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Health and Economic Outcomes of HPV Vaccination in Selected Countries in Latin America





Our Team



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Background

- Human papillomavirus (HPV) is a virus that has been associated with cervical cancer and other malignancies
- Cervical cancer is the second most frequent form of malignant neoplasia affecting women worldwide, and the primary cause of cancer-related deaths in women
- In LAC, cervical cancer accounts for 2.5 million years of life lost, 72,000 cases and 38,000 deaths (Lewis, 2004)
- The estimated age-adjusted incidence rates for cervical cancer is 32.6 per 100,000 women in the Caribbean, 30.6 per 100,000 women in Central America and 28.6 per 100,000 women in South America



Objectives

- To provide an estimate of the cost of cervical cancer in six selected countries of Latin America (Argentina, Brazil, Chile, Colombia, Mexico, Peru)
- To estimate the health and economic outcomes of HPV vaccination in these selected countries

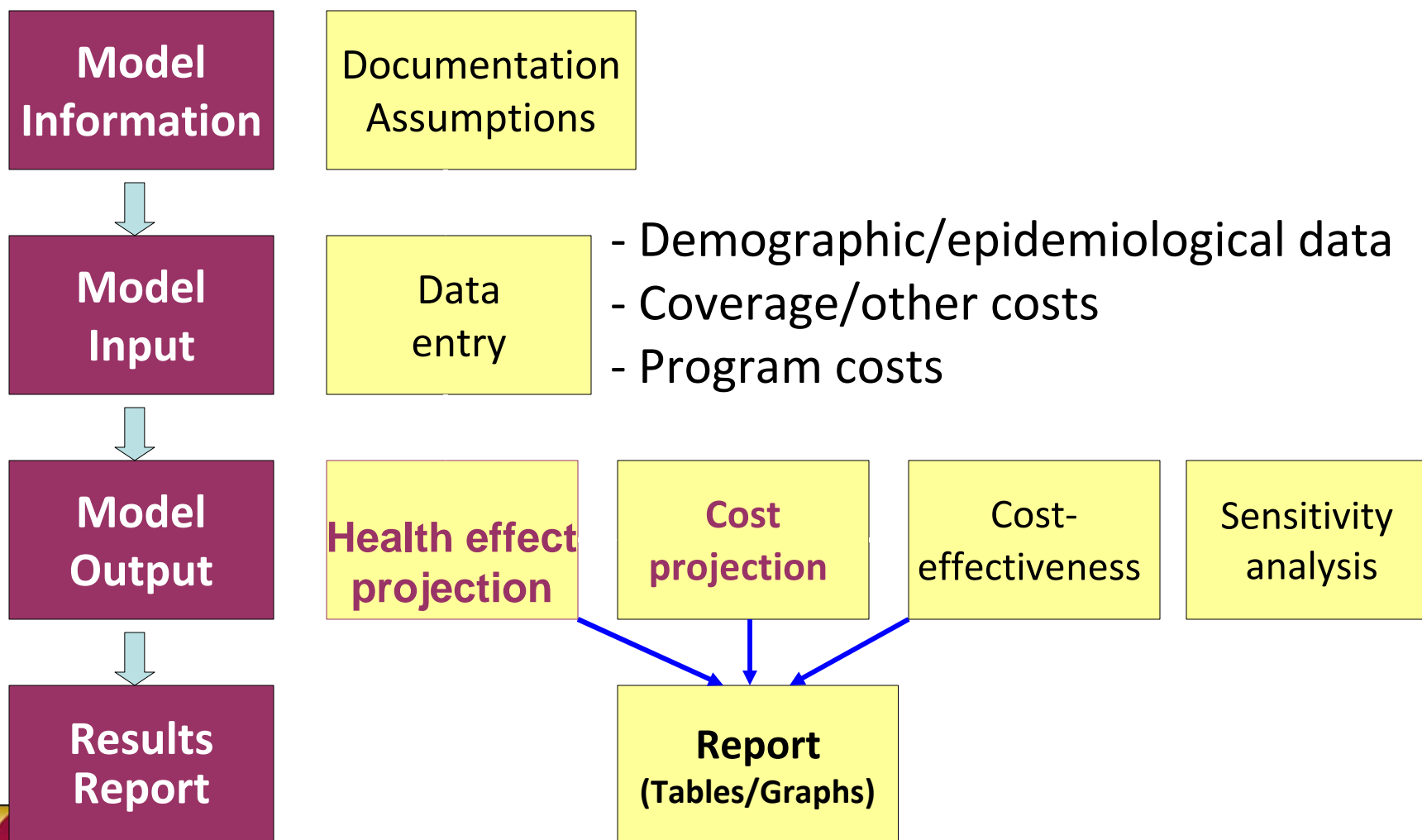
Model Overview



Model type	Excel-VB companion model (based on simplified assumptions identified using a validated more complex individual model)
Strategies	Routine vaccination of preadolescent girls (age 12 years) Single birth cohorts, multiple birth cohorts
Time horizon	Lifetime (for the next 100 years until death)
Model outcomes	Cervical cancer cases and deaths Years of life saved (YLS) Disability-adjusted life years (DALYs) averted Lifetime costs (2005 US\$, I\$, local currency)
Perspective	Modified societal perspective, healthcare perspective
