Proceedings of Scientific Research Universidad Anáhuac, 2025, 5(9): 16-26.
ISSN-e: 2954-3541.

Original research

# Epidemiological Overview of Cervical Cancer and Human Papillomavirus Vaccination in the Yucatán Peninsula, Mexico (2014-2024): Challenges and Perspectives

**Karla María Meléndez Dubón[a1], Sharon Nahomy Poblano Sandez[a2], Iris Aurora Nava Jimenez[a3*]**

[a] Universidad Anáhuac Cancún, Escuela Internacional de Medicina Cancún, Quintana Roo, México.

**ID ORCID:**

[1]https://orcid.org/0009-0006-4889-9053, [2]https://orcid.org/0009-0007-6888-9589, [3]https://orcid.org/0000-0002-2001-0420

https://doi.org/10.36105/psrua.2025v5n9.02

## ABSTRACT

**Introduction:** Since 2006, cervical cancer (CC) has remained a significant public health issue in Mexico, ranking as the second leading cause of cancer-related mortality among women over the age of 25. However, epidemiological data on this disease remain scarce in the Yucatán Peninsula. This study reviews the prevalence and mortality of cervical cancer in the Yucatán Peninsula over the past ten years, as well as recent progress in human papillomavirus (HPV) vaccination coverage among girls aged 10 to 14. **Objective:** The aim is to provide relevant data to support decision-making in the primary prevention of cervical cancer. **Materials and Methods:** Official data were retrieved from the Ministry of Health and statistical reports from the National Institute of Statistics and Geography. Additionally, a systematic literature review was conducted from 2014 to 2024 using PubMed and Google Scholar databases, with Medical Subject Headings (MeSH) terms. **Results:** The results indicate that the states of Campeche, Yucatán, and Quintana Roo have among the highest national rates of HPV prevalence and cervical cancer mortality. Despite recent improvements in vaccination coverage since 2022, further efforts are needed to achieve the target of at least 70% coverage, in alignment with the 2030 global goals. **Conclusion:** Reaching this threshold is crucial to reducing future cervical cancer incidence and mortality in the region.

**Key words:** HPV; vaccination; CC; incidence; mortality.

* *Corresponding Author:* Iris Aurora Nava Jiménez. Universidad Anáhuac Cancún Adress: Blvd. Luis Donaldo Colosio Km 13.5 M 2 Zona 8 SM 299, Carr. Cancún - Tulum, 77565 Cancún, Q. R. Tel.: (998) 264 1816. Email: aurora_nava@anahuac.mx

Received: June 4, 2025.
Accepted: November 20, 2025.

## RESUMEN

**Introducción:** Desde el año 2006, el cáncer cervicouterino (CaCU) en México representa un problema de salud pública, ocupando el segundo lugar en mortalidad por cáncer en mujeres mayores de 25 años. La información generada en torno a la epidemiología de esta patología es escasa en nuestra región. Por ello, se revisaron la prevalencia y mortalidad de CaCU en la Península de Yucatán durante los últimos 10 años, además de analizar los avances en la cobertura vacunación contra el Virus del Papiloma Humano (VPH) en niñas de 10 a 14 años. **Objetivo:** El objetivo es aportar información importante que podría ser de utilidad para la prevención primaria del CaCU. **Materiales y Métodos:** Se realizó una búsqueda de información en fuentes oficiales de la Secretaría de Salud, reportes estadísticos del Instituto Nacional de Estadística y Geografía. Adicionalmente se llevó a cabo una búsqueda sistemática de literatura entre 2014 y 2024 en bases de datos como PubMed y Google Scholar, utilizando términos MeSH. **Resultados:** Los resultados muestran que los estados de Campeche, Yucatán y Quintana Roo tienen altas tasas de prevalencia de VPH y mortalidad por CaCU a nivel nacional. A pesar de los avances en la cobertura de vacunación desde 2022, aún se requiere alcanzar al menos un 70% de cobertura, según los objetivos 2030. **Conclusión:** Esto es crucial para disminuir la prevalencia y mortalidad en las próximas generaciones de mujeres en la región.


**Palabras clave:** VPH; vacunación; CaCU; incidencia; mortalidad.

## INTRODUCTION

Cervical cancer (CC) is characterized by the uncontrolled growth, development, and multiplication of squamous cells in the transformation zone of the cervix. According to the World Health Organization (WHO), cervical cancer ranked eighth in incidence, with 661,021 new cases, and ninth in mortality, with 348,189 deaths reported in 2022.[1–3]

In Latin America, the association between human papillomavirus (HPV) infection and CC constitutes a major public health challenge, not only due to the high incidence reported in 2022 (ranging from 11.3 to 38.7 cases per 100,000 inhabitants) and mortality rates (5.2 to 18.3 deaths per 100,000 inhabitants),2 but also because of persistent structural barriers in prevention, diagnosis, and treatment programs. A recent analysis by Hernández-Silva et al. (2024) estimated the overall prevalence of HPV in Latin American women at 10.16%, with 8.52% corresponding to high-risk strains. Additionally, 1.83% of women were found to be co-infected with multiple genotypes simultaneously.[4]

### Epidemiology of cc in Mexico: incidence, prevalence, and demographic distribution

According to the Global Cancer Observatory (GLOBOCAN 2022), **CC** has been the second leading cause of cancer-related mortality among women in Mexico, with a total of 10,348 new cases (9.3%) and 4,909 deaths (5.1%) reported in 2022. The estimated annual prevalence for 2022 was 13,960 cases, with an incidence rate of 23.3 new cases per 100,000 women.[5]

