

# Public Health and Economic Impact of Gender-Neutral Nine-Valent Human Papillomavirus Vaccination Program in Algeria

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## Background

According to the Catalan Institute of Oncology (ICO)/International Agency for Research on Cancer (IARC) Information Centre on HPV and Cancer Information Report,<sup>1</sup> Algeria has a population of 15.2 million women aged 15 years and older who are at risk of developing cervical cancer. Current estimates indicate that every year in Algeria 1,663 women are diagnosed with cervical cancer and 930 die from the disease. Cervical cancer is the fourth-most frequent cancer among women in Algeria and the seventh-most frequent cancer among women between the ages of 15 and 44 years. Despite the significant burden of HPV-related diseases in Algeria, currently human papillomavirus (HPV) vaccination (HPVv) is not included in Algeria's National Immunization Program (NIP). Understanding the health, economic, and epidemiological impacts of vaccination is crucial to make evidence-based decisions on the expansion of the NIP in this country.

## Objectives

To assess the public health and economic impact of gender-neutral vaccination (GNV) with 9-valent HPV vaccine (9vHPV) with vaccine coverage rate (VCR) 80% girls and 60% boys in the 11-12 years age group in comparison to no vaccination (screening only) from the Algerian NIP perspective.

## Methods

- A published and validated HPV dynamic transmission model,<sup>2</sup> built in Wolfram Mathematica® (Wolfram Research), was adapted and calibrated to assess the public health and economic impact of vaccination of 11- to 12-year-old girls and boys with a 2-dose schedule.
- The age-structured mathematical model comprised demographic variables describing the age structure of the population, behavioral variables describing sexual activity, and epidemiologic variables describing transmission of HPV infection and any HPV-related diseases. The model assumed a 100-year time horizon, lifelong immunity following vaccination, herd immunity, ongoing cytology screening, and a discount rate of 3% for costs and benefits.
- Algeria-specific data have been used, ie, demographic,<sup>3</sup> epidemiological,<sup>1</sup> screening,<sup>4</sup> and economic parameters.<sup>5</sup> Costs of treatment, screening, and diagnostic tests were based on Bennacef et al. (2022).<sup>5</sup>

## Results

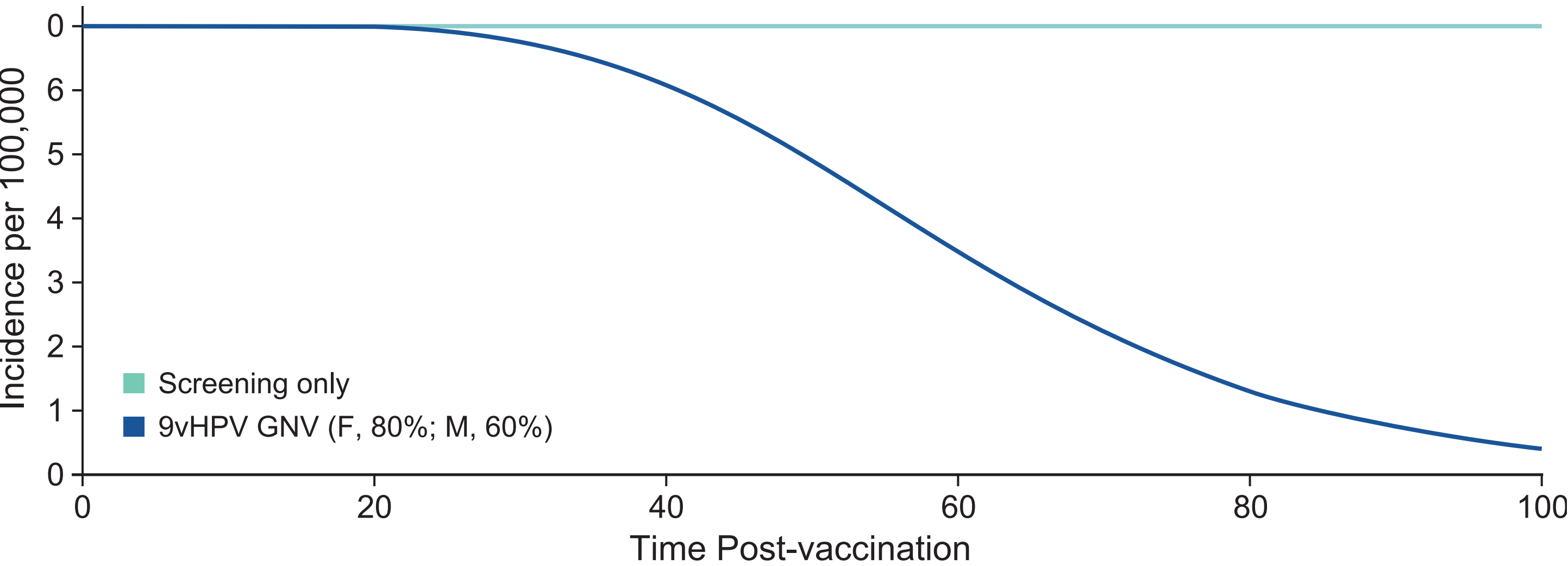
- The model demonstrated that vaccination with 9vHPV would additionally prevent 32,263 and 10,009 HPV-related deaths in women and men, respectively. Over a 100-year time frame, 58,012 cervical cancer cases and 3,377 head and neck cancer cases could be averted by 9HPVv in females. In males, 16,081 head and neck cancers cases could be prevented in the same period. In both genders, 2,268,080 genital warts cases could be prevented in both genders by 9vHPV. The cumulative number of quality-adjusted life years (QALY) gained over this period would be 133,050.
- Table 2** shows the economic results for the base-case analysis, which includes vaccinating girls and boys in the 11-12 years age range (VCR: girls, 80%; boys, 60%) vs screening only (no vaccination) for a 100-year time horizon. The results show reductions in the direct medical costs of all categories in both scenarios. The most significant reductions are observed in genital warts in males and females and cervical cancer costs equaling \$126,411,639 (~36.6%) and \$117,142,879 (~14.3%) for 100 years subsequently. Overall, the decrease of HPV-related disease costs is anticipated to be ~\$345,461,815 (~21.3%) with GNV in the 11-12 years age bracket in comparison with no vaccination.