Sensitivity analysis	One-way and multi-way sensitivity analyses



Model Schematic



Model Parameters



Types	Parameters	Sources
Demographic	Age-group specific population size Age-group specific life expectancy	UN World Population Prospects 2004 data WHO life tables
Epidemiological/ Biological	Cervical cancer incidence rates Cervical cancer mortality rates Distribution of HPV 16,18 in cervical cancer	CI5C* or Globocan Globocan Literature
Vaccine/ Vaccination related	Vaccine efficacy against HPV 16,18 Coverage Dose completion rates	100% (50%-100%) 70% (0% -100%) 70% (0% -100%)
DALY parameters	Disability weight for cervical cancer Duration of cervical cancer	Global Burden of Disease Global Burden of Disease



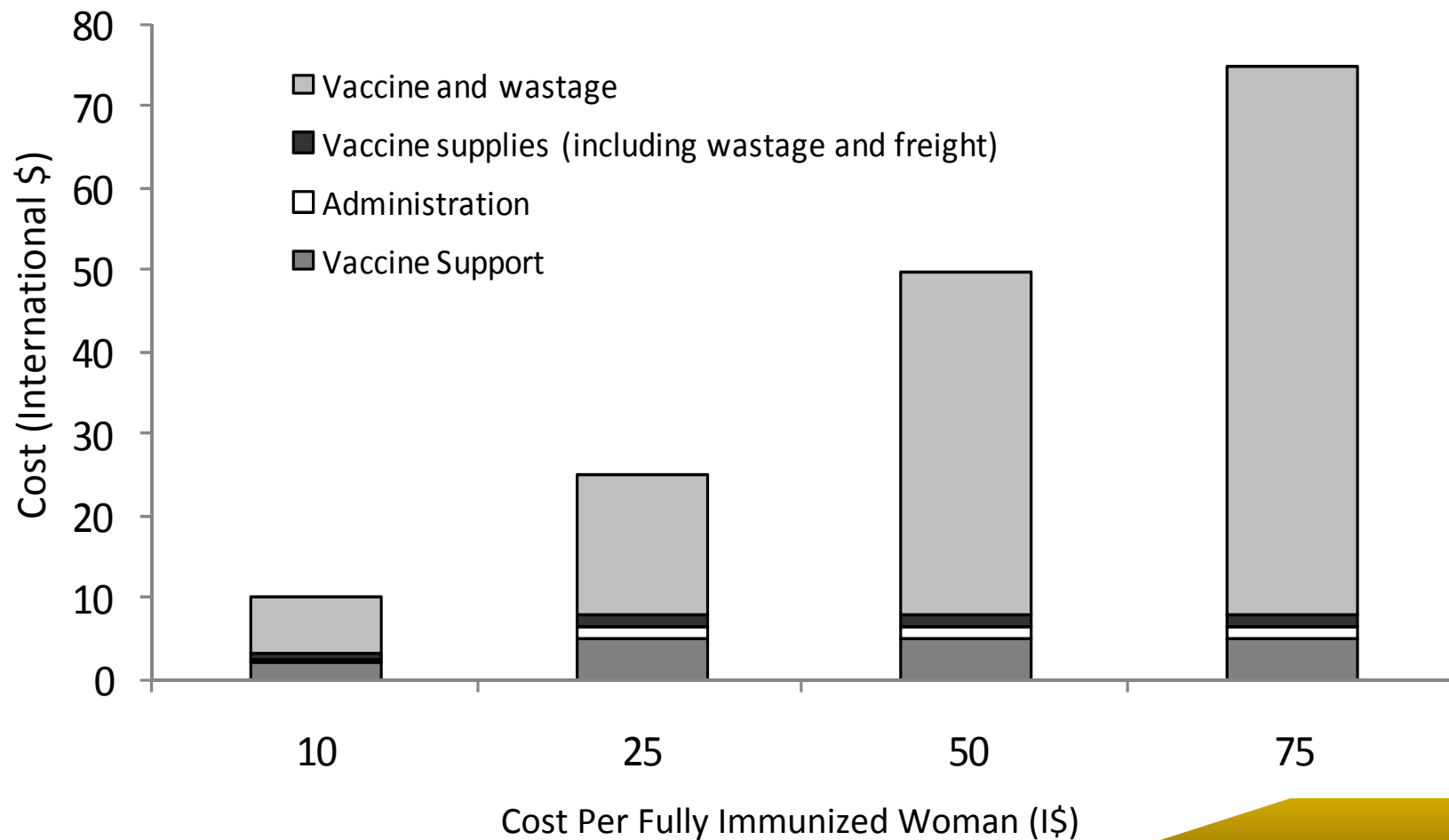
* CI5C: Cancer Incidence in Five Continents