A descriptive cross-sectional study was conducted using data from the Institutional Cancer Registry of the Mexican Social Security Institute (IMSS) for the period 2018-2022. The study revealed that the majority of premalignant and malignant cervical lesions manifested in women between the ages of 35 and 54.[6] Furthermore, the 2024 report of the World Health Organization, entitled Situation Analysis of Cervical Cancer in the Americas, indicated that Mexico had an incidence rate of 13.2 per 100,000 and a mortality rate of 6.2 per 100,000 in 2022, ranking fourth lowest in Central America.[7]

### Hpv vaccination coverage and strategies in Mexico: progress and 2030 goals

the WHO developed a plan titled Global Strategy to Accelerate the Elimination of Cervical Cancer as a Public Health Problem in response to global morbidity and mortality associated with CC. The primary objective of this strategy is to eliminate CC as a public health issue by promoting prevention, early detection, and effective treatment. The objective of the program is to reduce incidence rates to below 4 cases per 100,000 women, thereby preventing an estimated 300,000 CC deaths worldwide.

To achieve the targets set for the year 2030, the WHO introduced the “90-70-90” strategy, which outlines clear and measurable goals:

1. Vaccination: Ensure that 90% of girls worldwide are fully vaccinated against HPV before the age of 15.
2. Screening: Guarantee that at least 70% of women undergo high-precision screening, such as HPV DNA testing or cytology,by the age of 35, with a second screening by age 45.
3. Treatment: Ensure that 90% of women diagnosed with precancerous lesions or CC receive timely and appropriate treatment.[1]

### Cervical cancer survival in Mexico

CC remains a major public health concern in Mexico, where survival rates continue to reflect deeply rooted structural inequalities in access to healthcare services.[8] A recent study based on data from the Catastrophic Health Expenditures Fund (FPGC) of the now-defunct Seguro Popular revealed that women diagnosed at early stages had a survival rate of 88.0%, whereas those diagnosed at metastatic stages had a survival rate of only 43.6%.[8] Moreover, the risk of death from CC increased by 0.3% with each additional year of age (HR = 1.003; 95% CI: 1.001-1.004), suggesting cumulative vulnerability among older women, particularly those facing barriers to accessing specialized care.[8]

This study aims to synthesize epidemiological and bibliographic evidence on the incidence of premalignant cervical lesions, HPV detection rates, and CC mortality across the Yucatán Peninsula, including the states of Campeche, Quintana Roo, and Yucatán, and to assess HPV vaccination coverage among girls and women.

## METHODOLOGY

This study aimed to answer the research question: *What is the prevalence, incidence, and mortality rates of CC, and what is the HPV vaccination coverage in the Yucatán Peninsula between 2014 and 2024?*

A cross-sectional, observational, and descriptive study was conducted. The study focused on regional differences in comparison to the national average. The graphical representations were generated using data from epidemiological bulletins published by the National Institute of Statistics and Geography (INEGI). A linear smoothing model was employed to identify temporal trends from 2014 to 2024. This analysis was carried out in collaboration with Amphora Health, Mexico, using its Beluga Science platform, a digital tool designed for the management of scientific and epidemiological data, advanced statistical analysis, and data visualization.[9]

To obtain data on HPV vaccination coverage, reports from the National Institute of Public Health (INSP) and bulletins from the Ministry of Health (SSA) were used. The years for which data was obtained were 2015, 2020, and 2022–2023.

All statistical analyses were performed using Python (v3.11) to evaluate differences in HPV vaccination coverage between the Yucatán Peninsula and the national average. Mean values, standard deviations, confidence intervals, and p-values were calculated using Student's t-test, with statistical significance set at $p < 0.05$.

A systematic literature search was conducted in the PubMed and Google Scholar databases. In PubMed, MeSH terms included: ('Uterine Cervical Neoplasms'[Mesh] OR 'Cervical Cancer') AND ('Papillomavirus Infections'[Mesh] OR 'HPV') AND ('Incidence'[Mesh] OR 'Epidemiology') AND ('Mexico'[Mesh] OR 'Yucatán' OR 'Campeche' OR 'Quintana Roo') AND ('Vaccination'[Mesh] OR 'HPV vaccine'). Filters were applied for language (Spanish and English), publication date (2014-2024), and study type (original articles, systematic reviews, technical reports). In Google Scholar, search terms included both Spanish and English phrases such as "HPV vaccination Mexico Yucatán Campeche Quintana Roo," "cervical cancer incidence Mexico peninsula," and "cervical dysplasia and HPV Mexico."

Peer-reviewed publications retrieved from PubMed and Google Scholar were used to construct the contextual and conceptual framework of the study.

The selection of studies on HPV vaccination coverage and CC mortality followed specific inclusion criteria: only those reporting data disaggregated by state within the Yucatán Peninsula, or national data clearly applicable to the region, were considered. Priority was given to reports from the INSP platform and SSA bulletins, as these sources provide detailed, state, and municipality-level figures suitable for comparative statistical analysis.

