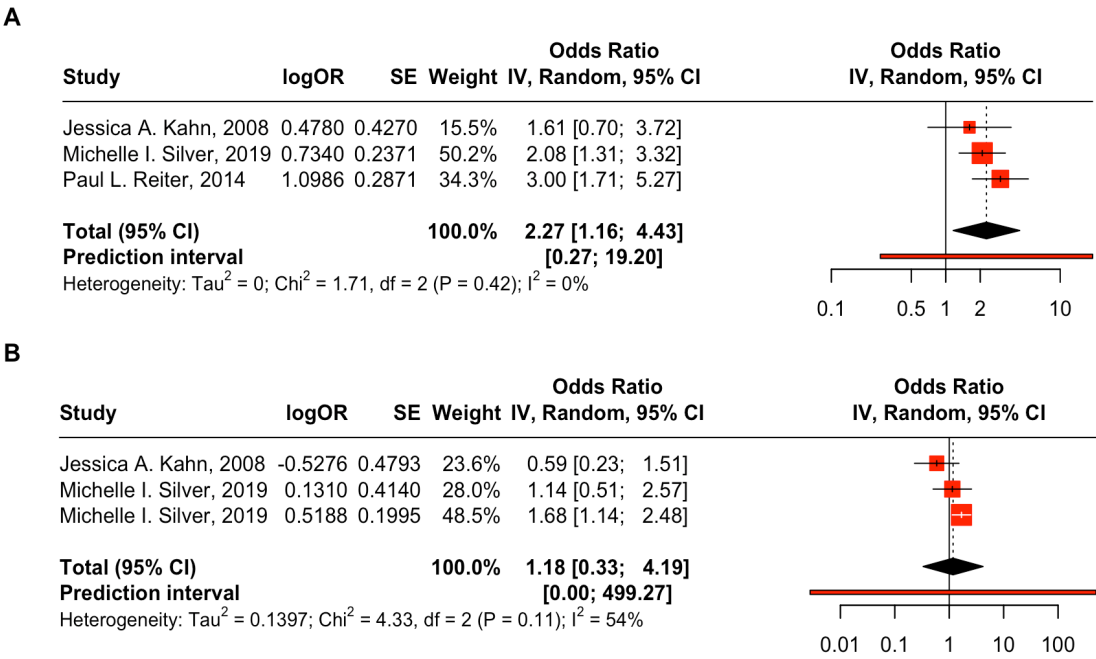


Figure 3. Odds Ratio for HPV Vaccination. Pooled odds ratio for HPV vaccination in women with insurance compared to women without insurance (A) and in married women compared to unmarried women (B).

