

# Evaluating the cost effectiveness of HPV vaccination in Egypt

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## Introduction

Cervical cancer remains a significant public health burden globally, particularly in low- and middle-income countries, where screening and early detection programs are limited. Persistent infection with high-risk human papillomavirus (HPV) types is the primary cause of cervical cancer and its precursor lesions, including squamous intraepithelial lesions (SIL). Prophylactic HPV vaccination has demonstrated substantial clinical efficacy in reducing HPV-related disease incidence and has been widely recognized as a cost-effective preventive strategy in multiple settings.

In Egypt, HPV vaccination is offered to female adolescents and adults aged  $\geq 12$  years; however, evidence on its economic value within the local healthcare context remains limited. Given constrained healthcare resources and competing priorities, economic evaluation is critical to inform policy decisions regarding vaccine implementation and scale-up.

## Objective

This analysis evaluated the cost-effectiveness of HPV vaccinations among females (aged  $\geq 12$  years) in Egypt.

## Methods

A static decision-tree model was adapted to the geographic setting of Egypt to estimate costs & health outcomes associated with HPV vaccination, compared to no vaccination. The model simulated the HPV vaccination over a lifetime horizon from a public payer perspective. The vaccination coverage was assumed to be 80%, and booster doses were administered at 10 & 20 years following the initial dose. Other parameters were derived from published literature. Costs were converted to US\$, 2025. Costs and benefits were discounted at 3% annually. Probabilistic sensitivity analysis (PSA) was conducted to assess parameter uncertainty by varying all model inputs across predefined probability distributions. Key parameters, including costs, utilities, vaccine efficacy, disease progression rates, and coverage, were assigned appropriate distributions (gamma for costs, and beta for probabilities and utilities). A Monte Carlo simulation (1,000 iterations) was performed, with results presented on the cost-effectiveness plane and cost-effectiveness acceptability curve (CEAC) estimating the probability of HPV vaccination being cost-effective across a range of willingness-to-pay (WTP) thresholds.

## Results

Vaccinating females aged  $\geq 12$  years with the HPV vaccine results in total costs of \$902.4 million and 35.5 million QALYs, compared to no vaccination which results in healthcare costs of \$19.2 million and 28.4 million QALYs. HPV vaccination increases costs by \$883.1 million while generating 7.08 million additional QALYs, resulting in an ICER of \$124.70 per QALY gained. The ICER remains well below the WTP threshold for Egypt, typically defined as one to three times the GDP per capita (approximately US \$3,400–\$3,500 per year). Therefore, HPV vaccination for females aged  $\geq 12$  years is highly cost-effective in the Egyptian context.

The cost-effectiveness plane demonstrates that HPV vaccination is consistently associated with higher costs and improved health outcomes, compared to no vaccination. The mean incremental estimate aligns closely with the deterministic base-case results, suggesting stability of the model outputs.

The cost-effectiveness acceptability curve shows that the probability of HPV vaccination being cost-effective is at 80% at WTP thresholds of approximately US\$ 450 per QALY and approaches nearly 100% at thresholds above US\$ 800 per QALY.

