

Global estimates of human papillomavirus vaccination coverage by region and income level: a pooled analysis

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Summary

Background Since 2006, many countries have implemented publicly funded human papillomavirus (HPV) immunisation programmes. However, global estimates of the extent and impact of vaccine coverage are still unavailable. We aimed to quantify worldwide cumulative coverage of publicly funded HPV immunisation programmes up to 2014, and the potential impact on future cervical cancer cases and deaths.

Methods Between Nov 1 and Dec 22, 2014, we systematically reviewed PubMed, Scopus, and official websites to identify HPV immunisation programmes worldwide, and retrieved age-specific HPV vaccination coverage rates up to October, 2014. To estimate the coverage and number of vaccinated women, retrieved coverage rates were converted into birth-cohort-specific rates, with an imputation algorithm to impute missing data, and applied to global population estimates and cervical cancer projections by country and income level.

Findings From June, 2006, to October, 2014, 64 countries nationally, four countries subnationally, and 12 overseas territories had implemented HPV immunisation programmes. An estimated 118 million women had been targeted through these programmes, but only 1% were from low-income or lower-middle-income countries. 47 million women (95% CI 39–55 million) received the full course of vaccine, representing a total population coverage of 1.4% (95% CI 1.1–1.6), and 59 million women (48–71 million) had received at least one dose, representing a total population coverage of 1.7% (1.4–2.1). In more developed regions, 33.6% (95% CI 25.9–41.7) of females aged 10–20 years received the full course of vaccine, compared with only 2.7% (1.8–3.6) of females in less developed regions. The impact of the vaccine will be higher in upper-middle-income countries (178 192 averted cases by age 75 years) than in high-income countries (165 033 averted cases), despite the lower number of vaccinated women (13.3 million vs 32.2 million).

Interpretation Many women from high-income and upper-middle-income countries have been vaccinated against HPV. However, populations with the highest incidence and mortality of disease remain largely unprotected. Rapid roll-out of the vaccine in low-income and middle-income countries might be the only feasible way to narrow present inequalities in cervical cancer burden and prevention.

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Introduction

Monitoring of human papillomavirus (HPV) vaccination coverage is fundamental to assess the performance of vaccination programmes and the potential impact of HPV vaccines on HPV-related diseases. Since their licensure in 2006, HPV vaccines have been progressively introduced in many countries, mainly targeting young adolescent girls aged 10–14 years. Comparison of coverage statistics is limited by differences in age at vaccination, programme delivery strategy, and year.¹

An HPV vaccination coverage of 70% in women has been regarded as the threshold for optimum cost-effectiveness.² A meta-analysis showed that a vaccination coverage of at least 50% delivered a 68% reduction in HPV types 16 and 18 and a 61% reduction in anogenital warts between the prevaccination and post-vaccination periods.³ Coverage will also affect the management of cervical cancer screening programmes. These programmes will need to be adjusted to the number of vaccinated females who will enter screening ages.

9 years after the introduction of vaccination, global quantification of the number of vaccinated women and HPV vaccination coverage is still unavailable. We aimed to quantify worldwide cumulative coverage of publicly funded HPV immunisation programmes up to 2014, and the potential impact on future cervical cancer cases and deaths in the vaccinated cohorts. We developed a specific methodology taking into account variations in national guidelines, target ages, financing, and delivery strategies, between and within countries at subnational level.

Methods

Data sources

We systematically reviewed the literature and official websites to identify HPV immunisation programmes worldwide from June, 2006, to October, 2014.^{1,4–9} Identification of data sources was done in two steps (appendix p 5). First, scrutiny of official websites of countries with an HPV immunisation programme (eg, health departments, national epidemiological centres) was

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See Online for appendix

Research in context**Evidence before this study**

Since 2006, many countries have introduced human papillomavirus (HPV) vaccines through national immunisation programmes. Vaccination coverage is a key indicator to assess programme performance and to monitor the potential impact of HPV vaccines on HPV-related diseases. Many countries produce HPV immunisation statistics from administrative data or representative surveys. However, these data are disseminated throughout miscellaneous sources and are non-standardised. Comparison of coverage statistics is limited by differences in age at vaccination, programme delivery strategy, and year. Country-specific coverage rates could range from less than 5% to more than 80%. 9 years after vaccine introduction, global estimates of vaccination coverage using appropriate methodology are still unavailable and the number of vaccinated women in the world is unknown.