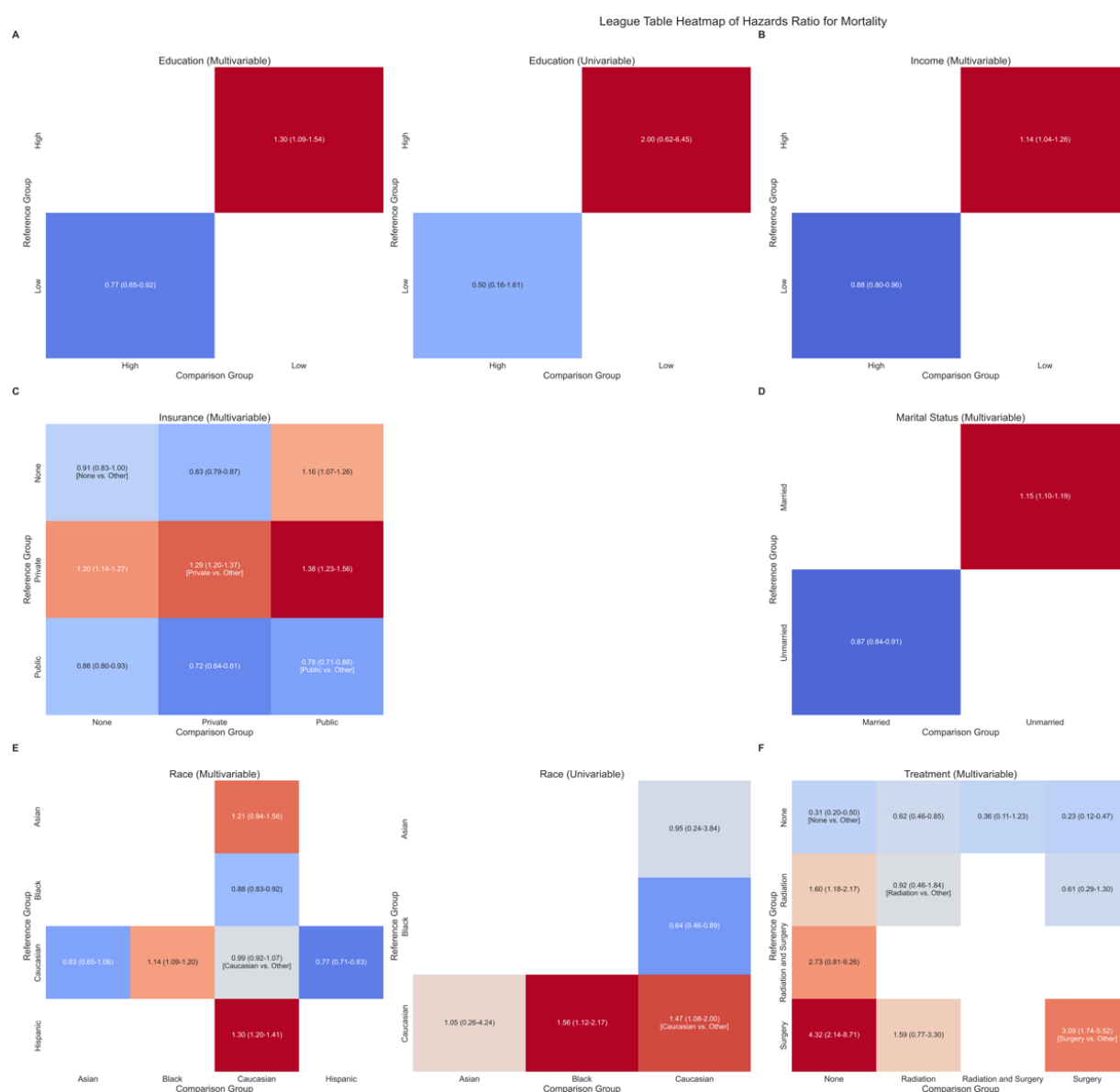


Figure 4. Hazards Ratio for Cervical Cancer Mortality. League table heatmap for cervical cancer mortality from pairwise comparison of multivariable (left) and univariable analysis (right). Comparison groups (columns) are compared to reference groups (rows). When comparison and reference groups are the same, the hazards ratio represents the overall hazards ratio of the other groups compared to the reference group. A. Education. B. Income. C. Insurance. D. Marital Status. E. Race. F. Treatment.

1.40–2.82; $I^2 = 0\%$), but no such association was observed with private insurance (OR 1.13; 95% CI, 0.04–31.94; $I^2 = 22\%$). Likewise, no significant differences were found when comparing private to public insurance (OR 0.86; 95% CI, 0.42–1.76; $I^2 = 39\%$) or private insurance alone to dual coverage (OR 1.06; 95% CI, 0.62–1.80; $I^2 = 0\%$).

In addition to comparing the effects between specific insurance categories, multiple meta-regression was conducted to examine the influence of the year of study initiation and study location on the odds of screening for each insurance group. Among individuals with private insurance, neither the year of study initiation nor the study location significantly affected the odds of screening ($p = 0.263$ and $p = 0.196$, respectively).

Marital status

Univariate analysis showed lower screening rates

among unmarried individuals (OR 0.74, 95% CI 0.61–0.90; $I^2 = 0\%$), but this association was not significant in multivariate analysis (OR 0.84, 95% CI 0.69–1.04; $I^2 = 99\%$).