Figure 1: Decision tree of HPV vaccine and control group

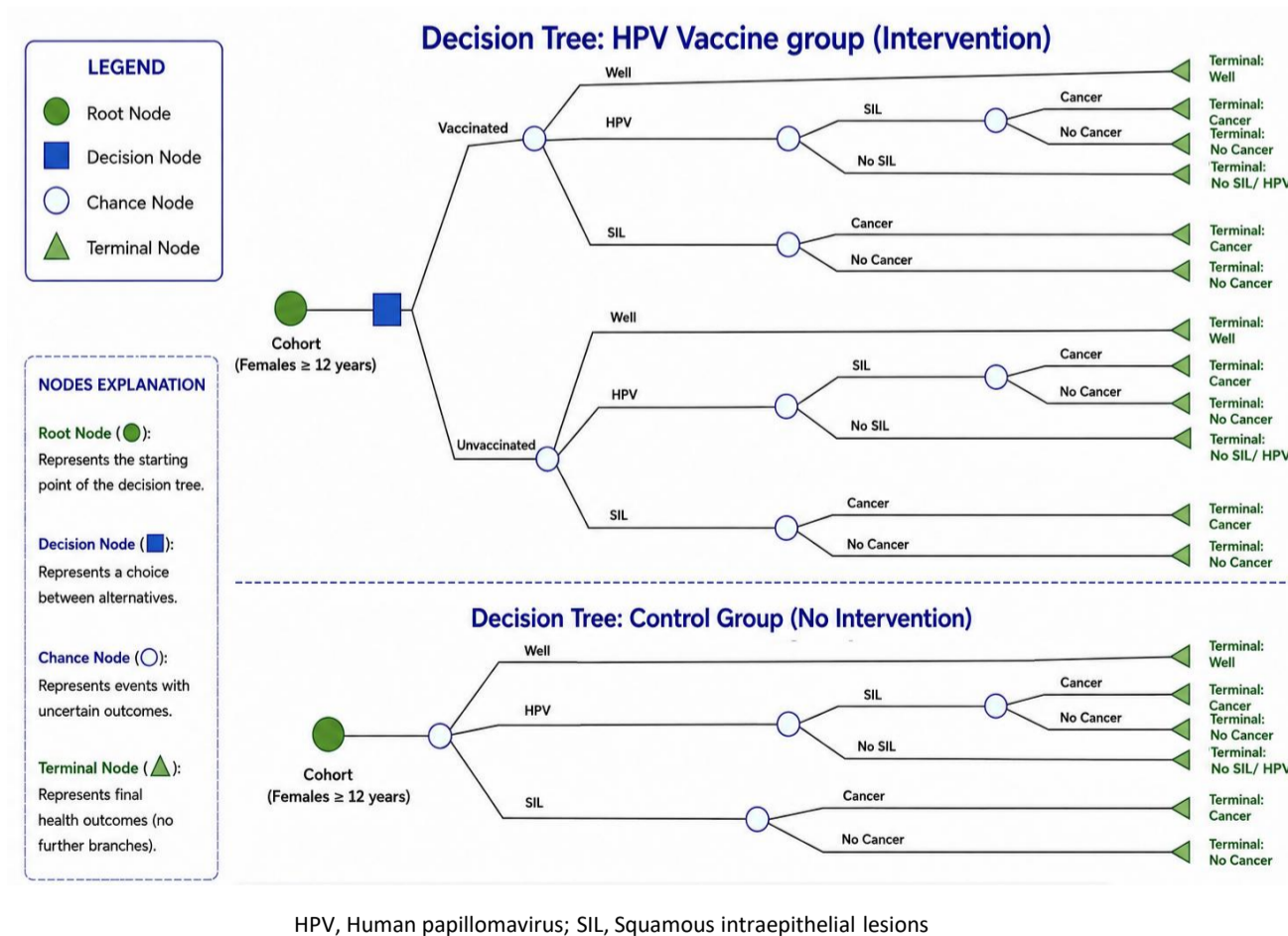


Figure 2: Probabilistic sensitivity analysis – Cost effectiveness Plane

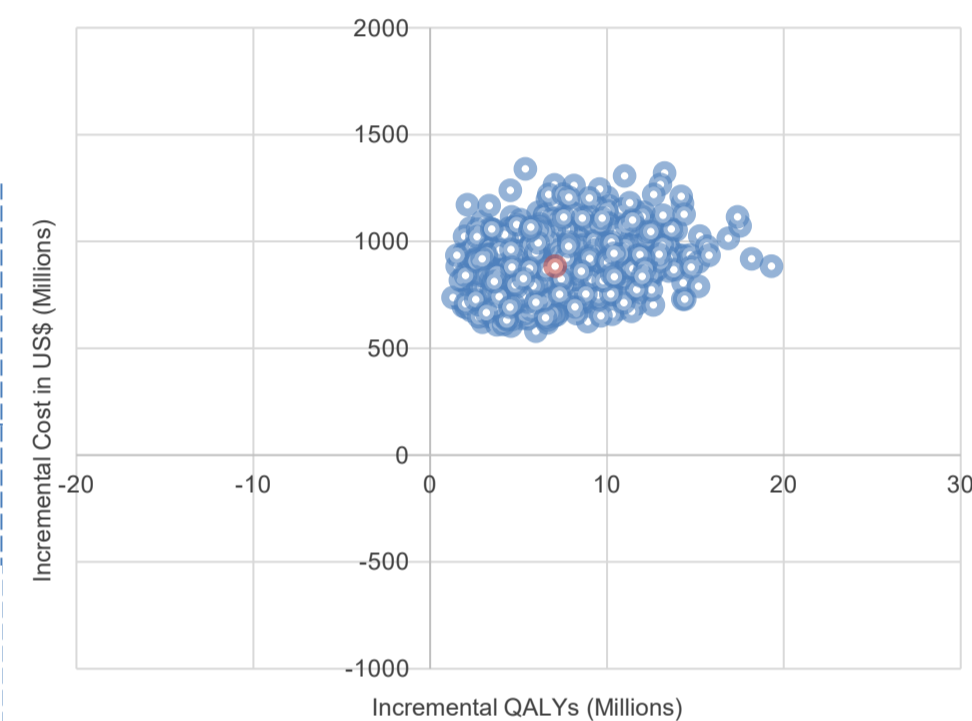
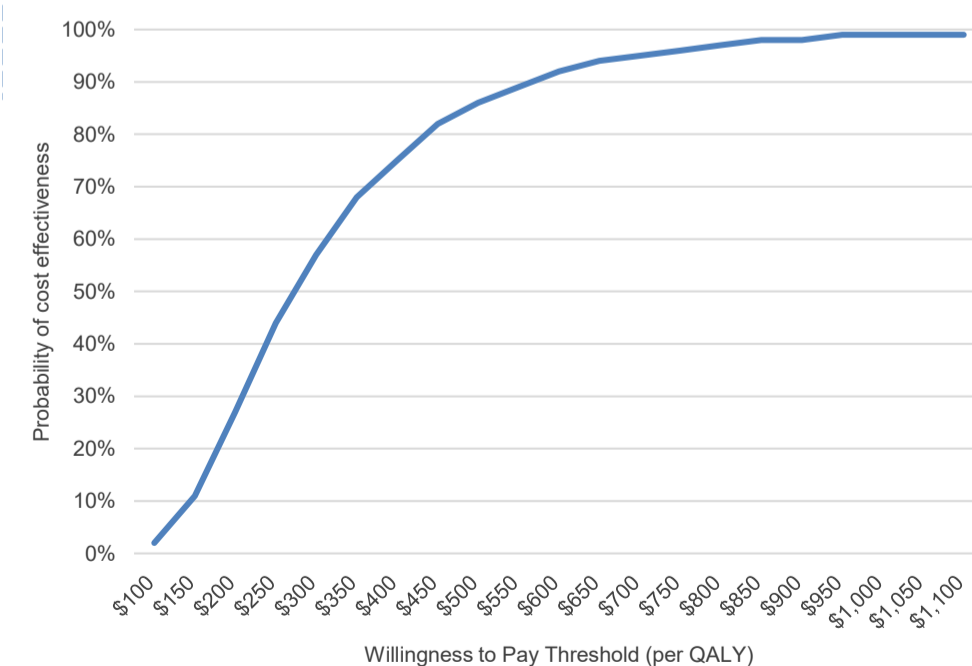


Figure 3: Cost effectiveness acceptability curve



## Discussion

This study shows that HPV vaccination is a very efficient use of healthcare resources in Egypt, with benefits that are exceptionally high relative to its cost. An ICER of \$124.70 per QALY is far below the threshold, indicating that the intervention delivers high health returns relative to its cost. The consistency observed in probabilistic analysis results strengthens the decision confidence. In practical terms, this reduces the decision risk for policymakers, which is an important factor in low- and middle-income settings such as Egypt, where budget misallocation has significant consequences.

However, the model structure introduces important limitations. The use of a static decision-tree framework does not capture herd immunity or transmission dynamics. Thereby, the analysis likely underestimates the full population-level benefits of vaccination. Also, assumptions such as 80% coverage and reliance on published parameters may overstate real-world performance if implementation barriers (e.g., uptake, access, or delivery infrastructure) are not addressed. In addition, a markov model may be more optimal than a decision-tree structure for modelling chronic, progressive diseases such as cancer.

## Conclusion

HPV vaccination for females aged  $\geq 12$  years is a highly cost-effective intervention in Egypt, delivering substantial health gains at a low incremental cost.

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