International Cartographic Association
Association Cartographique Internationale

Spatial Analysis of HPV Cancer Mortality in Persistent Poverty Counties in the US (1999-2020)

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Keywords: HPV Cancer mortality, persistent Poverty counties, Spatial analysis, US Counties

Abstract:

Human papillomavirus (HPV) is the most common sexually transmitted infection in the United States, with nearly 90% of men and 80% of women contracting an HPV strain at some point in their lives. Of these infections, approximately 50% involve high-risk, cancer-causing strains (Vickers et al., 2019). While many HPV infections are low-risk and resolve on their own, certain high-risk strains are linked to cancer development. Data from the Centers for Disease Control and Prevention (CDC) for 2017–2021 reports over 47,100 new cases of HPV-related cancer annually (Centers for Disease Control and Prevention, 2024). Globally, HPV accounts for 5% of all cancers (National Cancer Institute, 2023). Cervical cancer is the fourth most common cancer in women globally and caused an estimated 342,000 deaths in 2020 (World Health Organization, 2024). Cervical cancer is the most common HPV-associated cancer among women, and oropharyngeal cancers (cancers of the back of the throat, including the base of the tongue and tonsils) are the most common among men in the US (Centers for Disease Control and Prevention, 2024).

Previous research highlights racial and socioeconomic disparities in HPV-related cancer mortality. Economic burdens have been linked to increased HPV cancer mortality (Priyadarshini et al., 2021), and disparities are notably higher among Black residents in rural, persistently impoverished areas (Moss et al., 2020). Furthermore, low-income and uninsured women face elevated cervical cancer mortality risks (Freeman & Wingrove, 2005). These studies have laid a foundation for further investigations of cancer mortality in high-poverty areas and specific poor population groups within a standard nationwide poverty measure such as 'Persistent Poverty.' Persistent poverty, defined as areas with ≥20% of the population in poverty since 1980, is characterized by structural, economic, and behavioral vulnerabilities that exacerbate cancer disparities. This study focuses on understanding HPV cancer mortalities in persistent poverty counties across the United States of America.

This study utilized county-level HPV cancer mortality data from the National Center for Health Statistics (NCHS), accessed via SEER*Stat, combined with persistent poverty county classifications from the USDA and sociodemographic data from the U.S. Census Bureau. The analysis focused on disparities in HPV-related cancer mortality between 1999 and 2020, comparing persistent poverty counties to non-persistent poverty counties. Additionally, the study investigated the association of race and other socioeconomic factors with HPV cancer mortality and examined the spatial distribution of these disparities across the United States.

Inferential analyses included exploratory spatial analysis, independent sample t-tests, and multivariate spatial regression using a spatial autoregressive model. The findings showed significant disparities in HPV cancer mortality rates between persistent and non-persistent poverty counties (mean difference: 2.47 ± 3.41; $t = -16.9$, $p < 0.001$). HPV mortality rates were also significantly higher in non-metropolitan counties than metropolitan counties (mean difference: 3.05 ± 2.78; $t = 7.96$, $p < 0.001$). Spatial analysis revealed higher proportions of HPV-related cancer mortality in southern U.S. counties, particularly in persistently impoverished rural areas with heightened structural, social, and behavioral vulnerabilities. While the specific causes of elevated cancer mortality in persistent poverty counties remain unclear, Moss et al. (2020) suggest that these areas often experience low cancer screening rates and inadequate healthcare infrastructure to manage cancer burdens effectively.

Spatial regression analysis indicated significant positive associations between all HPV cancer mortality rates and the percentage of high school graduates, the percentage of non-Hispanic Black residents, the unemployment rate, and the percentage of the female population, with the model explaining 42% of the variance in HPV cancer mortality rates. Although persistent poverty status showed a positive but non-significant association with overall HPV cancer mortality rates, significant associations were observed for cervical and non-cervical cancer mortality rates, particularly among non-Hispanic Black populations and in counties with higher unemployment and female population percentages.

In conclusion, persistent poverty counties exhibit significantly higher HPV cancer mortality rates compared to other counties, although some disparities diminish when controlling for sociodemographic factors. To our knowledge, this is the first national study to evaluate the relationship between persistent poverty and HPV cancer mortality and to compare

Abstracts of the International Cartographic Association, 10, 66, 2025
32nd International Cartographic Conference (ICC 2025), 17–22 August 2025, Vancouver, Canada.
https://doi.org/10.5194/ica-abs-10-66-2025

disparities using a persistent poverty framework versus a non-persistent poverty framework. Additional research is necessary to assess the relationship between other types of HPV-related cancers and counties experiencing persistent poverty in the United States. Future investigations could utilize advanced modelling techniques, such as time series analysis, to examine how HPV cancer mortality rates vary across time and geographic regions. Moreover, factors like vaccination rates could be analyzed to understand their impact on HPV-related mortality. The methodological approach used in this study may also apply to research on other forms of cancer.

References

Freeman, H. P., & Wingrove, B. K. (2005). Excess Cervical Cancer Mortality: A Marker for Low Access to Health Care in Poor Communities (NIH Pub. No. 05–5282). Rockville, *MD: National Cancer Institute, Center to Reduce Cancer Health Disparities.*

Moss, J. L., Pinto, C. N., Srinivasan, S., Cronin, K. A., & Croyle, R. T. (2020). Persistent Poverty and Cancer Mortality Rates: An Analysis of County-Level Poverty Designations. *Cancer Epidemiology, Biomarkers & Prevention*, 29(10), 1949–1954. https://doi.org/10.1158/1055-9965.EPI-20-0007

National Cancer Institute. (2023). HPV and Cancer. https://www.cancer.gov/about-cancer/causes-prevention/risk/infectious-agents/hpv-and-cancer

Priyadarshini, M., Prabhu, V. S., Snedecor, S. J., Corman, S., Kuter, B. J., Nwankwo, C., Chirovsky, D., & Myers, E. (2021). Economic Value of Lost Productivity Attributable to Human Papillomavirus Cancer Mortality in the United States. Frontiers in Public Health, 8, 624092. https://doi.org/10.3389/fpubh.2020.624092

U.S. Centers for Disease Control and Prevention. (2024). Cancers Linked with HPV Each Year. Centers for Disease Control and Prevention. https://www.cdc.gov/cancer/hpv/cases.html?CDC_AAref_Val=https://www.cdc.gov/cancer/hpv/statistics/cases.htm

U.S. Centers for Disease Control and Prevention. (2024). United States Cancer Statistics: Cancers Associated with Human Papillomavirus. Centers for Disease Control and Prevention. https://www.cdc.gov/united-states-cancer-statistics/publications/hpv-associated-cancers.html