### Data extraction and quality assessment

The full process of article identification, selection, and exclusion for this systematic review is detailed in Figure 1, in accordance with PRISMA guidelines.


https://doi.org/10.36105/psrua.2025v5n9.02

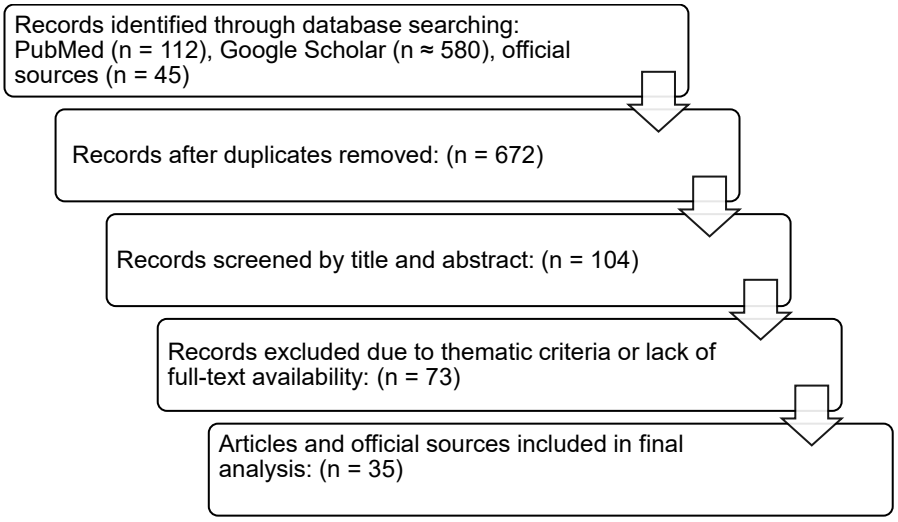


**Figure 1.** Stages of literature search and article process.

## RESULTS

### Incidence and Mortality of CC in Mexico

In 2017, a total of 306,675 deaths among women were recorded in Mexico, of which 42,891 (13.9%) were attributed to malignant tumors.[10,11] Among these, breast cancer and CC together accounted for approximately one-quarter (25%) of all cancer-related deaths in women.[11] The National Institute of Statistics and Geography (INEGI), in its 2018 report titled *"Statistics on the Occasion of World Cancer Day"*, analyzed data from the 2011-2016 period. This analysis showed that the highest incidence of CC occurred among women aged 30 to 59 years.[12]

In 2020, CC was the second most frequently diagnosed cancer and the second leading cause of cancer-related mortality among Mexican women, with an estimated 9,439 new cases and 4,335 deaths. This corresponded to an incidence rate of 12.6 and a mortality rate of 5.7 per 100,000 women.[13]

In 2021, the Mexican Social Security Institute (IMSS) reported 1,155 new cases and 1,059 deaths from CC among its insured population, corresponding to incidence and mortality rates of 2.26 and 5.23 per 100,000 women, respectively.[14] That same year, national health authorities reported an overall increase in CC burden, with 3,058 newly diagnosed cases and 4,111 deaths attributed to the disease.[10]

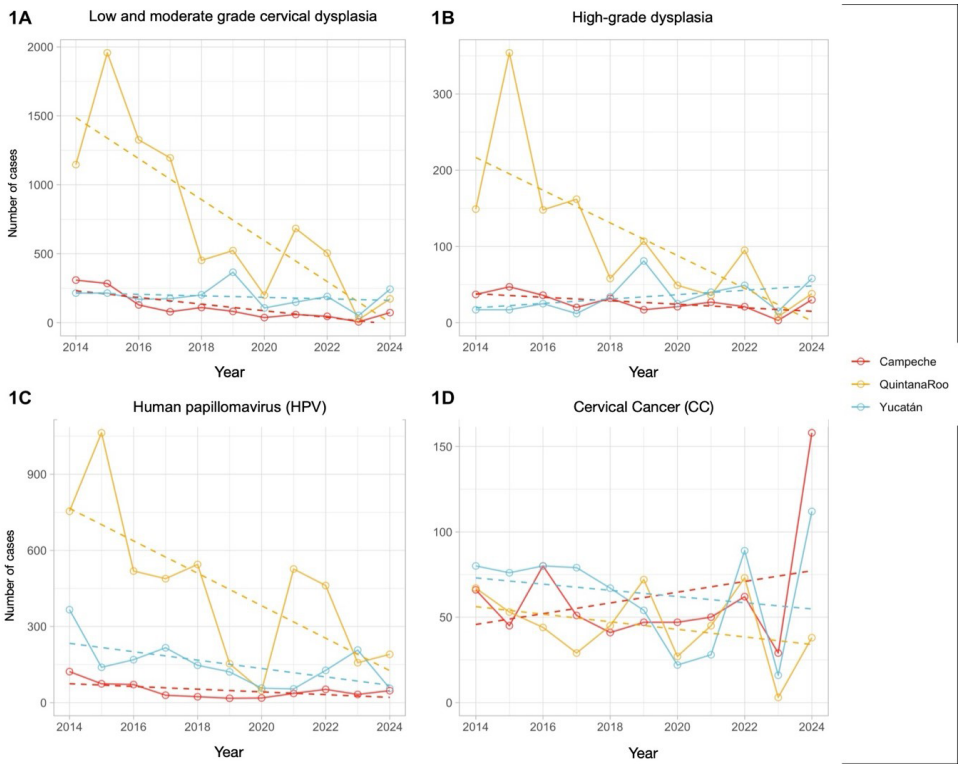


**Figure 1. Incidence of cervical dysplasia and cervical cancer in the Yucatán Peninsula, Mexico (2014–2024)**. (1A) shows the annual number of cases of mild to moderate cervical dysplasia among women in the three states. (1B) presents the annual number of cases of severe dysplasia and carcinoma in situ. (1C) depicts the annual number of HPV cases. (1D) illustrates the annual number of cervical cancer cases among women in the three states. Source: Prepared by the authors in collaboration with Amphora Health, Mexico, using the Beluga Science platform and based on epidemiological bulletins from the Ministry of Health (SSA). The graphs display state-specific data using the following color scheme: Quintana Roo (yellow), Campeche (red), and Yucatán (blue).

