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Estimating the future burden of unvaccinated girls against human papilloma virus (HPV) in Europe: a modeling study

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Background

- Cervical cancer remains one of the most common cancers and causes of cancer-related deaths among females across Europe and worldwide[1]
- The World Health Organization (WHO) urges countries to achieve 90% human papilloma virus (HPV) vaccination coverage rate (VCR) by 2030 for 15-year-old girls to eliminate cervical cancer[2] Understanding the potential burden of unvaccinated girls in Europe is critical to addressing elimination goals

Objectives

- This analysis aims to estimate the number of 15-year-old girls who remain unvaccinated in Europe by 2030 and 2040

Methods

- To estimate the number of unvaccinated girls, first the projected year in which a 90% VCR threshold will be achieved for 20 European countries was estimated using a previously published Excel-based tool. The tool was populated with publicly available VCR data (last dose of the HPV vaccine in 15-year-old girls) between 2017 and 2023[3]
- Univariate regression models (linear, exponential, logarithmic, power, 2nd order, and piecewise linear regressions) were fitted to each country's VCR and selected based on highest R^2 and visual inspection. Logic tests were used to minimize the risk of overfitting
- The best fitting regression model was used to extrapolate country-specific VCR throughout the study time horizon to estimate the year in which the 90% target is met
- The tool projected VCR growth until 2040 and estimated the cumulative number of girls who remain unvaccinated at 15 years old each year until 2040 based on the respective target population size in each country

Results

- Of the 20 European countries included in the analysis, only eight are expected to reach 90% before 2030. If VCR continues to grow following the observed trajectory in 2017–2023, the accumulated number of unvaccinated girls between 2024 and 2030 would reach approximately 4,429,000 (Table 1, Figure 1)

Figure 1. Cumulative number (in thousands) of unvaccinated girls at 15 years of age by 2040 in European countries

