A.1. Bangladesh

Bangladesh currently implements a single routine opportunity for vaccination for infants 9 months of age with an average coverage rate of 88%, along with follow-up supplemental immunization activities every four years targeting children 9 months up to 59 months of age (though this target age group shows some variation in historical SIAs from 1995 – 2006). A second routine dose is not presently included in the country's vaccination strategy, and the current vaccine formulation is single-antigen (measles) only.

A catch-up campaign was performed in Bangladesh in 2006, followed by a large outbreak in 2007 (based on cases reported by WHO, though not reflected in primary data collection), after which yearly incidence dropped again to lower levels. A regular follow-up campaign was performed in 2009, targeting 99% of children aged 9 months through 4 years (reported coverage). Due to the sporadic nature of vaccination campaigns and oscillations in recent reported incidence, it is difficult to predict whether Bangladesh will be able to achieve 90% mortality reduction goals by the target date of 2013 by continuing its current vaccination strategy.

Bangladesh was simulated as consisting of ten districts (aggregated from a country total of 64 districts) based on average MCV1 coverage for 2009 (only year available for district-level coverage data), with values ranging from 76% to 98%. As defined in the sections above, the transmission model yielded average mortality figures for 2000 of 14,751(range: 11,569 – 15,888), which falls within the range of estimated mortality provided by WHO. Comparing model results for simulated district-level incidence of the period from 2004 to 2009 with reported incidence over the same period (based on district-level passive surveillance case reports from Bangladesh) results in an average correlation coefficient of 0.7969 (range: 0.7721 – 0.8212).

Table A.1.1. Vaccination assumptions and simulation outcomes for mortality reduction scenarios, Bangladesh.

Scenario	Goal	Target Year	Initial Vaccination Assumptions						
			MCV1		MCV2		SIA		
			Covg	Age	Covg	Age	Covg	Age	Freq
1	Baseline	2013	88%	9 mo	N/A	N/A	95%	9 mo - 59 mo	4 yrs
2	No SIA		88%	9 mo	N/A	N/A	95% (until 2010)	9 mo - 59 mo	4 yrs
3	95% Mortality Reduction	2015	88%	9 mo	N/A	N/A	95%	9 mo - 59 mo	4 yrs
4	98% Mortality Reduction	2020	88%	9 mo	N/A	N/A	95%	9 mo - 59 mo	4 yrs

Scenario	Goal	Target Year	Ramp-Up Vaccination Assumptions							
			MCV1		MCV2			SIA		
			Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq
1	Baseline	2013	N/A	N/A	N/A	18 mo	N/A	95%	9 mo - 59 mo	4 yrs
2	No SIA		N/A	N/A	N/A	18 mo	N/A	N/A	N/A	N/A
3	95% Mortality Reduction	2015	1.0	N/A		18 mo	N/A	95%	9 mo - 59 mo	4 yrs
4	98% Mortality Reduction	2020	1.0	N/A		18 mo	N/A	95%	9 mo - 59 mo	4 yrs

Scenario	Goal	Target Year	Target (and post-target) Vaccination Assumptions							Average % Mortality Reduction
			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	
1	Baseline	2013	88%	9 mo	N/A	N/A	95%	9 mo - 59 mo	4 yrs	59%
2	No SIA		88%	9 mo	N/A	N/A	N/A	N/A	N/A	48%
3	95% Mortality Reduction	2015	89.2%	9 mo	80.2%	18 mo	95%	9 mo - 59 mo	4 yrs	80%
4	98% Mortality Reduction	2020	89.3%	9 mo	80.2%	18 mo	95%	9 mo - 59 mo	4 yrs	80%

Data were collected in Bangladesh in January/February 2010 on the costs of measles vaccination for routine immunization and SIAs. Because no data were available on the cost of increasing routine coverage, an assumption was made that 5% of the baseline cost would be needed to increase coverage by 1%. Information on societal costs, the cost of obtaining vaccination, and cost savings from not treating a measles case were taken from published studies.

Table A.1.2. Assumptions for Costs of Measles Vaccination in Bangladesh

Parameter	Value (costs in US$)
Initial Coverage	85%
Cost per dose of routine immunization	$1.46
Added Cost per additional percent of coverage for routine immunization	$0.07 until 90%; $0.15after 90%
Cost per dose of measles vaccination given through SIA	$0.52
Cost to Household of Obtaining Vaccination	$0.50
Cost of Treating Case of Measles	$12.40

Source: Bangladesh cMYP, WHO/Dhaka; Maskery et al. 2009

Table A.1.3. Transmission and cost results for reduction in mortality scenarios, Bangladesh (all totals discounted by 3%).

Bangladesh	Baseline (90% RM by 2013)	No SIA	95% RM by 2015	98% RM by 2020
Correlation Coefficient	0.7721	0.8059	0.7999	0.7999
2000 Mortality	11,569.32	14,603.20	15,559.66	15,559.66
Target Year Mortality	5,944.76	6,999.12	2,979.69	2,588.98
% Reduction in Mortality through 2050	59%	48%	80%	80%
Total Cost 2010 - 2030	$ 227,892,625.21	$ 149,854,448.88	$ 459,393,952.04	$ 448,066,217.12
Incremental Cost over Baseline, 2010 - 2030	$ -	$ (78,038,176.33)	$ 231,501,326.83	$ 220,173,591.91
Total DALYs, 2010 - 2030	2,412,591.89	3,510,404.44	1,579,828.47	1,547,006.63
Total Deaths, 2010 - 2030	78,029.87	110,996.24	48,506.77	47,520.14
Total Cases, 2010 - 2030	11,678,967.05	16,802,964.29	6,005,692.38	5,936,737.20
DALYs Averted over Baseline, 2010 - 2030	-	(1,097,812.55)	832,763.42	865,585.26
Deaths Averted over Baseline, 2010 - 2030	-	(32,966.37)	29,523.10	30,509.73
Cases Averted over Baseline, 2010 - 2030	-	(5,123,997.24)	5,673,274.67	5,742,229.85
Cost per DALY, 2010 - 2030	$ -	$ 71.09	$ 277.99	$ 254.36
Cost per Death, 2010 - 2030	$ -	$ 2,367.21	$ 7,841.36	$ 7,216.50
Cost per Case, 2010 - 2030	$ -	$ 15.23	$ 40.81	$ 38.34
Total Cost 2010 - 2050	$ 339,617,241.20	$ 228,600,513.67	$ 655,079,084.94	$ 644,770,779.65
Incremental Cost over Baseline, 2010 - 2050	$ -	$ (111,016,727.53)	$ 315,461,843.74	$ 305,153,538.45
Total DALYs, 2010 - 2050	3,684,549.45	5,540,973.79	2,466,201.53	2,394,268.10
Total Deaths, 2010 - 2050	118,287.83	175,056.26	75,247.53	73,122.74
Total Cases, 2010 - 2050	17,637,747.29	27,000,755.31	9,367,817.21	9,198,446.91
DALYs Averted over Baseline, 2010 - 2050	-	(1,856,424.34)	1,218,347.92	1,290,281.35
Deaths Averted over Baseline, 2010 - 2050	-	(56,768.43)	43,040.30	45,165.09
Cases Averted over Baseline, 2010 - 2050	-	(9,363,008.02)	8,269,930.08	8,439,300.38
Cost per DALY, 2010 - 2050	$ -	$ 59.80	$ 258.93	$ 236.50
Cost per Death, 2010 - 2050	$ -	$ 1,955.61	$ 7,329.45	$ 6,756.40
Cost per Case, 2010 - 2050	$ -	$ 11.86	$ 38.15	$ 36.16