This study analyzed the annual number of cases among women (Figure 1), focusing on cumulative totals of low- and moderate-grade cervical dysplasia (Figure 1A), high-grade dysplasia (Figure 1B), annual HPV infection cases (Figure 1C), and CC (Figure 1D) recorded between 2014 and 2024 in the states of Campeche, Quintana Roo, and Yucatán. Figures 1A and 1B show that the state of Quintana Roo consistently exhibited the highest incidence rates of cervical lesions, both low- to moderate-grade and high-grade dysplasia, across the Yucatán Peninsula. Notably, between 2015 and 2017, an annual average of 1,416 cases of low, to moderate grade dysplasia and approximately 203 cases of high-grade dysplasia were recorded. From 2019 onward, both types of cervical lesions showed a steady decline, with particularly notable reductions observed between 2023 and 2024.

Figure 1D indicates that CC cases peaked between 2019 and 2022, with an average of 171 cases per year. In contrast, Campeche consistently reported fewer cases than Quintana Roo and Yucatán, although it experienced distinct spikes in both low- and high-grade dysplasia from 2016 to 2018 (Figures 1A and 1B). Nevertheless, Campeche maintained a relatively stable average of approximately 54 CC cases annually throughout the 2014-2022 period.

In Yucatán, the number of cases peaked in 2019, with an annual average of 316 cases of low- to moderate-grade dysplasia and a concurrent increase in high-grade dysplasia, reaching 81 cases (Figures 1A and 1B). It is important to note that throughout the study period, Yucatán and Campeche consistently reported the lowest incidence rates


https://doi.org/10.36105/psrua.2025v5n9.02

of both mild and severe cervical dysplasia compared to Quintana Roo. However, as shown in Figure 1D, the trend for CC revealed a more variable distribution. During the early years of the study (2014–2019), no single state predominated in terms of case numbers. In 2024, the incidence of CC rose across all three states, with Campeche experiencing a particularly marked increase, rising from fewer than 30 annual diagnoses to 74.

Regarding HPV infection (Figure 1C), a sustained decline in detection rates was observed over the 2014-2024 period. Quintana Roo, which reported over 300 cases annually in 2014, experienced a gradual reduction to fewer than 100 cases by 2023.

## CC Mortality in the Yucatán Peninsula

CC continues to disproportionately affect certain regions of Mexico, particularly the southeastern states. According to data published by the National Center for Gender Equity and Reproductive Health in August 2019 (5), the states with the highest CC mortality rates were Chiapas (19.7%), Quintana Roo (17.7%), Morelos (16.0%), Yucatán (15.6%), and Veracruz (14.4%). Notably, two of the five states with the highest mortality are in the Yucatán Peninsula, underscoring the region's priority status for public health interventions.

In 2023, INEGI reported 4,504 CC deaths nationwide, with the majority occurring among older women. Specifically, 33.9% of deaths were recorded in women aged 65 years and older, followed by 21.8% in those aged 45-54, and 21.2% in the 55–64 age group.[15] These age-related patterns highlight the need to strengthen screening and early detection programs for older women, who remain at increased risk for late-stage diagnosis.[15]

A study by Sánchez-Mercader et al. (2021) analyzed CC mortality in Yucatán between 2013 and 2017 using SSA data.16 The findings revealed that women over 70 years of age had mortality rates consistently higher than the national average. For Yucatán, mortality rates (per 100,000 women) were: 4.76 (2013), 5.03 (2014), 4.91 (2015), 5.07 (2016), and 5.17 (2017). In contrast, the national averages for these years ranged from 3.16 to 3.43, indicating a persistent regional disparity.[16]

An analysis of female mortality in Quintana Roo, based on the 2015 report by the National Institute for Women and cited by Guarneros-Cuellar et al. (2016), documented a CC mortality rate of 15.2 deaths per 100,000 women. This rate exceeded that of breast cancer in the same state and period, which was reported at 9.7 deaths per 100,000 women.[17]

However, despite a thorough search, no recent or official data on CC mortality in Campeche was found. This lack of localized data restricts the possibility of conducting a thorough epidemiological assessment of the Yucatán Peninsula, thereby emphasizing the necessity of enhancing cancer surveillance systems in the region.

## HPV Vaccination Coverage in the Yucatán Peninsula, Mexico

Clinical trials have demonstrated that HPV vaccination significantly reduces infection rates and, consequently, the likelihood of developing precancerous lesions and CC in women.[18] As part of its global elimination strategy, the WHO has established a target of 90% vaccination coverage among girls by age 15 by the year 2030.[19]

Although national-level data on HPV vaccination coverage in Mexico remain limited, the *Vaccination Atlas* published by the National Institute of Public Health (INSP) provides regional data for girls aged 10-14 in the Yucatán Peninsula (Table I).[20]

**Table I.** HPV vaccination coverage in females aged 10-14 years in the Yucatán Peninsula, Mexico, based on recorded vaccine doses in 2015 and 2020 (percentage values)

| Peninsula States | Year 2015 | Year 2020 |
|---|---|---|
| Quintana Roo | 29% | 10% |
| Yucatán | 32% | 20% |
| Campeche | 30% | 16% |

Source: Elaborated by the authors based on an analysis of data from the study "National Institute of Public Health, Center for Research in Evaluation and Surveys, Atlas of Coverage of the HPV Vaccination Program".

