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Burden of HPV-Related Diseases in the Czech Republic: Model-Based Study

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Introduction

Human papillomavirus (HPV) infections are among the most prevalent sexually transmitted infections worldwide and are associated with various cancers. This model-based study assessed the burden of HPV-related diseases in the Czech Republic and evaluated the cost-effectiveness of a potential 9vHPV catch-up vaccination program.

Methods

- A Markov multistate model was developed to calculate the lifetime health and economic outcomes of HPV infections and vaccination (Fig.1) [1].
- The model was simulated for 94 cycles (up to the age of 105), separately for 11-years old males and females The simulation comprised 58,368 females and 60,994 males.
- Additionally, cohorts of ages 15-21 were simulated to assess the impact of catch-up vaccination outside the 11-year-old age group. Four possible scenarios were considered: one where none of the unvaccinated receive the vaccine, and three others where 10%, 20%, and 30% of the remaining individuals are vaccinated with the 9vHPV vaccine.

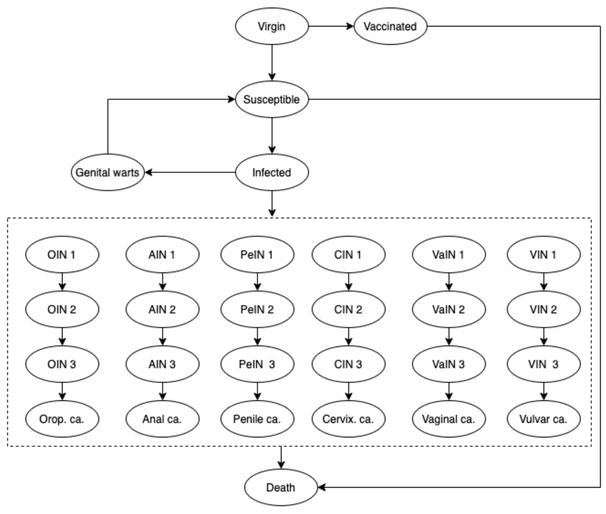

***Fig 1** The simplified structure of the Markov model. Intraepithelial neoplasia (3 degrees of severity) is referred as -IN, which can progress to cancer. Cervical (CIN), vulvar (VIN), vaginal (VaIN), anal (AIN), penile (PeIN) and oropharyngeal (OIN) areas.*

Results

1. 11-year-olds group

Considering the outcomes evaluated, the vaccination scenario produced significant benefits for both sex cohorts (Fig. 2; Table 1).

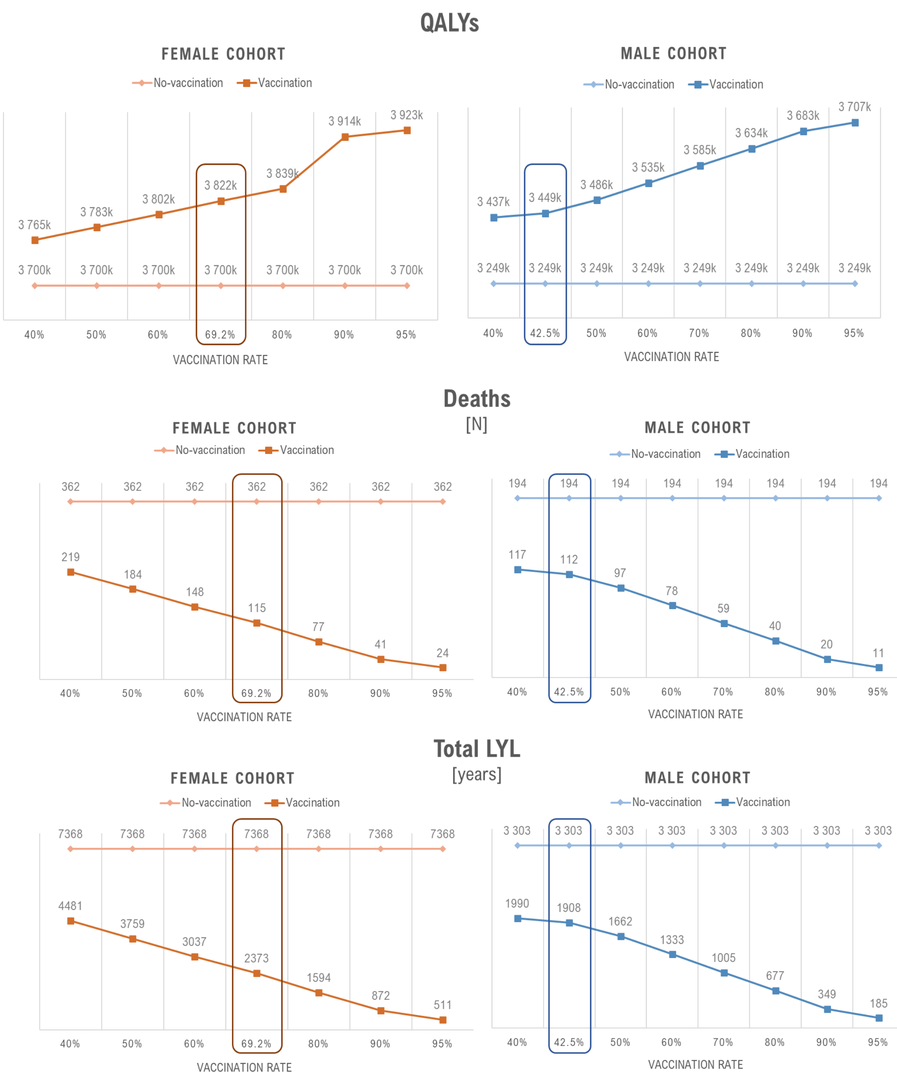

***Fig 2** Graphical representations of QALY outcomes in both 11-years-olds cohorts as a function of vaccination rates, comparing scenarios without vs. with vaccination.*

Table 1: Economic outcomes from simulation of 11-years-olds cohorts.