Added value of this study

We present the first estimates of global HPV vaccination coverage up to October, 2014. We have developed a specific method to address comparability limitations and appropriately combine coverage statistics. Methods comprise the compilation of the most comprehensive database to date on publicly funded national HPV immunisation programmes, including conversion of all retrieved coverages from multiple sources into birth-cohort-specific coverages, design of an imputation algorithm to treat missing data, and use of global

population estimates and projections. These procedures allow continuous monitoring and production of vaccination coverage trends, together with the use of cancer statistics to approximate the expected reduction on cervical cancer in vaccinated cohorts.

Implications of all the available evidence

By October, 2014, 64 countries nationally, four countries subnationally, and 12 overseas territories have introduced the HPV vaccine into their national immunisation programmes, mostly in high-income and upper-middle-income settings. Globally, we estimate that 47 million women received a full course of HPV vaccine between 2006 and 2014, and 59 million women received at least one dose, representing 39.7% and 50.1% of the targeted female cohorts, respectively. Behind these statistics there are huge differences not only in global distribution by development level, but also in the performance of HPV immunisation programmes. Individually, many countries with a national HPV vaccination programme achieve high coverage rates, mostly in the younger cohorts, but older cohorts and large countries with poorer performances contribute to lowering of the overall coverage estimates. The most vulnerable populations, which would benefit most from vaccination, still remain unprotected. Access to HPV vaccination in low-income and lower-middle-income countries is almost non-existent, despite these countries carrying most of the burden of cervical cancer cases worldwide.

followed by a global review with internet search engines between Nov 1 and Dec 22, 2014. Search terms included specific country names and “HPV”, “vaccine”, “immunization calendar” or “cervical cancer” for immunisation programmes, and “HPV”, “coverage”, “uptake”, “vaccine” for data on coverage. Second, we systematically searched PubMed and Scopus from Jan 1, 2006, to Oct 31, 2014, using MESH terms related to “HPV”, “vaccine”, and “coverage”. References cited in retrieved articles were also assessed and included if appropriate. Publication languages other than English, Spanish, or French were assessed using online language translation services. Eligibility criteria comprised a detailed description of the characteristics of the HPV immunisation programmes or the availability of age-specific HPV coverage data with the date of the estimation. Coverage data included official estimates or survey data. Surveys had to include a detailed description of the methodology and be representative of the targeted population. Data were extracted by two independent investigators (LB and LB-R), with discrepancies resolved by forced consensus.

Procedures

For HPV immunisation programmes, we retrieved information about year of introduction, target ages, the vaccination schedule, and other features of specific

programmes (appendix pp 17–29). We subdivided each immunisation programme into two possible implementation strategies: primary and catch-up. Both strategies could use either an organised or an opportunistic approach (appendix p 26). For each immunisation programme and strategy, we derived the birth cohorts that had been targeted by the end of 2014. We considered subnational variations in Belgium, Canada, Italy, Spain, Switzerland, and the UK.

For HPV vaccination coverage rates, we obtained data for one-dose, two-dose, and three-dose HPV vaccine coverage by country and birth cohort (appendix pp 30–35). If data were not originally reported by birth cohort, we converted retrieved coverage rates into birth-cohort-specific rates from the population age and the year of the estimation. We made an effort to obtain vaccination coverage by single year of age. When coverage rate was only available for a specific age group, that rate was assigned to all relevant birth cohorts. When there were discrepancies among multiple sources, official estimates prevailed or, in the absence of official estimates, we selected the most representative sample.

Female population data by birth cohort and country were obtained annually for the years 2010–2100 from the UN Population Division, or from the US Census Bureau when unavailable from the UN.^{10,11} For

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