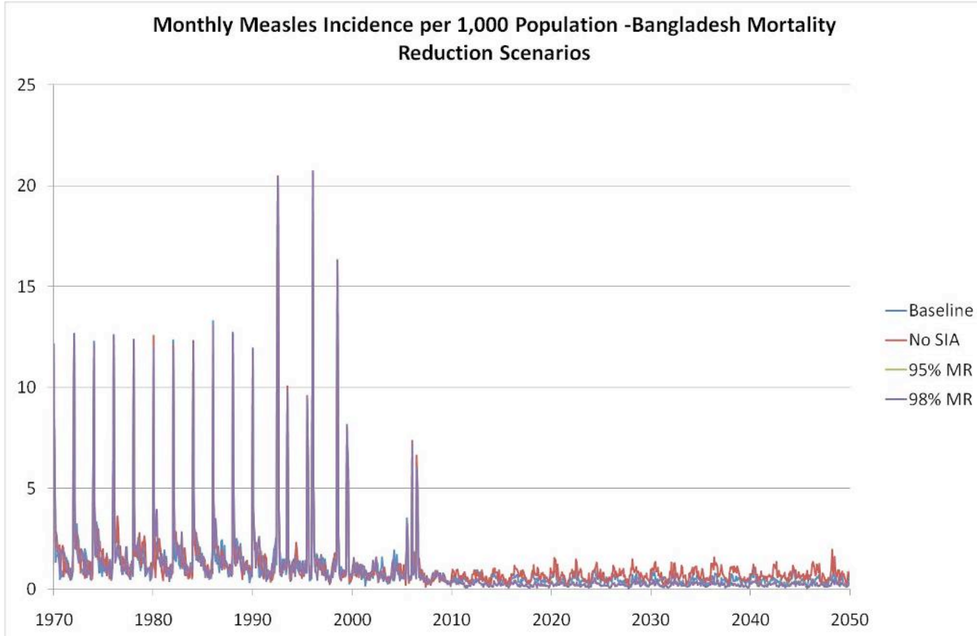

Figure A.1.1. Country-level monthly incidence for 10-district simulations for Bangladesh, reduction in mortality scenarios.

Table A.1.4. Vaccination assumptions and simulation outcomes for eradication scenarios, Bangladesh.

Scenario	Goal	Target Year	Initi al Vaccinati on Assumpti ons							Ramp-Up Vaccinati on Assumpti ons								Post-Goal Vaccinati on Assumpti ons							Average % Mortality Reducti on
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
5	Eradicati on	2020	88%	9 mo	N/A	N/A	95%	9 mo - 59 mo	4 yrs	1.0	2020		18 mo	2010	95%	9 mo - 59 mo	4 yrs	89.3%	12 mo	80.2%	18 mo	95%	9 mo - 59 mo	4 yrs	100%
																		89.3%	12 mo	80.2%	18 mo	-	-	-	100%
																		89.3%	12 mo	-	-	-	-	-	100%
6	Eradicati on	2025	88%	9 mo	N/A	N/A	95%	9 mo - 59 mo	4 yrs	1.0	2025		18 mo	2010	95%	9 mo - 59 mo	4 yrs	89.6%	12 mo	80.2%	72 mo	95%	9 mo - 59 mo	4 yrs	100%
																		89.6%	12 mo	80.2%	72mo	-	-	-	100%
																		89.6%	12 mo	-	-	-	-	-	100%

Table A.1.4. Transmission and cost results for eradication scenarios, Bangladesh (all totals discounted by 3%).

Bangladesh	E2020 - MCV1+MCV2+SIA	E2020 - MCV1+MCV2	E2020 - MCV1	E2025 - MCV1+MCV2+SIA	E2025 - MCV1+MCV2	E2025 - MCV1
Correlati on Coeffi cient	0.7999	0.7852	0.7999	0.7919	0.8212	0.7933
2000 Mortality	15,559.66	14,446.23	15,559.66	14,437.14	14,331.83	15,888.43
Target Year Mortality	221.52	130.03	221.52	208.94	166.17	188.88
% Reducti on in Mortality through 2050	100%	100%	100%	100%	100%	100%
Total Cost 2010 - 2030	$ 327,028,916.35	$ 308,883,967.31	$ 266,753,907.64	$ 382,098,221.40	$ 339,896,747.26	$ 341,179,469.90
Incremental Cost over Baseline, 2010 - 2030	$ 99,136,291.14	$ 80,991,342.10	$ 38,861,282.43	$ 154,205,596.19	$ 112,004,122.05	$ 113,286,844.69
Total DALYs, 2010 - 2030	513,411.79	558,709.37	513,411.79	787,391.79	743,875.64	779,691.18
Total Deaths, 2010 - 2030	16,214.96	17,644.75	16,214.96	24,627.63	23,233.13	24,383.24
Total Cases, 2010 - 2030	2,173,072.76	2,353,312.80	2,173,072.76	3,217,773.27	3,031,847.60	3,201,783.29
DALYs Averted over Baseline, 2010 - 2030	1,899,180.10	1,853,882.52	1,899,180.10	1,625,200.10	1,668,716.25	1,632,900.71
Deaths Averted over Baseline, 2010 - 2030	61,814.91	60,385.12	61,814.91	53,402.24	54,796.74	53,646.63
Cases Averted over Baseline, 2010 - 2030	9,505,894.29	9,325,654.25	9,505,894.29	8,461,193.78	8,647,119.45	8,477,183.76
Cost per DALY, 2010 - 2030	$ 52.20	$ 43.69	$ 20.46	$ 94.88	$ 67.12	$ 69.38
Cost per Death, 2010 - 2030	$ 1,603.76	$ 1,341.25	$ 628.67	$ 2,887.62	$ 2,043.99	$ 2,111.72
Cost per Case, 2010 - 2030	$ 10.43	$ 8.68	$ 4.09	$ 18.23	$ 12.95	$ 13.36
Total Cost 2010 - 2050	$ 459,834,337.15	$ 388,423,817.02	$ 299,600,525.23	$ 552,054,443.15	$ 433,772,538.49	$ 395,814,066.48
Incremental Cost over Baseline, 2010 - 2050	$ 120,217,095.95	$ 48,806,575.82	$ (40,016,715.97)	$ 212,437,201.95	$ 94,155,297.29	$ 56,196,825.28
Total DALYs, 2010 - 2050	513,411.79	558,709.37	513,411.79	787,391.79	743,875.64	779,691.18
Total Deaths, 2010 - 2050	16,214.96	17,644.75	16,214.96	24,627.63	23,233.13	24,383.24
Total Cases, 2010 - 2050	2,173,072.76	2,353,312.80	2,173,072.76	3,217,773.27	3,031,847.60	3,201,783.29
DALYs Averted over Baseline, 2010 - 2050	3,171,137.66	3,125,840.08	3,171,137.66	2,897,157.66	2,940,673.81	2,904,858.27
Deaths Averted over Baseline, 2010 - 2050	102,072.87	100,643.08	102,072.87	93,660.20	95,054.70	93,904.59
Cases Averted over Baseline, 2010 - 2050	15,464,674.53	15,284,434.49	15,464,674.53	14,419,974.02	14,605,899.69	14,435,964.00
Cost per DALY, 2010 - 2050	$ 37.91	$ 15.61	$ (12.62)	$ 73.33	$ 32.02	$ 19.35
Cost per Death, 2010 - 2050	$ 1,177.76	$ 484.95	$ (392.04)	$ 2,268.17	$ 990.54	$ 598.45
Cost per Case, 2010 - 2050	$ 7.77	$ 3.19	$ (2.59)	$ 14.73	$ 6.45	$ 3.89