Meta-regression found no significant effect of study year or location on screening rates by marital status ($p = 0.415$ and $p = 0.768$, respectively).

Income

Individuals with higher income levels were associated with increased screening in univariate analysis (OR 2.07; 95% CI, 1.60–2.67; $I^2 = 0\%$). However, the multivariable analysis did not confirm this association (OR 1.20; 95% CI, 0.66–2.18; $I^2 = 99\%$).

Meta-regression showed that neither the year of study initiation nor geographic location significantly impacted the association between income level and screening ($p =$

0.765 and $p = 0.532$, respectively). Vaccination (Figure 3).

Marital status

No significant difference in vaccination rates was observed between married and unmarried individuals (OR 1.18, 95% CI 0.33–4.19; $I^2 = 54\%$).

Insurance

Insured individuals were more likely to be vaccinated than the uninsured (OR 2.27, 95% CI 1.16–4.43; $I^2 = 0\%$). Mortality (Figure 4 and Table 2).

Race

Univariate analysis revealed higher mortality among non-Caucasians (HR 1.47, 95% CI 1.08–2.00; $I^2 = 23\%$) and Black individuals (HR 1.56, 95% CI 1.12–2.17; $I^2 = 0\%$) compared to Caucasians. No difference was seen between Asians and Caucasians (HR 1.05, 95% CI 0.26–4.24; $I^2 = 0\%$).

According to the multivariate analysis, compared with Caucasian individuals, non-Caucasian individuals had similar risk factors for mortality (HR 0.99, 95% CI 0.92–1.07; $I^2 = 90\%$); increased risk factors were detected among Black individuals (HR 1.14, 95% CI 1.09–1.20, $I^2 = 59\%$); while Hispanic individuals had lower mortality (HR 0.77, 95% CI 0.71–0.83, $I^2 = 69\%$). No difference was observed among Asians (HR 0.83, 95% CI 0.64–1.07, $I^2 = 40\%$).

Insurance

Insured individuals had a lower mortality risk (HR 0.91, 95% CI 0.83–1.00; $I^2 = 81\%$). Private insurance alone was associated with reduced mortality compared to the uninsured (HR 0.83, 95% CI 0.79–0.87; $I^2 = 40\%$), while public insurance was linked to increased mortality (HR 1.16, 95% CI 1.07–1.26; $I^2 = 0\%$). Private insurance was also superior to public insurance (HR 0.72, 95% CI 0.64–0.81; $I^2 = 85\%$).

Multiple meta-regression analyses showed that the year of study initiation and study location were not significantly associated with mortality risk when comparing individuals with versus without health coverage ($p = 0.112$ and $p = 0.056$, respectively). However, when comparing public insurance to other insurance types, the year of study initiation was significantly linked to increased mortality in the other insurance categories, with a log HR increase of 0.010 per year (95% CI: 0.004–0.017). In contrast, study location had no significant impact on mortality risk in these groups ($p = 0.203$).

Education

Univariate analysis indicated that individuals with higher education had a lower risk of mortality (HR 0.50, 95% CI: 0.16–1.61; $I^2 = 53\%$). This association remained significant in multivariate analysis (HR 0.77, 95% CI: 0.65–0.92; $I^2 = 50\%$).

Marital status

Multivariate analysis showed that unmarried individuals had a higher risk of mortality compared to married individuals (HR 1.15, 95% CI: 1.10–1.19; $I^2 =$