**Table 1. Changes in incidence and mortality with 9vHPV GNV vs no vaccination (screening only) over a 100-year time horizon**

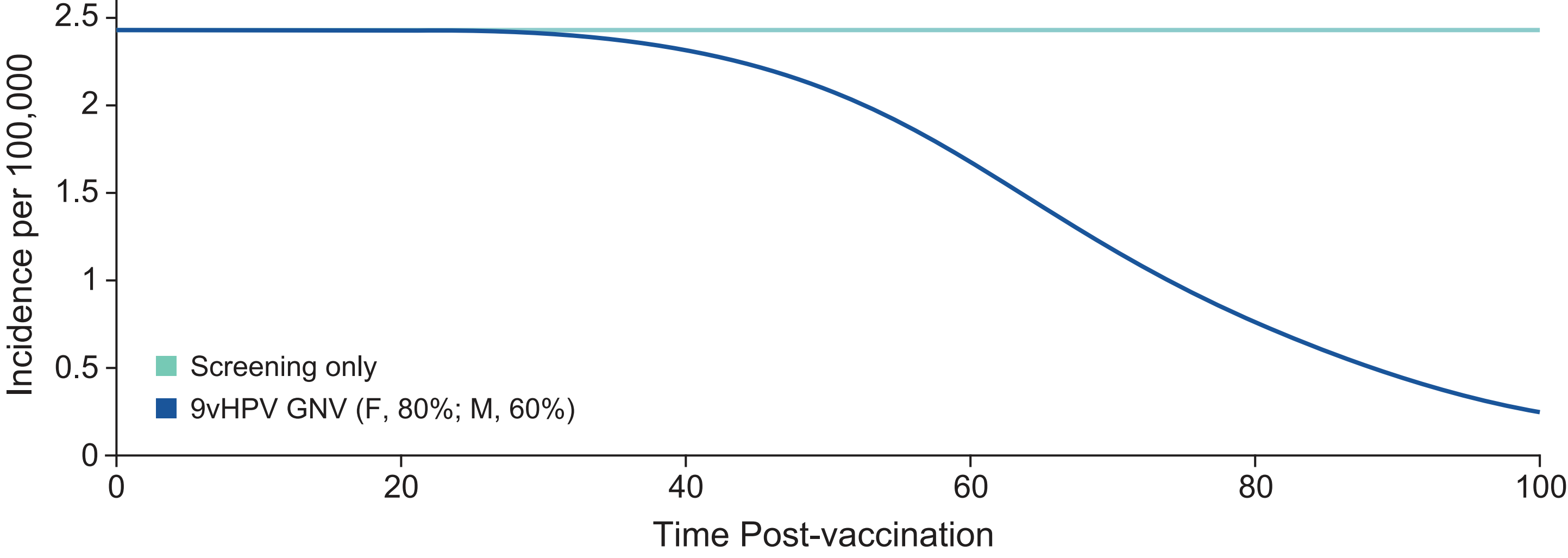
HPV-Related Diseases	Incidence Cases Prevented		Mortality Deaths Prevented	
	Female, n (%)	Male, n (%)	Female, n (%)	Male, n (%)
Cervical cancer	58,012 (38.3%)	–	29,417 (34.7%)	–
CIN 1	106,799 (69.2%)	–	–	–
CIN 2+	183,933 (68.4%)	–	–	–
Anal cancer	916 (31.3%)	887 (28.4%)	329 (30.1%)	427 (27.3%)
Genital warts	1,135,008 (65.0%)	1,133,072 (63.0%)	–	–
Head and neck	3,377 (30.8%)	16,081 (29.7%)	1,483 (27.9%)	9,064 (27.4%)
Vaginal cancer	777 (32.9%)	–	285 (29.5%)	–
VAIN 1	1,775 (58.7%)	–	–	–
VAIN 2/3	2,038 (57.5%)	–	–	–
Vulvar cancer	596 (28.7%)	–	210 (25.9%)	–
Penile cancer	–	88 (40.7%)	–	26 (37.1%)
Recurrent respiratory papillomatosis	12,265 (67.2%)	11,269 (66.6%)	539 (62.7%)	492 (62.3%)