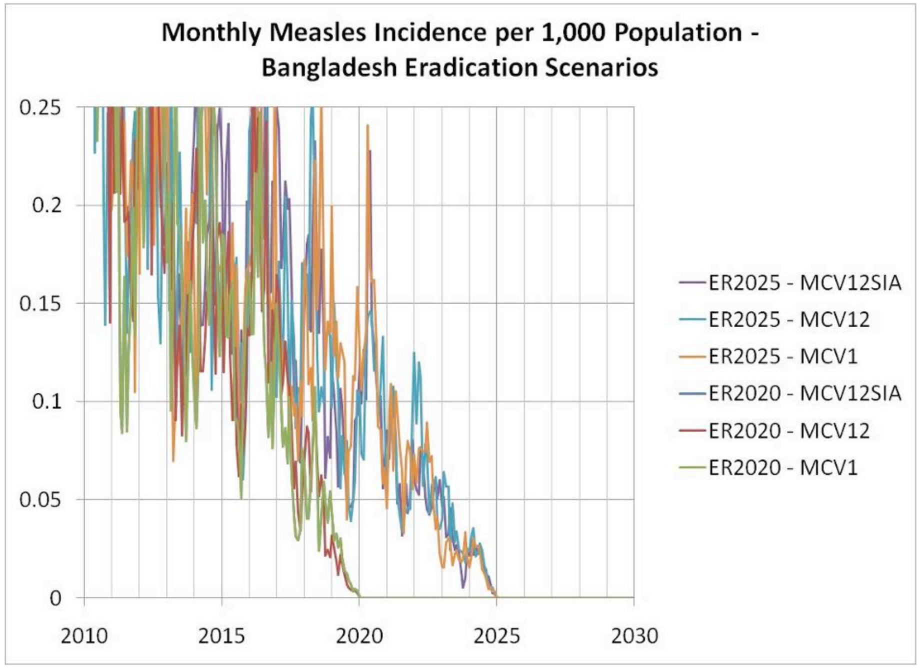

Figure A.1.2. Country-level monthly incidence for 10-district simulations for Bangladesh, eradication scenarios.

A.2. Brazil

Brazil currently implements two routine opportunities for vaccination – MCV1 for infants 12 months of age with an average coverage rate of 94%, and MCV2 for children 4-6 years with an average coverage of 16% – along with irregular catch-up and follow-up supplemental immunization activities from 1992 – 2009 targeting a range of age groups. The current vaccine formulation is trivalent (measles-mumps-rubella).

Measles was eliminated locally in Brazil in 2000, and incidence and mortality have been maintained at this level since then with the exception of occasional cases imported from outside the country in 2003, 2005 and 2006.

Brazil was simulated as consisting of ten districts (aggregated from a country total of 27 districts) based on average MCV1 coverage for 1994 – 2007, with 2007 values ranging from 89% to 97%. As defined in the sections above, the transmission model yielded average mortality figures for 2000 of no deaths (range: 0 – 0.09), which corresponds with estimated mortality provided by WHO. Comparing model results for simulated district-level incidence of the period from 1989 to 2003 with reported incidence over the same period (based on district-level data from Brazil) results in an average correlation coefficient of 0.7037 (range: 0.6951 – 0.7141).

Table A.2.1. Vaccination assumptions and simulation outcomes for mortality reduction scenarios, Brazil.

Scenario	Goal	Target Year	Initial Vaccination Assumptions							Ramp-Up Vaccination Assumptions								Target (and post-target) Vaccination Assumptions							Average % Mortality Reduction
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
1	90% Mortality Reduction	2013	94%	12 mo	16%	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	N/A	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	94%	12 mo	16%	60 mo	95%	9 mo - 47 mo	4 yrs	91%
2	No SIA																								
3	95% Mortality Reduction	2015	94%	12 mo	16%	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	2012	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	94%	12 mo	16%	60 mo	95%	9 mo - 47 mo	4 yrs	93%
4	98% Mortality Reduction	2020	94%	12 mo	16%	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	2012	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	94%	12 mo	16%	60 mo	95%	9 mo - 47 mo	4 yrs	86%

Data were collected in Brazil in October 2009 on the costs of measles vaccination for routine immunization and SIAs, from one of the municipalities. In addition, national data were collected on the costs of vaccines, syringes and some logistical expenditures.

Table A.2.2. Assumptions for Costs of Measles Vaccination in Brazil

Parameter	Value (costs in US$)
Initial Coverage	94%
Cost per dose of routine immunization	$3.91
Added Cost per additional percent of coverage for routine immunization	$1.27
Cost per dose of measles vaccination given through SIA	N/A
Cost to Household of Obtaining Vaccination	$1.43
Cost of Treating Case of Measles	$198.50

Source: Data collection by Emily Simons; Acharya 2002.

Table A.2.3. Transmission and cost results for reduction in mortality scenarios, Brazil (all totals discounted by 3%).

Brazil	Baseline (90% RM by 2013)	No SIA	95% RM by 2015	98% RM by 2020
Correlation Coefficient	0.7017		0.7060	0.6951
2000 Mortality	0.62		0.55	0.34
Target Year Mortality	-		0.03	0.09
% Reduction in Mortality through 2050	91%		93%	86%
Total Cost 2010 - 2030	$ 1,051,147,065.26		$ 1,021,136,663.29	$ 933,748,545.37
Incremental Cost over Baseline, 2010 - 2030	$ -		$ (30,010,401.96)	$ (117,398,519.89)
Total DALYs, 2010 - 2030	37.16		28.86	26.30
Total Deaths, 2010 - 2030	1.15		0.72	0.72
Total Cases, 2010 - 2030	1,143.90		831.20	800.55
DALYs Averted over Baseline, 2010 - 2030	-		8.30	10.86
Deaths Averted over Baseline, 2010 - 2030	-		0.43	0.43
Cases Averted over Baseline, 2010 - 2030	-		312.70	343.35
Cost per DALY, 2010 - 2030	$ -		$ (3,617,107.51)	$ (10,813,367.35)
Cost per Death, 2010 - 2030	$ -		$ (69,925,100.36)	$ (273,541,930.41)
Cost per Case, 2010 - 2030	$ -		$ (95,971.39)	$ (341,919.31)
Total Cost 2010 - 2050	$ 1,526,615,403.91		$ 1,491,701,167.44	$ 1,399,605,151.39
Incremental Cost over Baseline, 2010 - 2050	$ -		$ (34,914,236.47)	$ (127,010,252.52)
Total DALYs, 2010 - 2050	52.18		44.39	39.63
Total Deaths, 2010 - 2050	1.53		1.06	1.11
Total Cases, 2010 - 2050	1,559.44		1,258.10	1,170.89
DALYs Averted over Baseline, 2010 - 2050	-		7.79	12.55
Deaths Averted over Baseline, 2010 - 2050	-		0.47	0.42
Cases Averted over Baseline, 2010 - 2050	-		301.34	388.55
Cost per DALY, 2010 - 2050	$ -		$ (4,481,211.00)	$ (10,119,330.72)
Cost per Death, 2010 - 2050	$ -		$ (73,933,403.86)	$ (300,801,805.31)
Cost per Case, 2010 - 2050	$ -		$ (115,864.71)	$ (326,885.81)

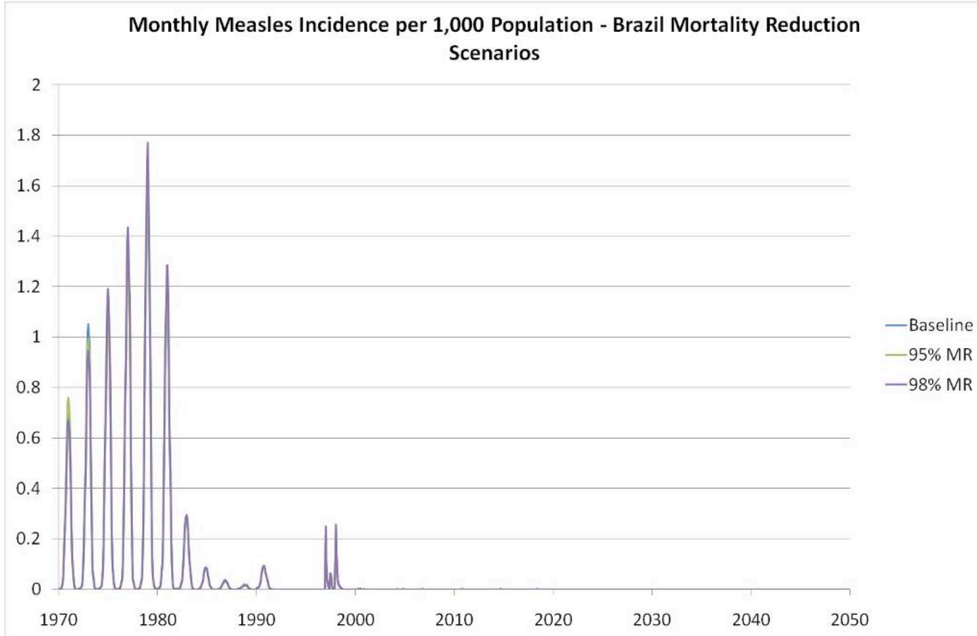

Figure A.2.1. Country-level monthly incidence for 10-district simulations for Brazil, reduction in mortality scenarios.