Cancer Treatment Costs and Model Inputs (I\$, 2005)



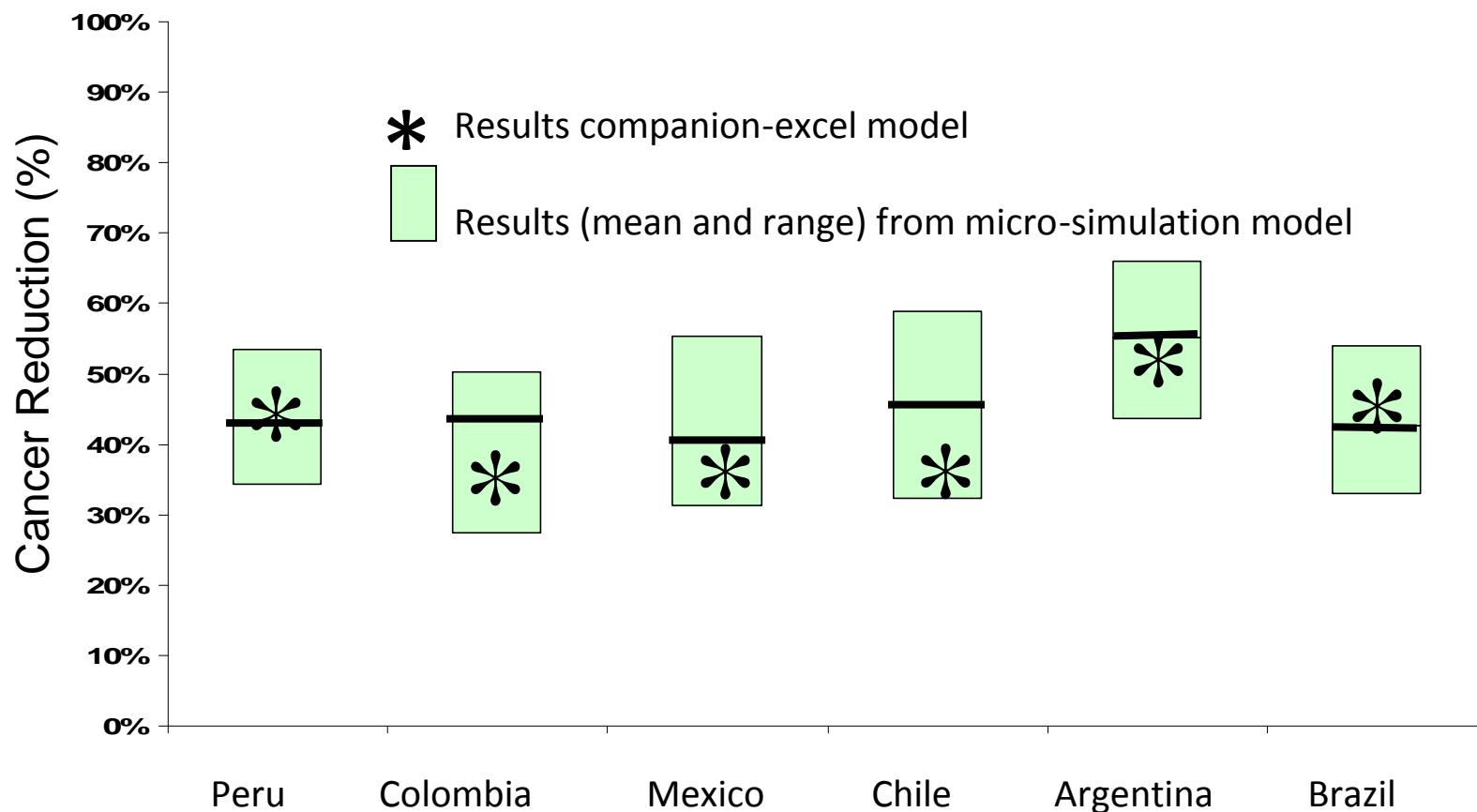
Country	Derived estimates (Lower Bound)		In-country data collection (Upper Bound)	
	Stage I	Stages II-IV	Stage I	Stages II-IV
Argentina	5,107.37	4,301.72	9,894.72	14,516.96
Brazil	3,834.30	3,229.46	7,416.14	8,755.72
Chile	4,388.56	3,696.30	6,095.07	9,442.39
Colombia	3,444.84	2,901.44	6,003.79	7,787.16
Mexico	4,368.55	3,679.44	7,313.91	9,295.52
Peru	2,749.07	2,315.42	6,425.95	8,507.53

Cost per Vaccinated Woman (I\$, 2005)





Impact of HPV 16,18 vaccination on the mean reduction in lifetime risk of cervical cancer



Goldie et al. Regional Report on HPV Vaccines and Screening – Latin America. Chapter 13. Mathematical models of cervical cancer prevention in Latin America and the Caribbean. *Vaccine* (in press)

