

Epidemiological and Economic Impact of Gender-Neutral Nine-Valent Human Papillomavirus Vaccination Program in Kazakhstan

Kaidarova D¹; Ugrekhelidze D²; Pavelyev A³; Daniels V³; Mamane C⁴

¹Kazakh Research Institute for Oncology and Radiology, Almaty, Kazakhstan; ²MSD, Zurich, Switzerland; ³Merck & Co., Inc., Rahway, NJ, USA; ⁴MSD France, Puteaux, France

Background

According to the ICO/IARC Information Centre on HPV and Cancer Information Report,¹ Kazakhstan has a population of 7.24 million women aged 15 years and older who are at risk of developing cervical cancer. Current estimates indicate that every year, 2,100 women are diagnosed with cervical cancer, and 600 died from the disease in 2023.² Cervical cancer is the second most frequent cancer among women in Kazakhstan and the second most frequent cancer among women between the ages of 15 and 44. Currently, HPV vaccination (HPVv) is included in the National Immunization Program (NIP) with 4-valent HPV vaccine. Understanding the health economic and epidemiological impact of vaccination is crucial to making evidence-based decisions on the expansion of NIP in this country with 9-valent HPV vaccine (9vHPV).

Objectives

To assess the epidemiological and economic impact of gender-neutral vaccination (GNV) with 9-valent HPV vaccine with vaccine coverage rate (VCR) of 80% girls and 50% boys in the 11- to 12-year-old age group in comparison with 4-valent HPVv GNV from the Kazakhstan National Immunization Program perspective. An alternative scenario was to showcase the impact of GNV with 9vHPV in comparison with no vaccination without screening.

Methods

- A published and validated HPV dynamic transmission model,² built in Mathematica®, was adapted and calibrated to assess the public health and economic impact of 11- to 12-year-old girls' and boys' 9vHPV vaccination with a two-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.
- Kazakhstan-specific data have been used, ie, demographic,⁴ epidemiological,¹ screening,⁵ and economic parameters.⁶ Costs of treatment, screening, and diagnostic tests were based on tariffs of healthcare services in Kazakhstan.

Results

- The model demonstrated that 9vHPV GNV can also prevent 97,714 cases of HPV-related diseases over 100 years in comparison with 4vHPV GNV in Kazakhstan. The overall number of additionally prevented HPV-related deaths will equal 8,527. 21,439 cervical cancer cases (18.7%) and 24,452 CIN2+ cases (42.2%) can be averted by 9HPVv GNV in females over 100 years. The cumulative number of quality-adjusted life years gained over this period will be 23,136. The decrease of HPV-related disease treatment costs is anticipated to be around 6.6 billion KZT (\$14.7 million USD) over 100 years.
- In comparison with screening only without vaccination, 9vHPV GNV can prevent 1,681,623 cases of HPV-related diseases over 100 years (1,096,197 cases in females and 585,426 cases in males). 38,632 HPV-related deaths can be prevented in comparison with no vaccination. The decrease of HPV-related disease treatment costs is anticipated to be around 43.2 billion KZT (\$93.3 million USD) over 100 years.

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	71,688 (43.5%)	–	30,108 (39.0%)	–
CIN 1	80,502 (69.7%)	–	–	–
CIN 2+	79,814 (69.7%)	–	–	–
Anal cancer	1,408 (35.3%)	730 (32.2%)	707 (32.1%)	460 (29.3%)
Genital warts	655,889 (58.6%)	555,387 (45.0%)	–	–
HPV 6/11-related CIN 1	180,601 (54.5%)	–	–	–
Head and neck	1,485 (35.3%)	5,850 (36.5%)	930 (32.8%)	3,437 (34.6%)
Vaginal cancer	1,234 (37.1%)	–	470 (33.0%)	–
Vulvar cancer	718 (33.2%)	–	328 (29.9%)	–
Penile cancer	–	488 (48.2%)	–	149 (44.2%)
RRP	22,858 (52.6%)	22,971 (50.0%)	1,021 (49.3%)	1,022 (47.0%)

CIN, cervical intraepithelial neoplasia.