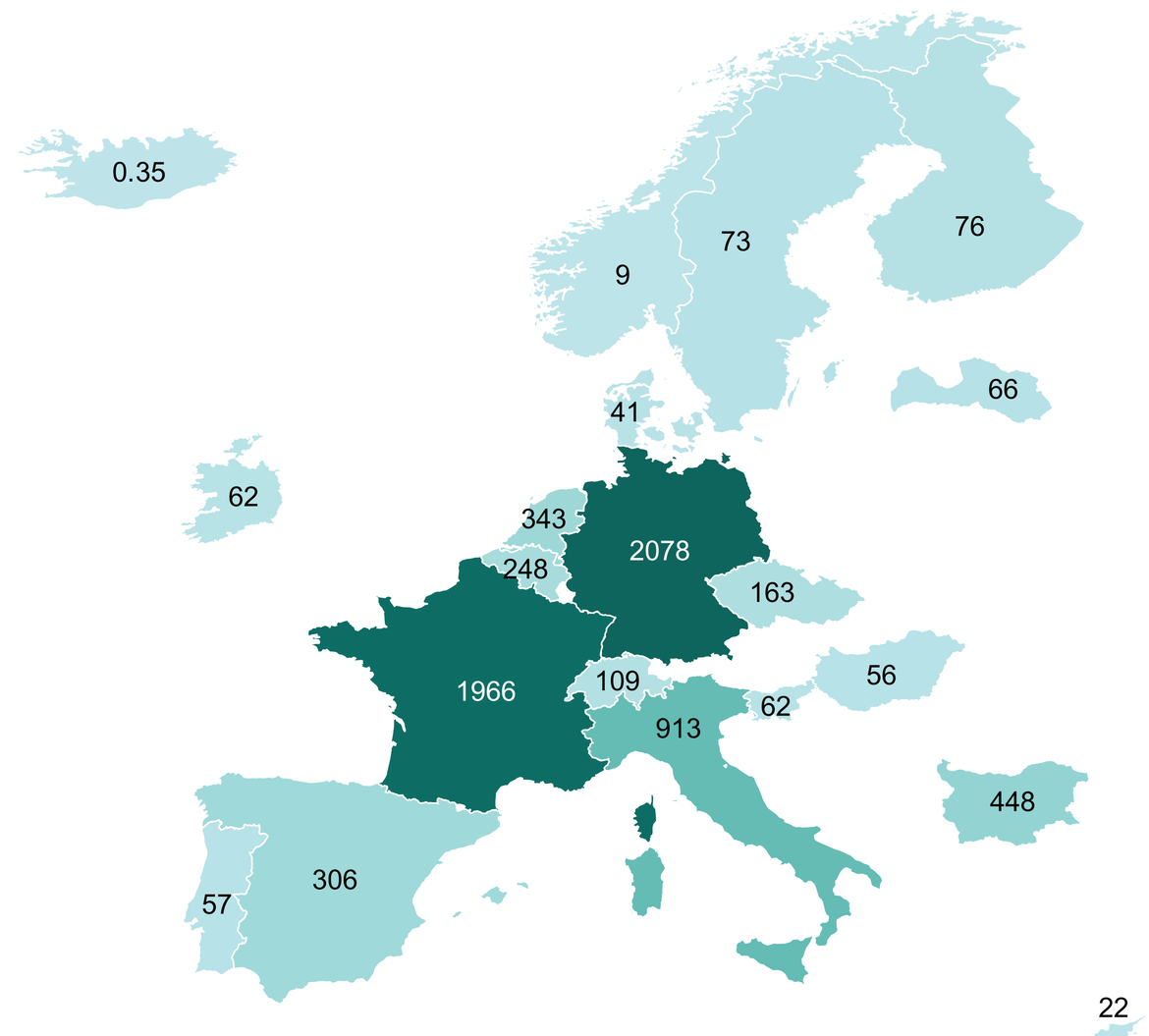

Table 1. Year in which 90% VCR target is reached among 15-year-old girls and a cumulative number of unvaccinated girls at 15 years of age in 2030 and 2040 in European countries

Country	Selected distribution	Year 90% is achieved	Cumulative number of unvaccinated girls	
			2030	2040
Belgium	Logarithmic	After 2040	123,764	248,538
Bulgaria	Piecewise from 2019	After 2040	195,773	448,504
Cyprus	Logarithmic	2034	14,510	22,624
Czechia	Piecewise from 2018	2033	103,155	163,136
Denmark	Logarithmic	2028	33,321	41,991
Finland	Logarithmic	2033	45,651	76,148
France	Logarithmic	2035	1,322,805	1,966,107
Germany	Logarithmic	2038	1,209,127	2,078,839
Hungary	2nd order	2028	55,558	56,621
Iceland	Piecewise from 2018	Already reached	350	350
Ireland	Piecewise from 2018	2029	51,683	62,854
Italy	2nd order	2034	590,166	913,827
Latvia	Exponential	After 2040	34,554	66,377
Netherlands	Logarithmic	2033	221,517	343,821
Norway	Logarithmic	Already reached	9,657	9,657
Portugal	Power	Already reached	29,208	57,781
Slovenia	Power	2039	34,594	62,916
Spain	Linear	2027	215,350	306,537
Sweden	Linear	2026	59,389	73,385
Switzerland	Linear	2032	78,946	109,145
Total			**4,429,078**	**7,109,158**

Limitations

- VCR data quality and accuracy reported by countries to WHO may be inconsistent, causing under- or overestimation of time to reach VCR targets. Some countries lack reliable national vaccine coverage tracking
- Some countries lack robust national data systems for tracking vaccine coverage, so reported VCRs may not reflect true coverage
- Countries with stagnant VCR data or insufficient data for reliable regression were excluded from regional analysis, limiting future VCR projections
- The analysis used VCR data from 2017 to 2023 (seven years); a longer data span could improve trend estimates
- COVID-19 occurred during the observed period and could have influenced VCRs, though most countries showed consistent data except Italy
- The tool uses simple univariate regression, not accounting for country-specific factors like differing vaccination policies that may affect VCR trends
- Although this analysis is based on HPV vaccine uptake among 15-year-old girls, vaccinating both girls and boys is essential to ensure protection against all HPV-related cancers.

Conclusions

Our study estimates that a substantial number of girls are expected to remain unvaccinated against HPV due to suboptimal vaccine uptake in European countries. Therefore, it is important to develop catch-up programs in late adolescent and adult populations.

References

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3. World Health Organization (WHO). Human papillomavirus (HPV) vaccination coverage. https://immunizationdata.who.int/pages/coverage/hpv.html.

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