Table A.2.4. Vaccination assumptions and simulation outcomes for eradication scenarios, Brazil.

Scenario	Goal	Target Year	Initial Vaccination Assumptions							Ramp-Up Vaccination Assumptions								Post-Goal Vaccination Assumptions							Average % Mortality Reduction
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
5	Eradication	2020	94%	12 mo	16.2	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	N/A	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	94.4%	12 mo	16.2%	60 mo	95%	9 mo - 47 mo	4 yrs	100%
																		94.4%	12 mo	16.2%	60 mo	-	-	-	100%
																		94.4%	12 mo	-	-	-	-	-	100%
6	Eradication	2025	94%	12 mo	16.2	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	N/A	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	94.4%	12 mo	16.2%	60 mo	95%	9 mo - 47 mo	4 yrs	100%
																		94.4%	12 mo	16.2%	60 mo	-	-	-	100%
																		94.4%	12 mo	-	-	-	-	-	100%

Table A.2.5. Transmission and cost results for eradication scenarios, Brazil (all totals discounted by 3%).

Brazil	E2020 – MCV1+MCV2+SIA	E2020 – MCV1+MCV2	E2020 – MCV1	E2025 – MCV1+MCV2+SIA	E2025 – MCV1+MCV2	E2025 – MCV1
Correlation Coefficient	0.7020	0.6988	0.7138	0.7030	0.6989	0.7141
2000 Mortality	0.41	0.70	1.33	0.95	0.58	1.11
Target Year Mortality	0.00	0.00	0.00	0.00	-	0.00
% Reduction in Mortality through 2050	100%	100%	100%	100%	100%	100%
Total Cost 2010 - 2030	$ 861,886,040.01	$ 877,780,949.38	$ 746,531,839.35	$ 876,384,714.13	$ 939,961,986.03	$ 855,431,782.92
Incremental Cost over Baseline, 2010 - 2030	$ (189,261,025.25)	$ (173,366,115.88)	$ (304,615,225.91)	$ (174,762,351.13)	$ (111,185,079.23)	$ (195,715,282.34)
Total DALYs, 2010 - 2030	8.30	15.24	8.85	13.53	19.54	12.05
Total Deaths, 2010 - 2030	0.26	0.38	0.21	0.38	0.51	0.38
Total Cases, 2010 - 2030	249.75	471.72	286.06	403.92	600.34	381.78
DALYs Averted over Baseline, 2010 - 2030	28.86	21.92	28.31	23.63	17.62	25.11
Deaths Averted over Baseline, 2010 - 2030	0.89	0.77	0.94	0.77	0.64	0.77
Cases Averted over Baseline, 2010 - 2030	894.15	672.18	857.84	739.98	543.56	762.12
Cost per DALY, 2010 - 2030	$ (6,558,629.29)	$ (7,910,194.47)	$ (10,761,204.82)	$ (7,396,785.99)	$ (6,311,311.17)	$ (7,795,311.07)
Cost per Death, 2010 - 2030	$ (212,849,125.48)	$ (225,391,046.90)	$ (324,341,947.16)	$ (227,206,274.31)	$ (173,949,763.92)	$ (254,446,909.41)
Cost per Case, 2010 - 2030	$ (211,665.49)	$ (257,915.62)	$ (355,094.98)	$ (236,171.23)	$ (204,549.20)	$ (256,803.24)
Total Cost 2010 - 2050	$ 1,165,921,600.88	$ 1,107,256,826.12	$ 946,880,633.23	$ 1,181,500,432.28	$ 1,169,437,862.78	$ 1,055,780,576.80
Incremental Cost over Baseline, 2010 - 2050	$ (360,693,803.03)	$ (419,358,577.79)	$ (579,734,770.68)	$ (345,114,971.62)	$ (357,177,541.13)	$ (470,834,827.11)
Total DALYs, 2010 - 2050	8.30	15.24	8.85	13.53	19.54	12.05
Total Deaths, 2010 - 2050	0.26	0.38	0.21	0.38	0.51	0.38
Total Cases, 2010 - 2050	249.75	471.72	286.06	403.92	600.34	381.78
DALYs Averted over Baseline, 2010 - 2050	43.88	36.94	43.33	38.65	32.64	40.13
Deaths Averted over Baseline, 2010 - 2050	1.27	1.15	1.32	1.15	1.02	1.15
Cases Averted over Baseline, 2010 - 2050	1,309.69	1,087.72	1,273.38	1,155.52	959.10	1,177.66
Cost per DALY, 2010 - 2050	$ (8,219,770.42)	$ (11,352,040.73)	$ (13,379,137.85)	$ (8,928,947.17)	$ (10,942,520.22)	$ (11,732,373.74)
Cost per Death, 2010 - 2050	$ (283,511,041.50)	$ (363,951,037.02)	$ (438,449,306.12)	$ (299,516,829.91)	$ (349,407,078.22)	$ (408,626,012.84)
Cost per Case, 2010 - 2050	$ (275,404.74)	$ (385,540.42)	$ (455,273.75)	$ (298,667.35)	$ (372,410.53)	$ (399,806.68)

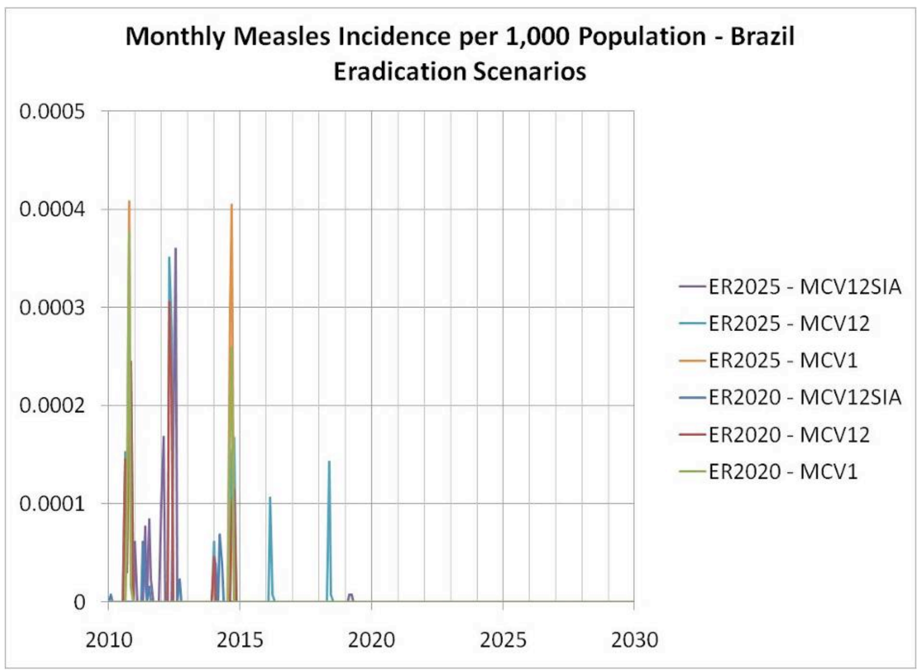

Figure A.2.2. Country-level monthly incidence for 10-district simulations for Brazil, eradication scenarios.