Discount rate	No vaccination		Vaccination	
	0%	3%	0%	3%
Female cohort (69.2% vaccinated girls)				
Total QALYs	3,699,533	1,594,906	3,821,782	1,641,168
Total costs [CZK]	3,121,654,628	1,164,470,603	1,268,140,794	649,587,351
Cost per patient [CZK]	53,482	19,950	21,727	11,129
Indirect costs [CZK]	39,863,033		12,886,959	
Male cohort (42.5% vaccinated boys)				
Total QALYs	3,248,566	1,497,037	3,449,418	1,573,312
Total costs [CZK]	1,229,962,168	370,703,660	886,453,336	390,646,360
Cost per patient [CZK]	20,165	6,078	14,533	6,405
Indirect costs [CZK]	22,281,130		12,879,109	

2. Probabilistic sensitivity analysis

In the probabilistic sensitivity analysis of model with female population, vaccination was the dominant strategy in 99.3% of the iteration, and in only 0.7% of the iterations was vaccination the more costly strategy with higher benefits (the average ICER value in this case was 796 CZK per QALY). In the male population, vaccination was the dominant strategy in 80.3% of iterations, and in 19.7% of iterations, vaccination was the more costly strategy with higher benefits (the average ICER value in this case was 452 CZK per QALY)(Fig.3).

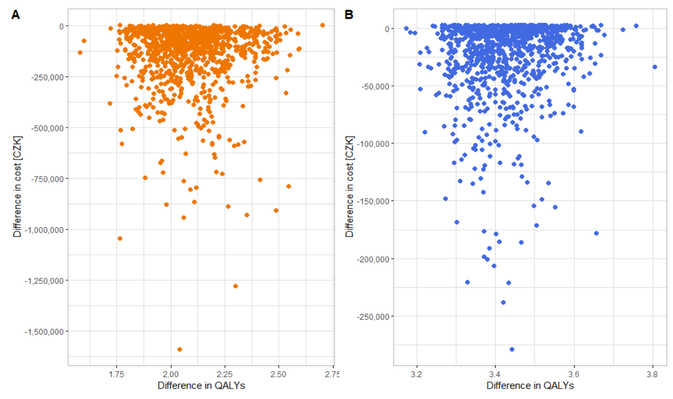

***Fig 3** Incremental costs vs. incremental QALYs from 1,000 probabilistic sensitivity analysis simulations. A - female cohort; B- male cohort*

3. Catch-up vaccination

The three-dose catch-up vaccination strategy for the 15-21 age group was found to be more effective and cost-efficient, similar to the strategy for the 11-year-old group, making it the dominant intervention compared to the no-vaccination scenario. (Table 2).

Table 2: Total (discounted) QALYs, costs, and the ICER associated with catch-up vaccination strategy in female and male cohort.

Female cohort	No vaccination	10%	20%	30%
0% discount rate				
Total QALYs	6,471,884	6,500,298	6,528,712	6,557,126
Total costs [CZK]	6,080,615,328	5,787,944,250	5,495,273,171	5,202,602,093
Indirect costs [CZK]	77,898,321	73,510,487	68,614,245	63,718,003
ICER [CZK per QALY]	dominated	dominant	dominant	dominant
3% discount rate				
Total QALYs	2,790,094	2,791,389	2,803,590	2,815,792
Total costs [CZK]	2,268,251,502	2,246,910,071	2,197,233,155	2,147,556,239
Indirect costs [CZK]	77,898,321	73,510,487	68,614,245	63,718,003
ICER [CZK per QALY]	dominated	dominant	dominant	dominant

Male cohort	No vaccination	10%	20%	30%
0% discount rate				
Total QALYs	13,173,861	13,358,031	13,542,202	13,726,372
Total costs [CZK]	5,718,085,119	5,565,285,753	5,479,398,719	5,360,055,519
Indirect costs [CZK]	103,778,242	95,867,064	87,955,886	80,044,708
ICER [CZK per QALY]	dominated	dominant	dominant	dominant
3% discount rate				
Total QALYs	5,679,384	5,736,269	5,815,357	5,894,444
Total costs [CZK]	2,268,251,502	2,367,946,175	2,439,305,362	2,510,664,550
Indirect costs [CZK]	77,898,321	73,510,487	68,614,245	63,718,003
ICER [CZK per QALY]	dominated	1,753	1,258	1,127

CONCLUSIONS

The results emphasised the extensive benefits of the HPV vaccination. The results strongly encourage the implementation of the 9vHPV catch-up vaccination program in the Czech Republic to address the current immunisation gap and extend the benefits of the HPV vaccination to older age groups who missed the initial vaccinations.

References: [1] Simons JJM, Vida N, Westra TA, Postma MJ. Cost-effectiveness analysis of a gender-neutral human papillomavirus vaccination program in the Netherlands. Vaccine. 2020 Jun;38(30):4687–94.