CIN, cervical intraepithelial neoplasia; VAIN, vaginal intraepithelial neoplasia.

**Figure 1. Estimated HPV 16/18/31/33/45/52/58-related incidence of cervical cancer over a 100-year time horizon**



**Figure 2. Estimated HPV 16/18/31/33/45/52/58-related incidence of head and neck cancers among males over a 100-year time horizon**



**Table 2. Cumulative HPV-related disease costs for 9vHPV GNV vs no vaccination (screening only) in an 11- to 12-year-old population over a 100-year time horizon**

HPV-Related Diseases	No Vaccination	9vHPV (F, 80%; M, 60%)	Cost Reduction
Cervical cancer	\$817,049,366	\$699,906,487	\$117,142,879 (14.3%)
CIN 1	\$57,253,054	\$36,185,522	\$21,067,532 (36.8%)
HPV 6/11-related CIN 1	\$6,620,893	\$3,996,487	\$2,624,406 (39.6%)
CIN 2/3	\$126,781,762	\$75,103,841	\$51,677,921 (40.8%)
Vaginal cancer	\$6,847,418	\$6,084,028	\$763,390 (11.1%)
VAIN 1	\$9,257	\$6,672	\$2,585 (27.9%)
VAIN 2/3	\$891,299	\$649,998	\$241,301 (27.1%)
Vulvar cancer	\$6,523,408	\$5,922,833	\$600,575 (9.2%)
Genital warts, males	\$175,378,231	\$113,187,741	\$62,190,490 (35.5%)
Genital warts, females	\$170,157,865	\$105,936,716	\$64,221,149 (37.7%)
Anal cancer, males	\$9,279,425	\$8,407,418	\$872,007 (9.4%)
Anal cancer, females	\$8,692,903	\$7,760,613	\$932,290 (10.7%)
Head & neck cancers, males	\$195,101,212	\$176,069,202	\$19,032,010 (9.8%)
Head & neck cancers, females	\$39,534,980	\$35,499,960	\$4,035,020 (10.2%)
Penile cancer	\$390,117	\$331,857	\$58,260 (14.9%)
Recurrent respiratory papillomatosis, males	Costs not available	Costs not available	–
Recurrent respiratory papillomatosis, females	Costs not available	Costs not available	–
<b>Total disease costs</b>	<b>\$1,620,511,193</b>	<b>\$1,275,049,374</b>	<b>\$345,461,815 (21.3%)</b>

CIN, cervical intraepithelial neoplasia; VAIN, vaginal intraepithelial neoplasia.

## Limitations

- Direct medical costs associated with potential complications and palliative care in HPV-related cancers were not included in the model. This may result in underestimation of costs of treatment
- Indirect costs were not taken into consideration
- Costs of recurrent respiratory papillomatosis were not collected in the cost analysis. That underestimates the burden of HPV-related diseases

## Conclusions

Gender-neutral vaccination with the 9vHPV vaccine (VCR: girls, 80%; boys, 60%) in the 11- to 12-years age group will show a significant decrease in the incidence and mortality of many types of cancers in Algeria. It is an important advancement for the public health system, which is evident by the results of this analysis demonstrating its impact on the reduction of epidemiological and economic burden of disease attributable to HPV.

## References

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