In 2015, Quintana Roo reported an HPV vaccination coverage rate of 29%, with the highest municipal rate observed in Bacalar (46.2%) and the lowest in Playa del Carmen (11.6%). By 2020, this rate had dropped sharply to 10%, likely due to disruptions caused by the COVID-19 pandemic.[20] That same year, the state of Yucatán achieved a coverage rate of 32%. Within the state, the municipality of Ticul reported the highest coverage (54.9%), while Motul recorded the lowest (2.8%).[20] Notably, Yucatán, the most populous state in the region, lacked vaccination data for several of its 116 municipalities. In contrast, Campeche reported a statewide

coverage of 30% in 2015 and, unlike the other two states, provided vaccination data for all of its municipalities.[20] The municipality of Tenabo recorded the highest rate at 42.8%, whereas the state capital, Campeche, had the lowest at 17.6%.[20]

To assess progress in HPV vaccination coverage, data from the National Institute of Public Health (INSP) for the years 2022-2023 show a notable increase across the region. In Campeche, coverage reached 65.6% in 2022 and rose to 74.8% in 2023. Similarly, Yucatán reported a coverage rate of 63.1% in 2022, increasing to 73.9% in 2023.[20] In contrast, the state of Quintana Roo reported a coverage rate of 56.5% in 2022, which declined to 53.2% in 2023, a 3.3% decrease, making it the only state in the Yucatán Peninsula to exhibit a reduction during this period. At the national level, coverage stood at 39.7% in 2022 and rose substantially to 74.4% in 2023, reflecting significant progress in vaccination efforts across the country (Table II).[20] It is important to clarify that the data for individual municipalities was sourced directly from the INSP platform, rather than being extracted from Tables I and II.

**Table II .** HPV Vaccination Coverage (Cumulative, 2022–2023) in Girls Aged 10–14 Years in the Yucatán Peninsula and Nationally, Mexico

| | 2022 (%) | 2023 (%) |
|---|---|---|
| National Average | 39.7 | 74.4 |
| Quintana Roo | 56.5 | 53.2 |
| Campeche | 65.6 | 74.8 |
| Yucatán | 63.1 | 73.9 |

Source: Prepared by the authors based on data from the National Institute of Public Health, Center for Research in Evaluation and Surveys. Atlas of Coverage of the HPV Vaccination Program.

Table II presents a comparative analysis of HPV vaccination coverage in girls aged 10-14 across the states of the Yucatán Peninsula and the national average for the years 2022 and 2023. The data highlight notable differences in both the scale and consistency of immunization efforts during this period. In 2022, Table III shows that the average HPV vaccination coverage across the Yucatán Peninsula reached 61.73%, significantly higher than the national average of 39.7%. This difference was statistically significant ($p = 0.0148$) and was accompanied by low inter-state variability, indicating a more consistent and effective implementation of vaccination strategies within the Peninsula.

In contrast, although national coverage increased sharply to 74.4% in 2023, surpassing the peninsular average (which ranged from 53.2% in Quintana Roo to 74.8% in Campeche), the difference between the national and regional averages was not statistically significant ($p = 0.397$). Therefore, no definitive conclusion can be drawn regarding a true difference in vaccination coverage between the two levels for that year.

**Table III.** Statistical Comparison of National HPV Vaccination Coverage vs. the Yucatán Peninsula Average (Campeche, Quintana Roo, Yucatán), Cumulative Period 2022–2023

| Indicator | Period 2022 | Period 2023 |
|---|---|---|
| National coverage average | 39.7% | 74.4% |
| Average in the peninsula (Campeche, Quintana Roo, Yucatán) | 61.73% | 67.3% |
| Standard deviation | 4.70% | 12.38% |
| 95% confidence interval | (50.05%, 73.41%) | (44.94%, 89.65%) |
| P-value | 0.0148 | 0.397 |

Source: prepared by the authors based on data from the National Institute of Public Health, Center for Research in Evaluation and Surveys, Atlas of HPV Vaccination Program Coverage.

The statistical comparison presented in Table III demonstrates that, in 2022, the average HPV vaccination coverage in the Yucatán Peninsula (61.73%) was significantly higher than the national average (39.7%), with a p-value of 0.0148 and a narrow confidence interval, indicating both consistency and significance in the regional efforts. However, in 2023, despite continued improvements, the peninsular average (67.3%) was slightly lower than the national average (74.4%), and this difference was not statistically significant ($p = 0.397$), suggesting no meaningful variation between the two levels during that year. These trends make it clear that sustained and coordinated efforts are needed at federal, state and local levels to strengthen vaccine supply chains and reinforce immunization campaigns. These actions are essential to achieving the 90% coverage target by 2030 and to significantly reducing the incidence and mortality associated with CC.[19,21-23]

## DISCUSSION

The epidemiological patterns of CC in the Yucatán Peninsula reveal significant disparities among its three states:


https://doi.org/10.36105/psrua.2025v5n9.02

Campeche, Yucatán, and Quintana Roo. These differences reflect a range of socioeconomic, structural, and healthcare-related factors. For example, Sánchez-Mercader et al. (2021) emphasized the importance of considering healthcare access, coverage of primary and secondary prevention strategies, social context, and the proportion of Indigenous populations when analyzing CC mortality in Yucatán.[16]