A.3. Colombia

Colombia currently implements two routine opportunities for vaccination – MCV1 for infants 12 months of age with an average coverage rate of 95%, and MCV2 for children 5 years with an average coverage of 69% – along with irregular catch-up and follow-up supplemental immunization activities from 1993 – 2006 targeting a range of age groups. The current vaccine formulation is trivalent (measles-mumps-rubella).

Measles was eliminated locally in Colombia in 2000, and incidence and mortality have been maintained at this level since then with the exception of occasional cases imported from outside the country in 2002.

Colombia was simulated as consisting of ten districts (aggregated from a country total of 33 districts) based on average MCV1 coverage for 2006 – 2009, with 2009 values ranging from 83% to 99%. As defined in the sections above, the transmission model yielded average mortality figures for 2000 of 0.14 deaths (range: 0.04 – 0.25), which corresponds with estimated mortality provided by WHO. Comparing model results for simulated district-level incidence of the period from 1990 to 2009 with reported incidence over the same period (based on country-level data from Colombia) results in an average correlation coefficient of 0.9706 (range: 0.9678 – 0.9745).

Table A.3.1. Vaccination assumptions and simulation outcomes for mortality reduction scenarios, Colombia.

Scenario	Goal	Target Year	Initial Vaccination Assumptions							Ramp-Up Vaccination Assumptions								Target (and post-target) Vaccination Assumptions							Average % Mortality Reduction
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
1	90% Mortality Reduction	2013	95%	12 mo	69%	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	N/A	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	95%	12 mo	69%	60 mo	95%	9 mo - 47 mo	4 yrs	63%
2	No SIA																								
3	95% Mortality Reduction	2015	95%	12 mo	69%	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	N/A	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	95%	12 mo	69%	60 mo	95%	9 mo - 47 mo	4 yrs	88%
4	98% Mortality Reduction	2020	95%	12 mo	69%	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	N/A	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	95%	12 mo	69%	60 mo	95%	9 mo - 47 mo	4 yrs	74%

Data were collected in Colombia in March/April 2010 on the costs of measles vaccination for routine immunization and SIAs, in three districts in the country: Bogota, Cali and Medellin. Information on cost savings from not treating a measles case were taken from published studies.

Table A.3.2. Assumptions for Costs of Measles Vaccination in Colombia

Parameter	Value (costs in US$)
Initial Coverage	95%
Cost per dose of routine immunization	$7.77
Added Cost per additional percent of coverage for routine immunization	$2.87
Cost per dose of measles vaccination given through SIA	N/A
Cost to Household of Obtaining Vaccination	$3.80
Cost of Treating Case of Measles	$85.00

Source: WHO/Bogota; Salutia Foundation 2000; Acharya 2002.

Table A.3.3. Transmission and cost results for reduction in mortality scenarios, Colombia (all totals discounted by 3%).

Colombia	Baseline (90% RM by 2013)	No SIA	95% RM by 2015	98% RM by 2020
Correlation Coefficient	0.9744		0.9678	0.9691
2000 Mortality	0.10		0.25	0.13
Target Year Mortality	0.05		0.06	0.06
% Reduction in Mortality through 2050	63%		88%	74%
Total Cost 2010 - 2030	$ 608,568,477.45		$ 606,619,900.13	$ 608,462,348.70
Incremental Cost over Baseline, 2010 - 2030	$ -		$ (1,948,577.32)	$ (106,128.75)
Total DALYs, 2010 - 2030	27.71		21.11	26.22
Total Deaths, 2010 - 2030	0.60		0.46	0.47
Total Cases, 2010 - 2030	2,521.43		1,922.32	2,389.36
DALYs Averted over Baseline, 2010 - 2030	-		6.60	1.49
Deaths Averted over Baseline, 2010 - 2030	-		0.14	0.13
Cases Averted over Baseline, 2010 - 2030	-		599.11	132.07
Cost per DALY, 2010 - 2030	$ -		$ (295,238.99)	$ (71,227.35)
Cost per Death, 2010 - 2030	$ -		$ (13,918,409.43)	$ (816,375.00)
Cost per Case, 2010 - 2030	$ -		$ (3,252.45)	$ (803.58)
Total Cost 2010 - 2050	$ 925,292,633.60		$ 918,302,727.80	$ 920,421,181.31
Incremental Cost over Baseline, 2010 - 2050	$ -		$ (6,989,905.80)	$ (4,871,452.29)
Total DALYs, 2010 - 2050	48.73		35.62	38.48
Total Deaths, 2010 - 2050	0.85		0.72	0.81
Total Cases, 2010 - 2050	4,459.79		3,256.94	3,516.32
DALYs Averted over Baseline, 2010 - 2050	-		13.11	10.25
Deaths Averted over Baseline, 2010 - 2050	-		0.13	0.04
Cases Averted over Baseline, 2010 - 2050	-		1,202.85	943.47
Cost per DALY, 2010 - 2050	$ -		$ (533,173.59)	$ (475,263.64)
Cost per Death, 2010 - 2050	$ -		$ (53,768,506.15)	$ (121,786,307.25)
Cost per Case, 2010 - 2050	$ -		$ (5,811.12)	$ (5,163.34)

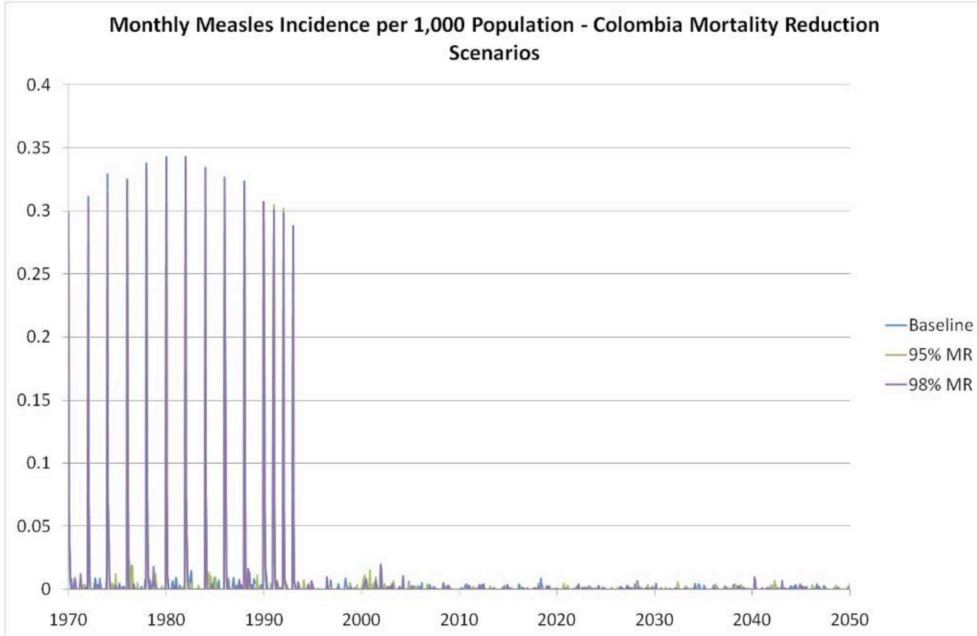

Figure A.3.1. Country-level monthly incidence for 10-district simulations for Colombia, reduction in mortality scenarios.

Table A.3.4. Vaccination assumptions and simulation outcomes for eradication scenarios, Colombia.