Adolescent HPV 16,18 Vaccination: Health Outcomes

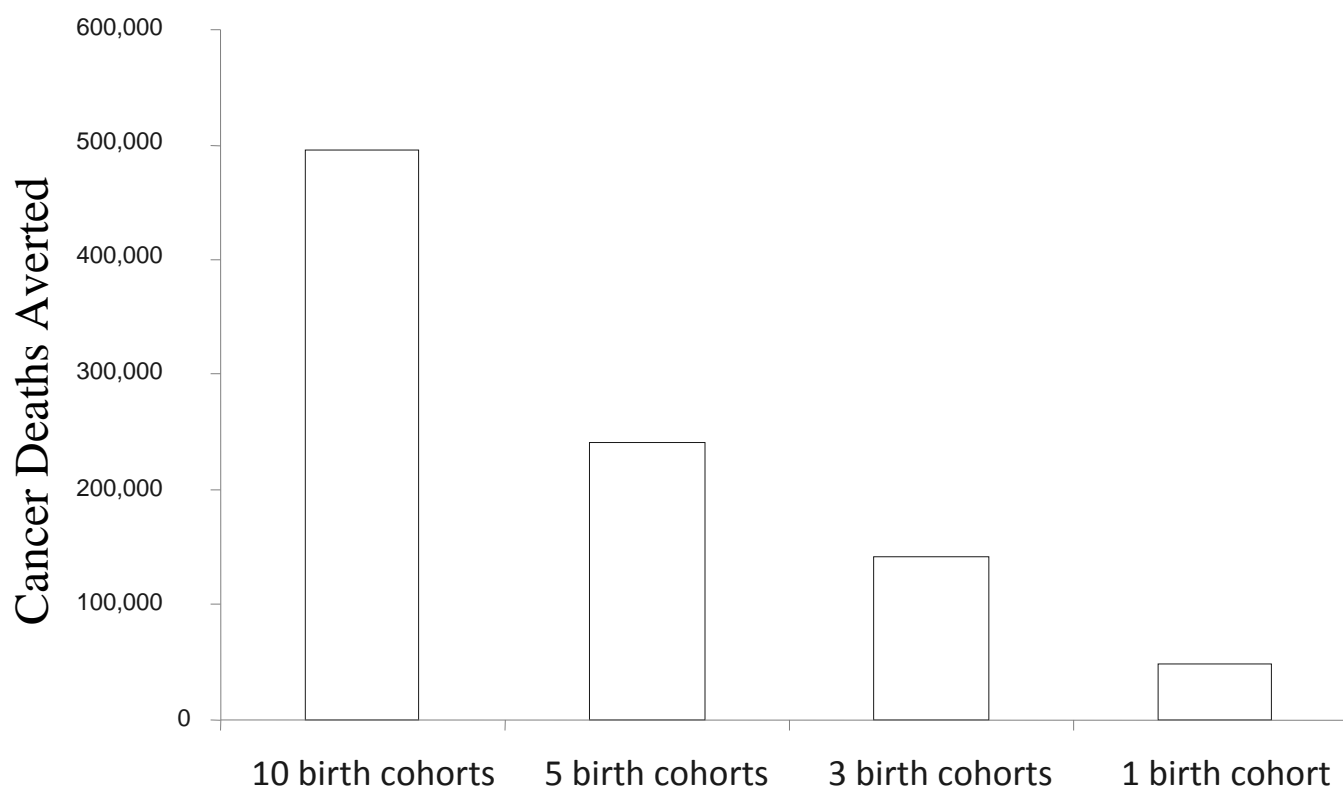


Country	Cancer Incidence†	Lifetime Reduction in Cancer, %	Cases of cancer averted	Cancer deaths averted	% of cases/Deaths across region	Years of life saved (YLS)
Argentina	23.2	53.86	5,796	3,478	6%	86,921
Brazil	23.4	48.17	35,363	21,218	35%	474,912
Chile	25.8	39.41	2,767	1,660	3%	48,461
Colombia	36.4	40.30	9,512	5,707	10%	140,264
Mexico	29.5	39.60	15,213	9,128	16%	215,813
Peru	48.2	47.46	5,218	3,131	5%	69,046
Total for 6 countries			73,869	44,322	75%	
Total for 33 countries			97,984	58,791	100%	

*Results shown are for a single birth cohort, 70% coverage by 12 years of age; e.g., for example, in Brazil, vaccinating 70% of the 12 year old girls next year would prevent 35,363 cervical cancer cases over the lifetime of that birth cohort.



Impact of HPV 16,18 vaccination on deaths averted for multiple birth cohorts



Cost per Vaccinated Girl: \$25 (~\$5 per dose)



Adolescent HPV 16,18 Vaccination: CEA *Assuming Lower Bound Cancer Costs*

Country	Cancer Incidence (Globocan 2002)	Incremental Costs (I\$)†	ICER (\$/YLS)	ICER (\$/DALY)
Argentina	23.2	-593,233	Saving	Saving
Brazil	23.4	648,421	10	10
Chile	25.8	-629,952	Saving	Saving
Colombia	36.4	1,101,643	40	40
Mexico	29.5	4,865,009	120	110
Peru	48.2	2,117,122	160	160

* This analysis assumes all women with detected invasive cancer get treated, and the costs are derived indirectly as previously described, and are considered lower bounds.