Table 2. Changes in incidence and mortality with 9vHPV GNV vs 4vHPV GNV over 100-year time horizon

HPV-related diseases	Incidence Cases prevented		Mortality Deaths prevented	
	Female, n (%)	Male, n (%)	Female, n (%)	Male, n (%)
Cervical cancer	21,439 (18.7%)	–	8,333 (15.2%)	–
CIN 1	51,465 (56.9%)	–	–	–
CIN 2+	24,452 (42.2%)	–	–	–
Anal cancer	68 (2.6%)	34 (2.2%)	34 (2.3%)	21 (1.9%)
Genital warts	0	0	–	–
Head and neck	0	0	–	–
Vaginal cancer	187 (8.3%)	–	72 (7.1%)	–
Vulvar cancer	107 (7.0%)	–	48 (6.0%)	–
Penile cancer	–	62 (10.6%)	–	19 (9.3%)

Figure 1. Estimated HPV 16/18/31/33/45/52/58-related incidence of cervical cancer over 100 years

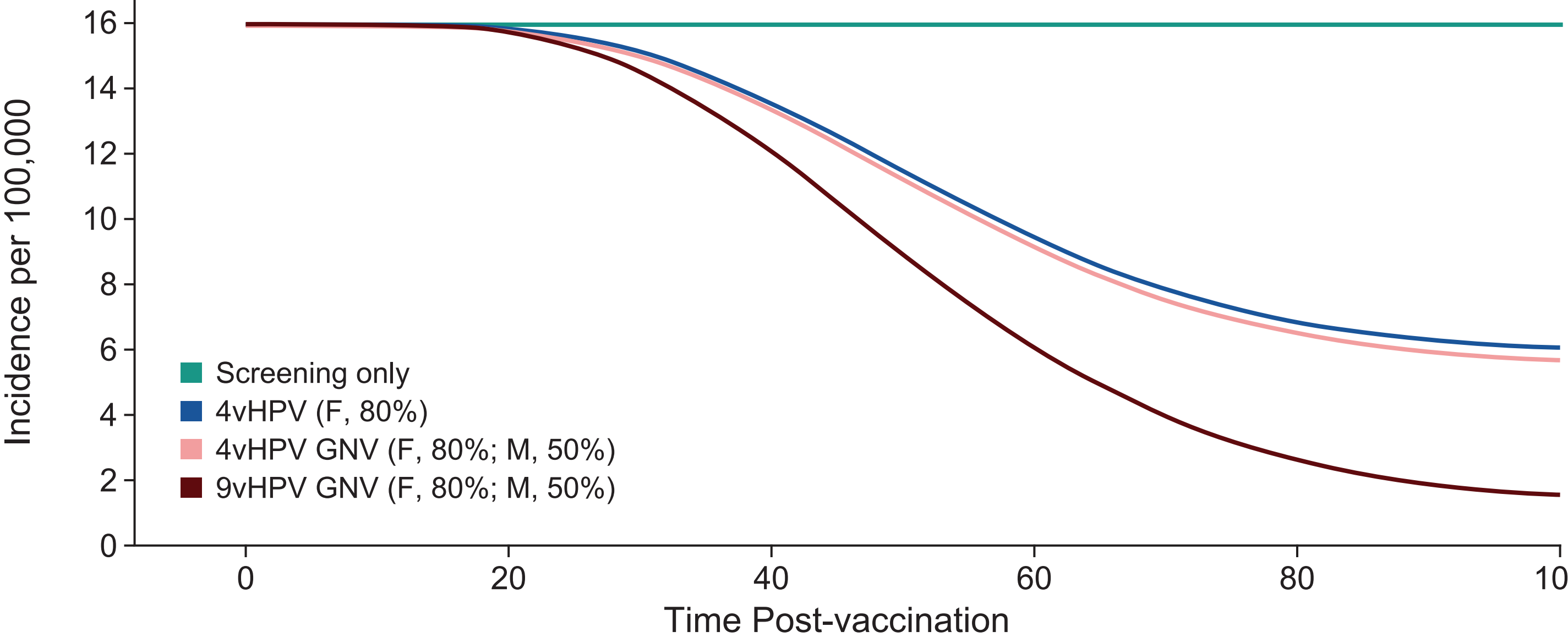


Figure 2. Estimated HPV 16/18/31/33/45/52/58-related incidence of CIN 2/3 among females over 100 years