Scenario	Goal	Target Year	Initi al Vaccinati on Assumpti ons							Ramp-Up Vaccinati on Assumpti ons								Post-Goal Vaccinati on Assumpti ons							Average % Mortality Reducti on
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
5	Eradicati on	2020	95%	12 mo	69%	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	N/A	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	94.6%	12 mo	68.9%	60 mo	95%	9 mo - 47 mo	4 yrs	100%
																		94.6%	12 mo	68.9%	60 mo	-	-	-	100%
																		94.6%	12 mo	-	-	-	-	-	100%
6	Eradicati on	2025	95%	12 mo	69%	60 mo	95%	9 mo - 47 mo	4 yrs	N/A	N/A	N/A	60 mo	N/A	95%	9 mo - 47 mo	4 yrs	94.6%	12 mo	68.9%	60 mo	95%	9 mo - 47 mo	4 yrs	100%
																		94.6%	12 mo	68.9%	60 mo	-	-	-	100%
																		94.6%	12 mo	-	-	-	-	-	100%

Table A.3.5. Transmission and cost results for eradication scenarios, Colombia (all totals discounted by 3%).

Colombia	E2020 – MCV1+MCV2+SIA	E2020 – MCV1+MCV2	E2020 – MCV1	E2025 – MCV1+MCV2+SIA	E2025 – MCV1+MCV2	E2025 – MCV1
Correlation Coefficient	0.9745	0.9715	0.9688	0.9695	0.9715	0.9681
2000 Mortality	0.04	0.10	0.18	0.21	0.10	0.16
Target Year Mortality	-	0.00	0.00	-	-	-
% Reduction in Mortality through 2050	100%	100%	100%	100%	100%	100%
Total Cost 2010 - 2030	$ 604,630,795.09	$ 575,700,560.03	$ 514,673,735.56	$ 606,905,231.72	$ 592,879,627.24	$ 569,747,481.38
Incremental Cost over Baseline, 2010 - 2030	$ (3,937,682.36)	$ (32,867,917.42)	$ (93,894,741.89)	$ (1,663,245.73)	$ (15,688,850.21)	$ (38,820,996.07)
Total DALYs, 2010 - 2030	5.53	9.66	9.66	8.38	12.85	11.24
Total Deaths, 2010 - 2030	0.09	0.17	0.17	0.13	0.26	0.17
Total Cases, 2010 - 2030	491.64	864.06	864.06	770.38	1,162.46	1,019.62
DALYs Averted over Baseline, 2010 - 2030	22.18	18.05	18.05	19.33	14.86	16.47
Deaths Averted over Baseline, 2010 - 2030	0.51	0.43	0.43	0.47	0.34	0.43
Cases Averted over Baseline, 2010 - 2030	2,029.79	1,657.37	1,657.37	1,751.05	1,358.97	1,501.81
Cost per DALY, 2010 - 2030	$ (177,533.02)	$ (1,820,937.25)	$ (5,201,924.76)	$ (86,044.79)	$ (1,055,777.27)	$ (2,357,073.23)
Cost per Death, 2010 - 2030	$ (7,720,945.80)	$ (76,437,017.26)	$ (218,359,864.86)	$ (3,538,820.70)	$ (46,143,677.09)	$ (90,281,386.21)
Cost per Case, 2010 - 2030	$ (1,939.95)	$ (19,831.37)	$ (56,652.85)	$ (949.86)	$ (11,544.66)	$ (25,849.47)
Total Cost 2010 - 2050	$ 917,454,022.03	$ 832,876,319.80	$ 669,305,589.91	$ 919,639,758.49	$ 850,055,387.01	$ 726,146,810.22
Incremental Cost over Baseline, 2010 - 2050	$ (7,838,611.57)	$ (92,416,313.80)	$ (255,987,043.69)	$ (5,652,875.11)	$ (75,237,246.59)	$ (199,145,823.38)
Total DALYs, 2010 - 2050	5.53	9.66	9.66	8.38	12.85	11.24
Total Deaths, 2010 - 2050	0.09	0.17	0.17	0.13	0.26	0.17
Total Cases, 2010 - 2050	491.64	864.06	864.06	770.38	1,162.46	1,019.62
DALYs Averted over Baseline, 2010 - 2050	43.20	39.07	39.07	40.35	35.88	37.49
Deaths Averted over Baseline, 2010 - 2050	0.76	0.68	0.68	0.72	0.59	0.68
Cases Averted over Baseline, 2010 - 2050	3,968.15	3,595.73	3,595.73	3,689.41	3,297.33	3,440.17
Cost per DALY, 2010 - 2050	$ (181,449.34)	$ (2,365,403.48)	$ (6,552,010.33)	$ (140,096.04)	$ (2,096,913.23)	$ (5,311,971.82)
Cost per Death, 2010 - 2050	$ (10,313,962.59)	$ (135,906,343.82)	$ (376,451,534.84)	$ (7,851,215.43)	$ (127,520,756.93)	$ (292,861,504.97)
Cost per Case, 2010 - 2050	$ (1,975.38)	$ (25,701.68)	$ (71,191.95)	$ (1,532.19)	$ (22,817.63)	$ (57,888.37)

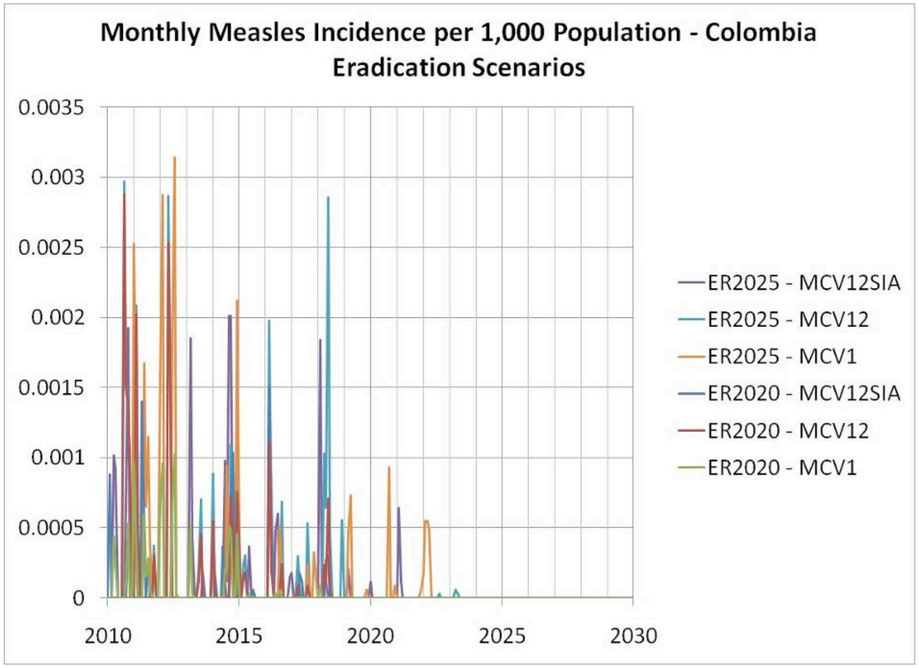

Figure A.3.2. Country-level monthly incidence for 10-district simulations for Colombia, eradication scenarios.

A.4. Ethiopia

Ethiopia currently implements a single routine opportunity for vaccination for infants 9 months of age with an average coverage rate of 74%, along with catch-up and follow-up supplemental immunization activities every year from 1998 - 2009 at national and sub-national levels targeting children 9 months up to 47 months of age (though this target age group shows some variation in historical SIAs). A second routine dose is not presently included in the country's vaccination strategy, and the current vaccine formulation is single-antigen only.

Since the most recent catch-up campaign performed in Ethiopia in 2006 and 2008 measles incidence appears to have declined, though the variable numbers of reported cases over recent years make it difficult to determine the likelihood that the country will be able to achieve 90% mortality reduction goals by the target date of 2013 by continuing its current vaccination strategy.

Ethiopia was simulated as consisting of ten districts (aggregated from a country total of 11 districts) based on average MCV1 coverage over the period 2008 – 2009, with values ranging from 40% to 98%. As defined in the sections above, the transmission model yielded average mortality figures for 2000 of 35,510 (range: 33,297 – 38,993), which falls somewhat above the range of estimated mortality provided by WHO. Comparing model results for simulated district-level incidence over the period from 2000 to 2008 with reported incidence over the same period (based on country-level case reports from Ethiopia) results in an average correlation coefficient of 0.7185 (range: 0.6752 – 0.7311).