† Incremental costs are for a strategy of vaccination of 70% of a single birth cohort of pre-adolescent girls (i.e., 12 year olds) in 2007 with a 100% effective vaccine at a cost per vaccinated woman of I\$25 (~\$5 per dose), compared to no vaccination.

Number of pre-adolescent girls vaccinated (70% coverage): Argentina 235,353 Brazil 1,183,850 Chile 91,956 Colombia 324,414 Mexico 762,080 Peru 206,588. Vaccine price per dose: \$5



Cost per Vaccinated Girl: \$25 (~\$5 per dose)

Adolescent HPV 16,18 Vaccination: CEA *Assuming Upper Bound Cancer Costs*

Country	Cancer Incidence (Globocan 2002)	Incremental Costs (I\$)†	ICER (\$/YLS)	ICER (\$/DALY)
Argentina	23.2	-12,834,602	Saving	Saving
Brazil	23.4	-41,301,364	Saving	Saving
Chile	25.8	-4,031,630	Saving	Saving
Colombia	36.4	-8,476,018	Saving	Saving
Mexico	29.5	-12,712,279	Saving	Saving
Peru	48.2	-4,659,049	Saving	Saving

*This analysis assumes all women with detected invasive cancer get treated, and the costs are based on protocols collected as part of a cost survey for the exercise.

†Incremental costs are for a strategy of vaccination of 70% of a single birth cohort of pre-adolescent girls (i.e., 12 year olds) in 2007 with a 100% effective vaccine at a cost per vaccinated woman of I\$25 (~\$5 per dose), compared to no vaccination.

Cost per Vaccinated Girl: \$50 (~\$12 per dose)



Adolescent HPV 16,18 Vaccination: CEA
Assuming Lower Bound Cancer Costs

Country	Cancer Incidence (Globocan 2002)	Incremental Costs (I\$)†	ICER (\$/YLS)	ICER (\$/DALY)
Argentina	23.2	5,290,582	320	310
Brazil	23.4	30,244,666	330	320
Chile	25.8	1,668,953	180	170
Colombia	36.4	9,212,000	36	340
Mexico	29.5	23,917,014	580	560
Peru	48.2	7,281,810	560	530

* This analysis assumes all women with detected invasive cancer get treated, and the costs are derived indirectly as previously described, and are considered lower bounds.

† Incremental costs are for a strategy of vaccination of 70% of a single birth cohort of pre-adolescent girls (i.e., 12 year olds) in 2007 with a 100% effective vaccine at a cost per vaccinated woman of I\$50 (~\$12 per dose), compared to no vaccination.



Cost per Vaccinated Girl: \$50 (~\$12 per dose)

Adolescent HPV 16,18 Vaccination: CEA
Assuming Upper Bound Cancer Costs

Country	Cancer Incidence (Globocan 2002)	Incremental Costs (I\$)†	ICER (\$/YLS)	ICER (\$/DALY)
Argentina	23.2	-6,950,787	Saving	Saving
Brazil	23.4	-11,705,119	Saving	Saving
Chile	25.8	-1,732,725	Saving	Saving
Colombia	36.4	-365,661	Saving	Saving
Mexico	29.5	6,339,726	150	150
Peru	48.2	505,639	40	40

*This analysis assumes all women with detected invasive cancer get treated, and the costs are based on protocols collected as part of a cost survey for the exercise.

†Incremental costs are for a strategy of vaccination of 70% of a single birth cohort of pre-adolescent girls (i.e., 12 year olds) in 2007 with a 100% effective vaccine at a cost per vaccinated woman of I\$50 (~\$12 per dose), compared to no vaccination.



Cost per Vaccinated Girl: \$75 (~\$20 per dose)

Adolescent HPV 16,18 Vaccination: CEA
Assuming Lower Bound Cancer Costs

Country	Cancer Incidence (Globocan 2002)	Incremental Costs (I\$)†	ICER (\$/YLS)	ICER (\$/DALY expressed as % GDP)
Argentina	23.2	11,174,397	670	640
Brazil	23.4	59,840,911	660	630
Chile	25.8	3,967,858	420	410
Colombia	36.4	17,322,358	670	650
Mexico	29.5	42,969,019	1,040	1,000
Peru	48.2	12,446,497	950	910

* This analysis assumes all women with detected invasive cancer get treated, and the costs are derived indirectly as previously described, and are considered lower bounds.