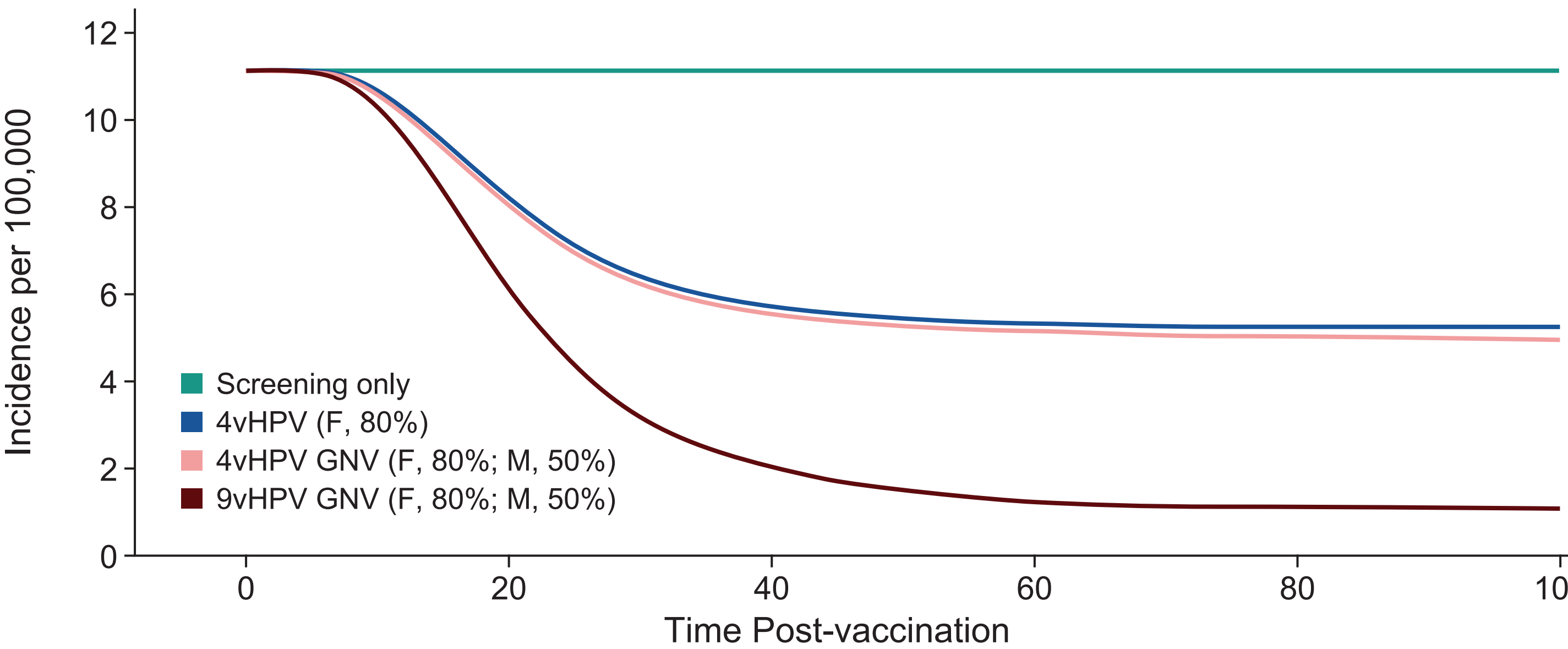
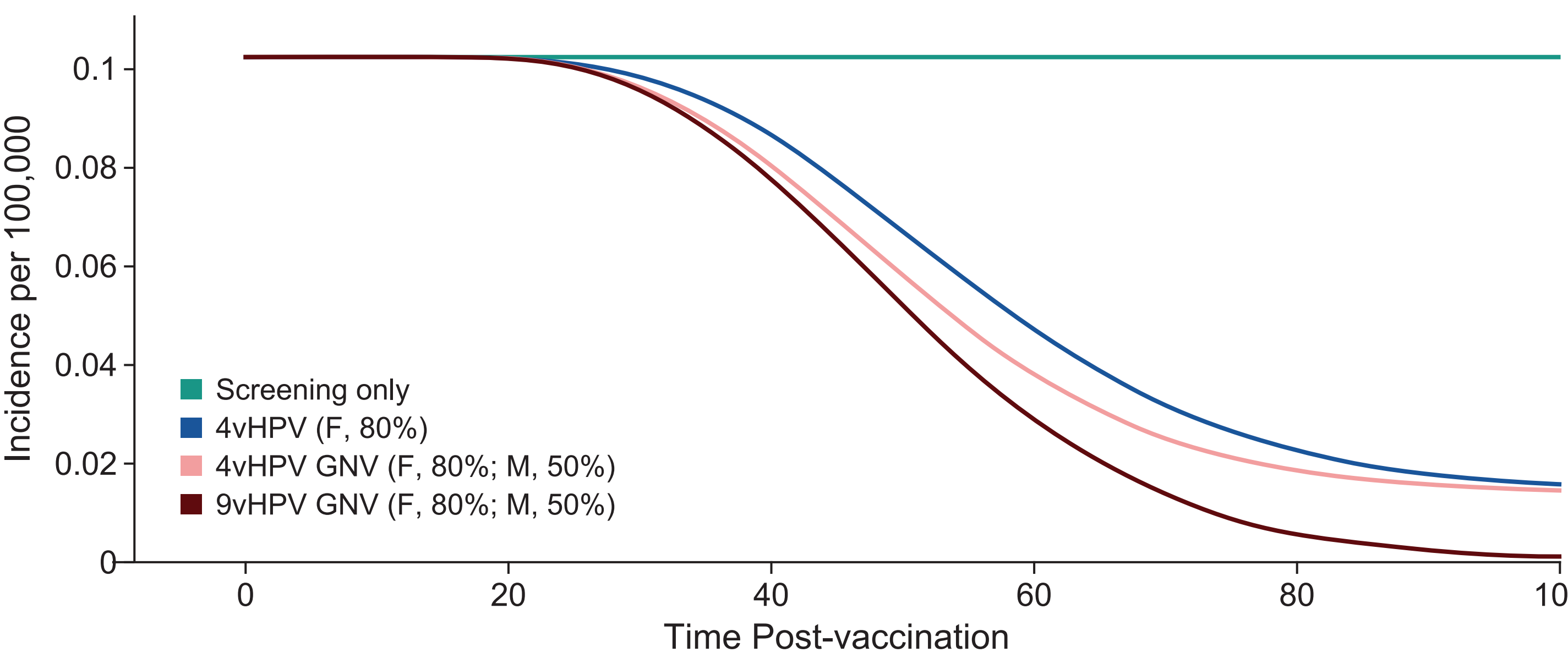


Figure 3. Estimated HPV 16/18/31/33/45/52/58-related incidence of penile cancer among males over 100 years



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 cost underestimation of treatment
- Indirect costs were not taken into consideration

Conclusions

Gender-neutral vaccination with the 9-valent HPV vaccine (vaccination coverage rate: 80% for girls and 50% for boys) in the 11- to 12-year-old age group in Kazakhstan shows a significant impact in terms of public health and economic benefits associated with the prevention of HPV-related diseases, compared with 4-valent HPV vaccine and screening only without vaccination.

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