Table A.4.1. Vaccination assumptions and simulation outcomes for mortality reduction scenarios, Ethiopia.

Scenario	Goal	Target Year	Initial Vaccination Assumptions							Ramp-Up Vaccination Assumptions								Target (and post-target) Vaccination Assumptions							Average % Mortality Reduction
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
1	90% Mortality Reduction	2013	72%	9 mo	N/A	N/A	90%	9 mo - 47 mo	3 yrs	N/A	N/A	N/A	N/A	N/A	90%	9 mo - 47 mo	3 yrs	72%	9 mo	N/A	N/A	90%	9 mo - 47 mo	3 yrs	90%
2	No SIA		72%	9 mo	N/A	N/A	90%	9 mo - 47 mo	3 yrs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	72%	9 mo	N/A	N/A	N/A	N/A	N/A	86%
3	95% Mortality Reduction	2015	72%	9 mo	N/A	N/A	90%	9 mo - 47 mo	3 yrs	2	2013	N/A	18 mo	2013	95%	9 mo - 47 mo	3 yrs	88.7%	12 mo	68%	N/A	95%	9 mo - 47 mo	3 yrs	94%
4	98% Mortality Reduction	2020	72%	9 mo	N/A	N/A	90%	9 mo - 47 mo	3 yrs	2	2013	N/A	18 mo	2013	95%	9 mo - 59 mo	2 yrs	90.1%	12 mo	81%	18 mo	95%	9 mo - 59 mo	3 yrs	97%

Data were collected in Ethiopia in March 2010 on the costs of measles vaccination for routine immunization and SIAs. Information on societal costs, the cost of obtaining vaccination, was taken from published studies.

Table A.4.2. Assumptions for Costs of Measles Vaccination in Ethiopia

Parameter	Value (costs in US$)
Initial Coverage	63%
Cost per dose of routine immunization	$1.35
Added Cost per additional percent of coverage for routine immunization	$0.64
Cost per dose of measles vaccination given through SIA	$0.055 until 80%; $0.118 after 80%
Cost to Household of Obtaining Vaccination	$0.25*
Cost of Treating Case of Measles	$12.34

Source: Data Collection in Ethiopia

Table A.4.3. Transmission and cost results for reduction in mortality scenarios, Ethiopia (all totals discounted by 3%).

Ethiopia	Baseline (90% RM by 2013)	No SIA	95% RM by 2015	98% RM by 2020
Correlati on Coeffi cient	0.6752	0.6752	0.7164	0.7311
2000 Mortality	38,992.68	38,993.02	33,297.44	34,830.40
Target Year Mortality	719.65	940.67	1,935.34	1,772.06
% Reducti on in Mortality through 2050	90%	86%	94%	97%
Total Cost 2010 - 2030	$ 163,190,735.77	$ 86,768,505.88	$ 264,972,282.57	$ 397,479,299.10
Incremental Cost over Baseline, 2010 - 2030	$ -	$ (76,422,229.89)	$ 101,781,546.80	$ 234,288,563.33
Total DALYs, 2010 - 2030	1,449,344.87	1,967,606.28	1,082,052.33	556,113.21
Total Deaths, 2010 - 2030	47,656.55	63,859.68	34,588.89	18,068.38
Total Cases, 2010 - 2030	3,677,901.24	5,155,858.75	2,399,399.78	1,260,505.77
DALYs Averted over Baseline, 2010 - 2030	-	(518,261.41)	367,292.54	893,231.66
Deaths Averted over Baseline, 2010 - 2030	-	(16,203.13)	13,067.66	29,588.17
Cases Averted over Baseline, 2010 - 2030	-	(1,477,957.51)	1,278,501.46	2,417,395.47
Cost per DALY, 2010 - 2030	$ -	$ 147.46	$ 277.11	$ 262.29
Cost per Death, 2010 - 2030	$ -	$ 4,716.51	$ 7,788.81	$ 7,918.32
Cost per Case, 2010 - 2030	$ -	$ 51.71	$ 79.61	$ 96.92
Total Cost 2010 - 2050	$ 253,881,583.40	$ 126,127,748.53	$ 404,882,480.23	$ 645,064,647.51
Incremental Cost over Baseline, 2010 - 2050	$ -	$ (127,753,834.87)	$ 151,000,896.83	$ 391,183,064.11
Total DALYs, 2010 - 2050	2,396,529.26	3,339,679.52	1,602,619.84	829,133.21
Total Deaths, 2010 - 2050	79,267.11	109,922.95	50,666.80	26,634.02
Total Cases, 2010 - 2050	6,389,957.15	9,400,370.94	3,490,625.15	1,850,073.84
DALYs Averted over Baseline, 2010 - 2050	-	(943,150.26)	793,909.42	1,567,396.05
Deaths Averted over Baseline, 2010 - 2050	-	(30,655.84)	28,600.31	52,633.09
Cases Averted over Baseline, 2010 - 2050	-	(3,010,413.79)	2,899,332.00	4,539,883.31
Cost per DALY, 2010 - 2050	$ -	$ 135.45	$ 190.20	$ 249.58
Cost per Death, 2010 - 2050	$ -	$ 4,167.36	$ 5,279.69	$ 7,432.26
Cost per Case, 2010 - 2050	$ -	$ 42.44	$ 52.08	$ 86.17

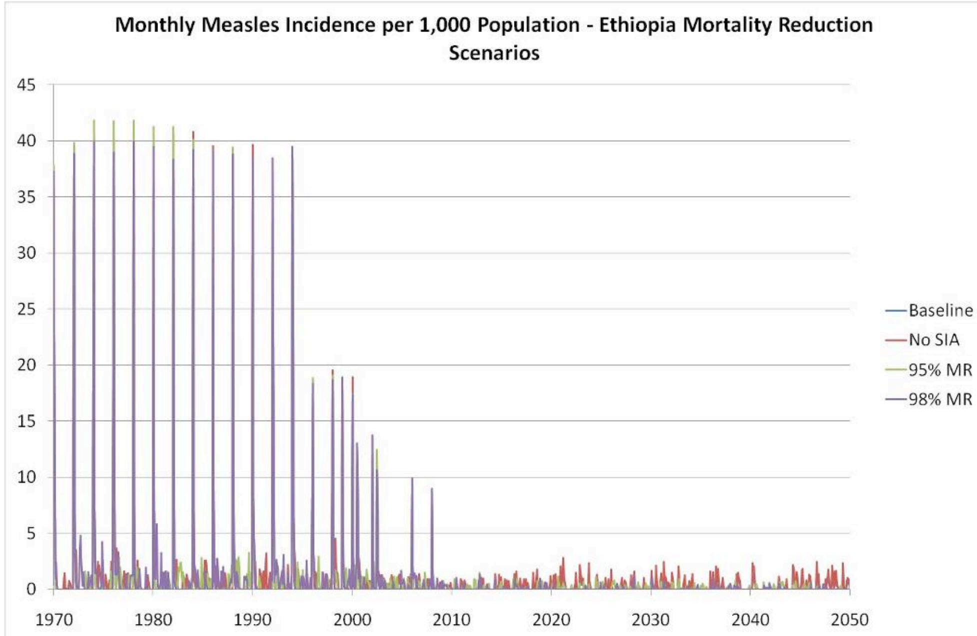

Figure A.4.1. Country-level monthly incidence for 10-district simulations for Ethiopia, reduction in mortality scenarios.

Table A.4.4. Vaccination assumptions and simulation outcomes for eradication scenarios, Ethiopia.