A key finding of this study is the paradox observed in Campeche and Yucatán: both states report low incidence of cervical dysplasia and HPV infection, yet they show an increasing number of CC cases. This trend suggests potential shortcomings in secondary prevention, particularly in screening programs. These shortcomings result in undetected lesions that progress to more advanced stages without timely diagnosis or treatment.[24-26] In contrast, Quintana Roo, initially characterized by high rates of HPV infection, cervical dysplasia, and CC incidence, has shown notable reductions across all three indicators. These improvements may be attributed to more effective implementation of screening programs, improved follow-up of positive cases, and broader HPV vaccination coverage.[26]

Ideally, early detection programs should lead to an increased diagnosis of low- or high-grade dysplasia and a corresponding decrease in invasive cancer incidence. However, national data indicate that over 50% of CC cases in Mexico are still diagnosed at advanced clinical stages, pointing to systemic failures in healthcare access and program effectiveness, particularly in socially and economically marginalized areas.[4,23] A study published in the Journal of Global Oncology by Unger-Saldaña et al. (2018) revealed that in public hospitals in Mexico City, only 9.5% of CC cases were diagnosed as carcinoma in situ, and just 16.9% were detected at Stage I. Alarmingly, over 60% were identified at stages II through IV, and only 15% were diagnosed through screening, most patients sought care due to the onset of symptoms.[27]

Similarly, Arango-Bravo et al. (2022), analyzing data from the national cohort of women treated under the Catastrophic Health Expenditures Fund, found that only 24.5% of CC cases were diagnosed at early stages (IA–IB1), while 68.5% were classified as locally advanced (IB2–IIIB), and 6.9% were already in advanced stages.[28] In this context, the trends observed in Yucatán are of particular concern. While the state reported relatively low rates of mild and moderate dysplasia, there was a sharp increase in cervical cancer (CC) incidence in 2019. This suggests possible weaknesses in screening systems, follow-up protocols or referral pathways.[16]

The situation is even more striking in Campeche, where, throughout the 2014-2024 period, the state consistently reported the lowest incidence of both dysplasia and HPV infection. Figure 1C shows a flat trend line, with fewer than 50 new HPV cases reported annually and minimal year-over-year variation. Rather than reflecting effective disease control, this pattern more likely points to limited diagnostic capacity and weak surveillance systems, possibly due to underutilized screening tools or narrow diagnostic criteria (e.g., HPV testing conducted only after detecting severe dysplasia or cancer).[29]

Unexpectedly, Campeche reported the highest number of new cervical cancer (CC) cases in 2024, with 220 cases, surpassing Yucatán (185) and Quintana Roo (173) (Figure 1D). This abrupt increase warrants further investigation into barriers such as access to healthcare, the availability of diagnostic infrastructure and sociocultural factors that may hinder the early detection and timely treatment of precancerous lesions.[24–26]

As highlighted by León-Maldonado et al. (2024), one of the main reasons for underreporting or the absence of HPV and dysplasia data in certain regions of Mexico is the limited coverage of CC screening programs and the restricted availability of high-sensitivity diagnostic technologies, such as HPV DNA testing. (29). These challenges are further exacerbated by entrenched sociocultural, geographic, and systemic barriers that continue to limit the reach and effectiveness of preventive services, particularly among women of reproductive age in rural and Indigenous communities.[29]

HPV vaccination remains the cornerstone of primary prevention. Although coverage in the Yucatán Peninsula improved notably between 2022 and 2023, rates still fall short of the 90% threshold recommended by the WHO to achieve herd immunity.[1,20] The 2023 decline observed in Quintana Roo, contrasting with improvements in Campeche and Yucatán, is particularly concerning. In some municipalities of Yucatán and Quintana Roo, vaccination coverage remains below 15%, underscoring the inequitable distribution of immunization efforts.[20] Evidence shows that HPV vaccination can reduce the incidence of high-grade cervical dysplasia by up to 87% when administered before sexual debut.[30] However, in Mexico, acceptance and implementation of HPV vaccination programs continue to be limited by sociocultural resistance, misinformation, and logistical challenges associated with school-based vaccination campaigns.[31] A comprehensive strategy should include a community-based health education initiatives targeting parents and caregivers.

Currently, Mexico primarily uses the bivalent vaccine (HPV types 16 and 18) and, to a lesser extent, the quadrivalent vaccine (types 6, 11, 16, and 18).[32,33] However, several high-

risk genotypes that are prevalent in the Mexican population—such as types 31, 33, 45, and 52, are not covered by these formulations. This gap may limit the long-term impact of vaccination on CC incidence at the national level.[34]

Anaya Rodríguez et al. (2024) argue that transitioning to the nonavalent vaccine, which protects against nine genotypes, including the most prevalent in Mexico (6, 11, 16, 18, 31, 33, 45, 52, and 58), would significantly enhance the effectiveness of the national vaccination program.[33] However, implementing this transition would require political commitment, sustainable funding, coordination with international suppliers, and the revision of national operational guidelines. Therefore, the selection of vaccine type should be informed by scientific evidence and cost-effectiveness analyses tailored to the country's specific epidemiological profile.[33]

Additionally, Guzmán Tapia et al. (2024) emphasize the importance of including males in HPV vaccination programs. Males not only serve as asymptomatic carriers and transmitters of the virus but are also at risk for HPV-related diseases such as anogenital warts and malignancies of the anus, oropharynx, and genital tract.[34] In many high-income countries, the nonavalent vaccine is routinely administered to both sexes starting at age 9, with documented effectiveness exceeding 90% in preventing these conditions.[34] In Mexico, the inclusion of males in national HPV vaccination efforts is expected to begin officially in 2025. While this is a positive development, its impact on achieving herd immunity is likely to be delayed, with full benefits only observable in the long term.[33]