† Incremental costs are for a strategy of vaccination of 70% of a single birth cohort of pre-adolescent girls (i.e., 12 year olds) in 2007 with a 100% effective vaccine at a cost per vaccinated woman of I\$75 (~\$20 per dose), compared to no vaccination.



Cost per Vaccinated Girl: \$75 (~\$20 per dose)

Adolescent HPV 16,18 Vaccination: CEA
Assuming Upper Bound Cancer Costs

Country	Cancer Incidence (Globocan 2002)	Incremental Costs (I\$)†	ICER (\$/YLS)	ICER (\$/DALY)
Argentina	23.2	-1,066,972	Saving	Saving
Brazil	23.4	17,891,126	200	190
Chile	25.8	566,180	60	60
Colombia	36.4	7,744,697	300	290
Mexico	29.5	25,391,731	610	590
Peru	48.2	5,670,326	430	420

*This analysis assumes all women with detected invasive cancer get treated, and the costs are based on protocols collected as part of a cost survey for the exercise.

†Incremental costs are for a strategy of vaccination of 70% of a single birth cohort of pre-adolescent girls (i.e., 12 year olds) in 2007 with a 100% effective vaccine at a cost per vaccinated woman of I\$75 (~\$20 per dose), compared to no vaccination.





Argentina

Strategy		Cost-per vaccinated woman				
		\$20	\$50	\$75	\$100	\$360
Vaccine Alone	C/S		\$450	\$900	\$1,360	Dom
Screen 3X lifetime	Dom	Dom	Dom	Dom	Dom	\$1,740
Screen every 5 yrs	Dom	Dom	Dom	Dom	Dom	\$4,850
Screen 3X + Vaccine	\$4,100	\$4,100	\$4,100	\$4,100	\$4,100	\$10,100
Screen 5yr + Vaccine	\$11,800	\$11,800	\$11,800	\$11,800	\$11,800	\$11,800

*Results shown are for vaccination 70% coverage by 12 years of age; screening results are for 70% coverage at ages 35, 40, 45 (3X lifetime) or every 5 years.



Based on models described in Goldie et al. Regional Report on HPV Vaccines and Screening – Latin America. Chp. 13. Mathematical models of cervical cancer prevention in Latin America and the Caribbean. Vaccine (*in press*)



Chile

Strategy		Cost-per vaccinated woman			
		\$20	\$50	\$75	\$100
Vaccine Alone	C/S	\$150	\$400	\$640	Dom
Screen 3X lifetime	Dom	Dom	Dom	Dom	\$690
Screen every 5 yrs	Dom	Dom	Dom	Dom	\$2,540
Screen 3X + Vaccine	\$1,250	\$1,320	\$1,320	\$1,320	Dom
Screen 5yr + Vaccine	\$4,680	\$4,680	\$4,680	\$4,680	\$4,840

*Results shown are for vaccination 70% coverage by 12 years of age; screening results are for 70% coverage at ages 35, 40, 45 (3X lifetime) or every 5 years.



Based on models described in Goldie et al. Regional Report on HPV Vaccines and Screening – Latin America. Chp. 13. Mathematical models of cervical cancer prevention in Latin America and the Caribbean. Vaccine (*in press*)



Peru

Strategy	Cost-per vaccinated woman				
	\$20	\$50	\$75	\$100	\$360
Vaccine Alone	\$430	\$90	\$1,410	Dom	Dom
Screen 3X lifetime	Dom	Dom	Dom	\$2,140	\$2,140
Screen every 5 yrs	Dom	Dom	Dom	Dom	Dom
Screen 3X + Vaccine	\$7,600	\$7,600	\$7,600	\$7,600	\$11,360
Screen 5yr + Vaccine	\$12,730	\$12,730	\$12,730	\$12,730	\$12,730

*Results shown are for vaccination 70% coverage by 12 years of age; screening results are for 70% coverage at ages 35, 40, 45 (3X lifetime) or every 5 years.