Table 2. Multiple Meta-Regression for Cervical Cancer Mortality

Outcome	Reference Group	Model	k	I^2	H^2	R^2	Test for Residual Heterogeneity	Test of Moderators	Degrees of Freedom	Coefficient	Log Hazards Ratio [95% CI]"	P-value (estimator)
Insurance	None	Insurance + Year + Location	18	0.00%	1	100.00%	$p = 0.609$	$p = 0.003$	14	Insurance (Public)	0.36 [0.27, 0.46]	$p = 0.002$
										Intercept	-13.84 [-28.16, 0.47]	$p = 0.093$
										Location (U.S.)	0.68 [-0.02, 1.38]	$p = 0.056$
Public	Insurance + Year + Location		16	54.29%	2.19	81.98%	$p = 0.001$	$p = 0.013$	12	Insurance (Private)	-0.15 [-0.27, -0.02]	$p = 0.036$
										Intercept	-19.99 [-33.32, -6.66]	$p = 0.012$
										Location (U.S.)	-0.46 [-1.24, 0.31]	$p = 0.203$
Marital Status	Married	Year + Location	25	53.80%	2.16	2.52%	$p = 0.006$	$p = 0.274$	22	Year	0.01 [0.00, 0.02]	$p = 0.011$
										Intercept	-5.94 [-14.46, 2.57]	$p = 0.110$
										Location (U.S.)	0.07 [-0.13, 0.26]	$p = 0.425$
										Year	0.00 [-0.00, 0.01]	$p = 0.107$

Multiple meta-regression for hazards of cervical cancer mortality based on year of study initiation and study location (U.S. or non-U.S.). For insurance which includes more than one comparison group, the effect of each group is also included in the model. k is the number of studies. I^2 represents the Higgins & Thompson's I^2 Statistic. H^2 represents the H^2 statistic. R^2 represents the R^2 statistic.

48%).

Multiple meta-regression analyses found that neither the year of study initiation nor the study location significantly influenced mortality risk ($p = 0.107$ and $p = 0.425$, respectively).

Treatment modality

According to the multivariate analysis, individuals who received treatment had a significantly lower risk of mortality compared to those who did not receive treatment (HR 0.31, 95% CI: 0.20–0.50; $I^2 = 97\%$). Specifically, reduced risks were observed among those who underwent surgery alone (HR 0.23, 95% CI: 0.12–0.47; $I^2 = 91\%$) or radiation alone (HR 0.62, 95% CI: 0.46–0.85; $I^2 = 0\%$). However, the combination of both treatments did not yield a statistically significant benefit (HR 0.36, 95% CI: 0.11–1.23; $I^2 = 66\%$). Furthermore, when comparing surgery alone to radiation alone, surgery was associated with a higher, though not statistically significant, risk of mortality (HR 0.61, 95% CI: 0.29–1.30; $I^2 = 91\%$).

Discussion

This is the first meta-analysis to systematically evaluate racial and sociodemographic disparities in cervical cancer prevention and outcomes. We found that disparities persist across racial, educational, insurance, and marital categories. These disparities were unaffected by the year or location of the studies, suggesting a widespread and longstanding issue.

Limited access to early detection remains a key factor driving the high burden of cervical cancer. Screening participation is low, primarily due to the logistical challenges of implementing screening programs and the influence of social determinants such as poverty, limited health literacy, and barriers to healthcare access [75]. Our findings revealed significant disparities in screening access, with non-Black and Asian individuals more likely to be screened. In contrast, those who were unmarried or had lower socioeconomic status were less likely to participate in screening, a trend that aligns with previous research [75–77]. Higher education levels, greater income, and coverage through public insurance were associated with increased screening participation. Despite policies designed to improve healthcare access, these inequalities persist.

The stage at which cervical cancer is diagnosed plays a crucial role in determining survival outcomes [78–81]. Evidence consistently shows that later-stage diagnoses are linked to higher metastasis rates and more complex treatment requirements [82]. Our study found that individuals who were uninsured, unmarried, or from lower-income backgrounds had a higher risk of mortality, likely due to lower screening rates. These disparities were observed across various demographic and socioeconomic groups, including race, income, insurance status, and marital status. Meta-regression analyses showed no significant association between these disparities and the year the study was initiated, or its geographic location, pointing to a longstanding and systemic issue.