Parental acceptance of HPV vaccination remains a crucial determinant of uptake. Many caregivers lack awareness of the vaccine's role in cancer prevention or express concerns about its safety and efficacy.[32] This presents an opportunity for health authorities to collaborate with schools and community leaders to disseminate evidence-based information and facilitate informed parental consent, key to increasing adolescent vaccination rates in the country.[32]

From a bioethical perspective, Bayefsky (2021) argues that mandatory HPV vaccination can be ethically justified when voluntary strategies fail to achieve sufficient coverage.[35] According to the author, mandates, when implemented with transparent communication and culturally sensitive approaches to informed consent, can promote social justice, reduce health inequities, and protect vulnerable populations.[35] In the case of the Yucatán Peninsula, a multisectoral response is urgently needed. This includes improving screening registries, actively following up on suspected cases, and expanding access to high-sensitivity screening methods such as HPV DNA testing.

## LIMITATIONS AND PERSPECTIVES

While this study provides a comprehensive overview of the epidemiological landscape of CC and HPV vaccination coverage in the Yucatán Peninsula, several limitations must be acknowledged. The availability and consistency of official data at the municipal level varied across the three states analyzed, limiting the precision of intra-regional comparisons and potentially affecting the accuracy of localized trend assessments. Special attention should be given to the availability and deployment of molecular HPV detection tools and the adequacy of medical supplies for effective diagnosis and clinical management. Such multidimensional approaches are essential for identifying systemic gaps and designing evidence-based, targeted interventions aimed at improving prevention, early detection, and care, particularly among vulnerable and underserved communities in the region.

## CONCLUSION

The findings of this study reveal persistently high prevalence and incidence rates of CC and HPV infection, alongside insufficient HPV vaccination coverage across many municipalities in the Yucatán Peninsula. These patterns underscore significant inequities in the implementation of both primary and secondary prevention strategies throughout the region. Effectively addressing this public health challenge will require a multifaceted approach that extends beyond the administration of the HPV vaccine. Public health policies must be restructured to ensure equitable access to vaccination, screening, and treatment services, particularly in rural, Indigenous, and underserved communities. This research provides valuable insights that can inform health policy development and support the design of evidence-based strategies aimed at increasing HPV vaccination coverage, strengthening early detection programs, and ultimately reducing the CC burden in this high-risk region of Mexico.

## CONFLICT OF INTEREST DECLARATION

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this study.


https://doi.org/10.36105/psrua.2025v5n9.02

## ACKNOWLEDGMENTS

We sincerely thank Dr. Olga Hernández Herman, Coordinator of the Medicine and Surgery program, and PhD. Daniela Rebolledo Solleiro, Coordinator of Basic Sciences, both from the International School of Medicine at Anáhuac Cancun University, for their valuable technical support in the completion of this manuscript.

## REFERENCES

1. Estrategia Mundial para Acelerar la Eliminación Del Cáncer Del Cuello Uterino Como Problema de Salud Pública. World Health Organization; 2021.
2. Ferlay J, Ervik M, Lam F, Laversanne M, Colombet M, Mery L, Piñeros M, Znaor A, Soerjomataram I, Bray F (2024), Global Cancer Observatory: Cancer Today. Lyon, France: International Agency for Research on Cancer.
3. Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024 May;74(3):229–63. https://doi.org/10.3322/caac.21834
4. Hernández-Silva CD, Ramírez de Arellano A, Pereira-Suárez AL, Ramírez-López IG. HPV and Cervical Cancer: Molecular and Immunological Aspects, Epidemiology and Effect of Vaccination in Latin American Women, Viruses. 2024;16(3):327. https://doi.org/10.3390/v16030327
5. Secretaria de Salud. Centro Nacional de Equidad de Género y Reproductiva. Hoja datos Cancer de Cuello Uterino 2019.
6. Capire-Castañeda AM, Vázquez-Vega S, Martínez-Salazar M, Valdespino-Vázquez R, Juárez-González K, Castillo-Pérez JJ. Prevalencia y seguimiento de cáncer cervicouterino (2018–2022): registro institucional de cáncer. Aten Fam. 2024;31(5):3. https://doi.org/10.22201/fm.14058871p.2024.5e.90002
7. Organización Panamericana de la Salud. Análisis de situación del cáncer cervicouterino en la Región de las Américas – Resumen ejecutivo. Washington; 2024.
8. Torreglosa-Hernández S, Grisales-Romero H, Morales-Carmona E, Hernández-Ávila JE, Huerta-Gutiérrez R, Barquet-Muñoz SA, Palacio-Mejía LS. Survival analysis and associated factors in patients with cervical cancer financed by the Seguro Popular in Mexico. Salud Publica Mex. 2022;64:76–86. https://doi.org/10.21149/13119
9. Amphora Health. Beluga Science. How [Internet]. 2025.
10. Prevención, detección, diagnóstico, tratamiento y seguimiento de lesiones precursoras de cáncer de cuello del útero. Guía de Práctica Clínica: Evidencias y Recomendaciones. México, CENETEC; 2024.
11. Instituto Nacional de Estadística y Geografía (INEGI). Estadística de defunciones registradas. 2017.
12. Instituto Nacional de Estadística y Geografía (INEGI). Estadísticas a propósito del día mundial contra el cáncer. 2018.
13. Secretaría de Salud. Información estadística: Estadísticas de cáncer de mama y cáncer cérvico uterino [Internet]. 2015.
14. Instituto Mexicano del Seguro Social. Epidemiología del cáncer cervicouterino. [Internet]. 2022.
15. Instituto Nacional de Estadística y Geografía (INEGI). Comunicado de prensa numero 478/24: estadísticas de defunciones registradas (edr). 2023.
16. Sánchez-Mercader Andrés, Cámara-Salazar Andrea, Traconis-Díaz Valeria, Sánchez-Buenfil Gabriel. Análisis de la mortalidad por cáncer cervicouterino en México y el estado de Yucatán. Ginecol. obstet. Méx. 2021; 89( 9 ): 671-677. https://doi.org/10.24245/gom.v89i9.4313
17. Guarneros-Cuellar AR, Reyes-Gabino PT, Valeria Jiménez-Baez M, Sandoval-Jurado L. Clinical profile women with and without human papiloma virus infection in Quintana Roo. Salud Quintana Roo. 2016;9(34):6-11.
18. Vázquez H, Montes JL, Panunzio ME, Ivalo S. Epidemiology and Recommendations on Human Papillomavirus (HPV) Vaccine. Actualizaciones En Sida E Infectología. 2024;32(115). https://doi.org/10.52226/revista.v32i115.333
19. Secretaría de Salud. Actualización de esquema de vacunación contra Virus del Papiloma Humano (VPH) en niñas/adolescentes femeninas y en la población de mujeres cis y trans que viven con VIH. Centro Nacional para la Salud de la Infancia y la Adolescencia. 2022.
20. Unidad de Inteligencia en Salud Pública (UISP). Campaña de vacunación contra el virus del papiloma humano en México [Internet]. 2023.
21. Organización Panamericana de la Salud (OPS). México lanza Campaña de Vacunación contra el Virus del Papiloma Humano. 2024.
22. Yelda A. Herrera. Historia de la evolución de las pruebas de tamizaje en el cáncer cervicouterino. Rev Med Inst Mex Seguro Soc. 2015;53(6):670–7.
23. Secretaría de Salud. Cáncer de cuello uterino. Prevención y detección oportuna [Internet]. 2015.