Based on models described in Goldie et al. Regional Report on HPV Vaccines and Screening – Latin America. Chp. 13. Mathematical models of cervical cancer prevention in Latin America and the Caribbean. Vaccine (*in press*)



Mexico

Strategy	Cost-per vaccinated woman				
	\$20	\$50	\$75	\$100	\$360
Vaccine Alone	\$16	\$600	\$1,000	\$1,980	Dom
Screen 3X lifetime	Dom	Dom	Dom	\$1,080	\$1,080
Screen every 5 yrs	Dom	Dom	Dom	Dom	Dom
Screen 3X + Vaccine	\$2,030	\$2,030	\$2,030	\$2,030	\$3,960
Screen 5yr + Vaccine	\$6,820	\$6,820	\$6,820	\$6,820	\$10,500

*Results shown are for vaccination 70% coverage by 12 years of age; screening results are for 70% coverage at ages 35, 40, 45 (3X lifetime) or every 5 years.



Based on models described in Goldie et al. Regional Report on HPV Vaccines and Screening – Latin America. Chp. 13. Mathematical models of cervical cancer prevention in Latin America and the Caribbean. Vaccine (*in press*)

Limitations



- Results are conservative in that model does not include:
 - Other HPV-related diseases such as vulvar, vaginal, penile and anal neoplasias and cancers and recurrent respiratory papillomatoses
 - Other target groups like boys, younger girls and boys
- Screening was not considered in the base case analysis as there is still lack of high-quality data on screening
- There is absence of data for the cost of initiating, scaling up and maintaining a new adolescent vaccination program, cost of reaching adolescents, etc.
- The degree of detail and quality of information may vary considerably as it's derived from many countries through the registration of vital events
- There are many gaps in our understanding of the natural history of HPV
- There are uncertainties around the epidemiology and temporal trends of cervical cancer in many countries

Conclusions



- HPV vaccination with current HPV vaccines can have a substantial impact on settings without effective screening programs
 - It has the potential to prevent almost 45,000 cancer deaths and 74,000 cervical cancer cases over the lifetime of a single birth cohort
 - It could prevent half a million deaths in ten birth cohorts
 - Assuming the per-woman cost of vaccination is < I\$75 (or < I\$100) (depending on the country), vaccination has the potential to be cost-effective when the per capita GPD criterion is used as a rough indicator of monetary resource constraints
 - HPV vaccination may, in some cases, be cost saving
 - HPV vaccination may be cost-effective provided screening programs are modified



Adolescent HPV 16,18 Vaccination

- Cost-effectiveness analysis (which is about *value for money*, and opportunity costs of not investing the dollars elsewhere) is not the same as affordability (which is about *impact on the current budget*, and financial costs over a shorter-time horizon)
- While according to a threshold of the country's GDP per capita, vaccination would be *cost effective* in all countries evaluated provided the cost per vaccinated girl is less than I\$75 (implied cost per dose of ~I\$20), it is unclear if it will be affordable.
- Of note, when the cost per vaccinated girl begins to exceed I\$75, screening without vaccination is no longer dominated by vaccination alone (i.e., at \$360 for 3 doses of the vaccine, the approximate US price, screening is more cost-effective).



Affordability and Budget Implications of HPV 16,18 Vaccination

	\$25	\$50	\$360
Argentina	\$22,708,877	\$50,145,266	\$389,255,369
Brazil	\$124,247,788	\$266,520,877	\$2,026,508,740
Chile	\$9,321,447	\$19,749,461	\$148,799,093
Colombia	\$31,854,537	\$69,912,684	\$540,388,762
Mexico	\$81,353,368	\$169,684,024	\$1,263,359,012
Peru	\$20,817,860	\$44,927,599	\$343,121,615
All 6 countries	\$290,303,902	\$620,939,961	\$4,711,432,951

Shown are financial costs in U.S. dollars to vaccinate 5 consecutive birth cohorts with 70% coverage (Present value, 3% annual discounting)



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