We also observed that Hispanic individuals, who

tended to participate in screening more frequently, had a lower mortality risk compared to Caucasian individuals. A lack of healthcare access among uninsured and low-income groups likely contributes to lower screening rates in these populations. Interestingly, publicly insured individuals were found to have a higher mortality risk than those without insurance. Our analysis showed that those with public insurance were more likely to receive radiotherapy; however, previous research suggested that this group often receives care in high-volume cancer centers, where survival outcomes tend to be better due to standardized treatment protocols and improved access to technologies like brachytherapy [63]. Lower educational attainment was also associated with higher mortality risk, likely reflecting deficits in health literacy. Notably, individuals who received any form of treatment had a substantially reduced risk of mortality, emphasizing the need to address treatment access as a matter of health equity.

In recent years, disparities in HPV vaccination rates and perceptions of the vaccine have become increasingly evident. One study found that uninsured women were significantly less likely to receive the HPV vaccine compared to their insured counterparts (adjusted OR: 0.48, 95% CI: 0.30–0.76), likely reflecting restrictive government policies around vaccine eligibility. Younger women (aged 21–29) were more likely to be vaccinated than older women (aged 30–36), which is consistent with current guidelines prioritizing adolescents and young adults [6]. Another study highlighted the importance of health insurance (OR: 0.34, 95% CI: 0.17–0.66) and showed that health literacy and personal beliefs played a strong role in vaccination intentions, with ORs of 6.42 (95% CI: 2.29–18.3), 1.74 (95% CI: 1.35–2.25), and 2.12 (95% CI: 1.61–2.79), respectively [7]. These findings suggest that even with the introduction of national screening and vaccination programs, outcomes may remain suboptimal in some countries—particularly in sub-Saharan Africa—due to gaps in awareness and understanding of cervical cancer. Our own results further confirmed the impact of insurance coverage, showing that individuals with insurance were more than twice as likely to receive HPV vaccination (OR: 2.27, 95% CI: 1.16–4.43) compared to the uninsured. However, the limited number of available studies prevented us from exploring additional contributing factors in greater detail.

Strengths and limitations

Our study is the first to systematically review the influence of individual-level factors on disparities in cervical cancer prevention and mortality. By comparing the most divergent groups within each study, we were able to identify consistent patterns of inequality. Although our review included studies from various countries, we found a notable lack of data on HPV vaccination, underscoring the need for further research in this area.

The findings from our study highlight persistent disparities in both cervical cancer mortality and access to prevention strategies, contributing to variations in incidence and outcomes across different population groups. Existing literature emphasizes the critical role of

early diagnosis in reducing mortality and the effectiveness of HPV vaccination in preventing disease onset. To promote health equity among all women at risk for HPV-related cervical cancer, it is essential that healthcare systems and government bodies prioritize expanding access to affordable HPV vaccination, early screening programs, and effective treatment—regardless of social or economic status. Furthermore, our analysis points to the importance of pairing these services with initiatives aimed at improving HPV-related health literacy. Increasing public awareness and vaccine acceptance, particularly among Black individuals, those without insurance, individuals with lower education levels, and unmarried populations, is key to bridging these gaps.

In conclusion, significant disparities remain in cervical cancer screening, vaccination, and mortality. These findings reinforce the urgent need to enhance healthcare accessibility for underserved women. Future health policies must prioritize addressing socioeconomic and racial inequities in order to reduce these preventable differences in outcomes.

Author Contribution Statement

All authors had access to the data and a role in writing the manuscript.

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This meta-analysis was conducted without specific funding support. The study was not part of a student thesis and was not commissioned or approved by any scientific body. As this research involved secondary analysis of published data, ethical approval was not required. We declare no conflict of interest.

All authors had full access to the data and contributed to the conceptualization, analysis, and writing of the manuscript. The raw data collected during the systematic review are available upon reasonable request from the corresponding author at phnatacha@gmail.com.

This study was prospectively registered with PROSPERO (CRD42024538245) on 21 April 2024.

Data sharing

The raw data collected during the systematic review, descriptions of the model structure, and the parameters included in the model are available on request to phnatacha@gmail.com

PROSPERO Registration

CRD no. 42024538245 registered on 21 April 2024

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