24. Secretaría de Salud del Estado de Yucatán. Boletín Epidemiológico [Internet]. 2023.
25. Secretaría de Salud del Estado de Campeche. Boletín Epidemiológico [Internet]. 2023.
26. Secretaría de Salud del Estado de Quintana Roo. Boletín Epidemiológico [Internet]. 2023.
27. Unger-Saldaña K, Fitch-Picos K, Villarreal-Garza C. Breast Cancer Diagnostic Delays Among Young Mexican Women Are Associated With a Lack of Suspicion by Health Care Providers at First Presentation. J Glob Oncol. 2019 Jul 23;(5):1–12. https://doi.org/10.1200/JGO.19.00093
28. Arango-Bravo EA, Cetina-Pérez L del C, Galicia-Carmona T, Castro-Eguiluz D, Gallardo-Rincón D, Cruz-Bautista I, et al. The health system and access to treatment in patients with cervical cancer in Mexico. Front Oncol. 2022 Nov 30;12:1028291. https://doi.org/10.3389/fonc.2022.1028291
29. León-Maldonado L, López-Olmedo N, Murillo R,Hurtado-Salgado E, Allen-Leigh B, Armengol-Alonso A, Torres-Mejía G, Bautista-Arredondo S,Barrientos-Gutiérrez T, Lazcano-Ponce E. Cervical cancer screening. Salud Publica Mex. 2024;66:549-555. https://doi.org/10.21149/15894
30. Drolet M, Bénard É, Pérez N, Brisson M, Ali H, Boily MC, et al. Population-level impact and herd effects following the introduction of human papillomavirus vaccination programmes: updated systematic review and meta-analysis. The Lancet. 2019 Aug 10;394(10197):497–509. https://doi.org/10.1016/S0140-6736(19)30298-3
31. Hernández-Ávila M, Palacio-Mejía LS, Hernández-Ávila JE, Charvel S. Vaccination in Mexico: imprecise coverages and deficiency in the follow-up of children with incomplete immunization. Salud Publica Mex. 2020;62:215-224. https://doi.org/10.21149/10682
32. Torres-Cruz C. Género, biomedicina y el virus del papiloma humano en México. Gender, Biomedicine, and the Human Papillomavirus in Mexico. Sociotechnical Complexities within the Public Policy Vaccination. MUSAS Revista de Investigación en Mujer, Salud y Sociedad. 2023 May 30;8(1). https://doi.org/10.1344/musas2023.vol8.num1.3
33. Anaya Rodríguez AF, Anaya Rodríguez AF. Nonavalent vaccine against human papillomavirus: a strategy to prevent cervical cancer. Ginecol Obstet Mex. 2024; 92(6):267–73. https://doi.org/10.24245/gom.v92i6.9659
34. Tapia MNG, González CNO, Davish MÁB, Barrios KF, Hernández VMV. En México es necesaria la incorporación de la vacuna nonavalente contra virus del papiloma humano a los programas de prevención de Salud Pública. Revista de enfermedades del tracto genital inferior. 2024;18(1):59–65.
35. Bayefsky MJ. The Ethical Case for Mandating HPV Vaccination. Journal of Law, Medicine & Ethics. 2018;46(2):501–10. https://doi.org/10.1177/1073110518782957