Scenario	Goal	Target Year	Initial Vaccination Assumptions							Ramp-Up Vaccination Assumptions								Post-Goal Vaccination Assumptions							Average % Mortality Reduction
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
5	Eradication	2020	72%	9 mo	N/A	N/A	90%	9 mo - 47 mo	3 yrs	2.0	2013	N/A	18 mo	2013	95%	9 mo - 59 mo	2 yrs	90.1%	12 mo	81.1%	18 mo	95%	9 mo - 59 mo	3 yrs	100%
																		90.1%	12 mo	81.1%	18 mo	-	-	-	100%
																		90.1%	12 mo	-	-	-	-	-	100%
6	Eradication	2025	72%	9 mo	N/A	N/A	90%	9 mo - 47 mo	3 yrs	2.0	2013	N/A	18 mo	2013	95%	9 mo - 59 mo	2 yrs	90.8%	12 mo	81.7%	18 mo	95%	9 mo - 59 mo	3 yrs	100%
																		90.8%	12 mo	81.7%	18 mo	-	-	-	100%
																		90.8%	12 mo	-	-	-	-	-	100%

Table A.4.5. Transmission and cost results for eradication scenarios, Ethiopia (all totals discounted by 3%).

Ethiopia	E2020 - MCV1+MCV2+SIA	E2020 - MCV1+MCV2	E2020 - MCV1	E2025 - MCV1+MCV2+SIA	E2025 - MCV1+MCV2	E2025 - MCV1
Correlati on Coeffi cient	0.7311	0.7311	0.7311	0.7311	0.7311	0.7311
2000 Mortality	34,830.40	34,830.40	34,830.40	34,830.40	34,830.40	34,830.40
Target Year Mortality	93.03	93.03	93.03	128.68	128.68	128.68
% Reducti on in Mortality through 2050	100%	100%	100%	100%	100%	100%
Total Cost 2010 - 2030	$ 387,055,310.40	$ 373,965,235.68	$ 338,659,726.79	$ 444,615,094.36	$ 438,328,075.24	$ 422,517,146.15
Incremental Cost over Baseline, 2010 - 2030	$ 223,864,574.63	$ 210,774,499.91	$ 175,468,991.02	$ 281,424,358.59	$ 275,137,339.47	$ 259,326,410.38
Total DALYs, 2010 - 2030	312,528.28	312,528.28	312,528.28	434,698.97	434,698.97	434,698.97
Total Deaths, 2010 - 2030	10,356.40	10,356.40	10,356.40	14,276.00	14,276.00	14,276.00
Total Cases, 2010 - 2030	750,751.91	750,751.91	750,751.91	999,529.64	999,529.64	999,529.64
DALYs Averted over Baseline, 2010 - 2030	1,136,816.59	1,136,816.59	1,136,816.59	1,014,645.90	1,014,645.90	1,014,645.90
Deaths Averted over Baseline, 2010 - 2030	37,300.15	37,300.15	37,300.15	33,380.55	33,380.55	33,380.55
Cases Averted over Baseline, 2010 - 2030	2,927,149.33	2,927,149.33	2,927,149.33	2,678,371.60	2,678,371.60	2,678,371.60
Cost per DALY, 2010 - 2030	$ 196.92	$ 185.41	$ 154.35	$ 277.36	$ 271.17	$ 255.58
Cost per Death, 2010 - 2030	$ 6,001.71	$ 5,650.77	$ 4,704.24	$ 8,430.79	$ 8,242.44	$ 7,768.79
Cost per Case, 2010 - 2030	$ 76.48	$ 72.01	$ 59.95	$ 105.07	$ 102.73	$ 96.82
Total Cost 2010 - 2050	$ 577,774,318.98	$ 533,409,758.32	$ 439,461,622.25	$ 654,809,243.78	$ 617,247,814.64	$ 526,227,267.78
Incremental Cost over Baseline, 2010 - 2050	$ 323,892,735.58	$ 279,528,174.92	$ 185,580,038.85	$ 400,927,660.38	$ 363,366,231.24	$ 272,345,684.38
Total DALYs, 2010 - 2050	312,528.28	312,528.28	312,528.28	434,698.97	434,698.97	434,698.97
Total Deaths, 2010 - 2050	10,356.40	10,356.40	10,356.40	14,276.00	14,276.00	14,276.00
Total Cases, 2010 - 2050	750,751.91	750,751.91	750,751.91	999,529.64	999,529.64	999,529.64
DALYs Averted over Baseline, 2010 - 2050	2,084,000.98	2,084,000.98	2,084,000.98	1,961,830.29	1,961,830.29	1,961,830.29
Deaths Averted over Baseline, 2010 - 2050	68,910.71	68,910.71	68,910.71	64,991.11	64,991.11	64,991.11
Cases Averted over Baseline, 2010 - 2050	5,639,205.24	5,639,205.24	5,639,205.24	5,390,427.51	5,390,427.51	5,390,427.51
Cost per DALY, 2010 - 2050	$ 155.42	$ 134.13	$ 89.05	$ 204.36	$ 185.22	$ 138.82
Cost per Death, 2010 - 2050	$ 4,700.18	$ 4,056.38	$ 2,693.05	$ 6,168.96	$ 5,591.01	$ 4,190.51
Cost per Case, 2010 - 2050	$ 57.44	$ 49.57	$ 32.91	$ 74.38	$ 67.41	$ 50.52

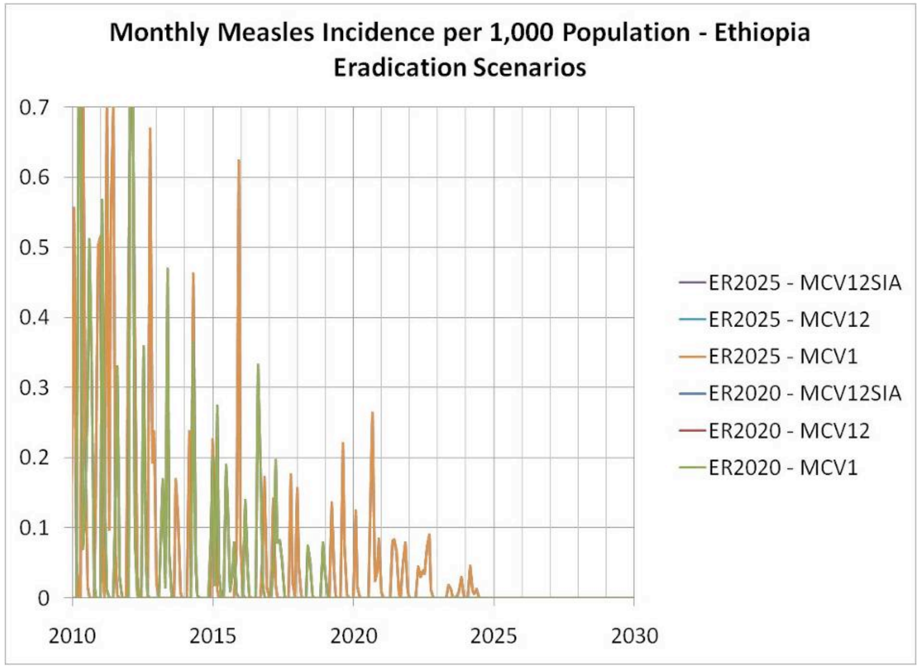

Figure A.4.2. Country-level monthly incidence for 10-district simulations for Ethiopia, eradication scenarios.

A.5. Tajikistan

Tajikistan currently implements two routine opportunities for vaccination – MCV1 for infants 12 months of age with an average coverage rate of 86%, and MCV2 for children 6 years with an average coverage of 83% – along with two supplemental immunization activities in 2004 and 2009 targeting children 1-14 years and 1-5 years, respectively. The current vaccine formulation is bivalent (measles-mumps).

Tajikistan has been near elimination of measles since 2004, and incidence and mortality have been maintained at very low levels since then, indicating a possibility that the country may achieve elimination in the near future by continuing its current vaccination strategy.

Tajikistan was simulated as consisting of five districts (representing all 5 districts in the country), with all districts maintaining recent MCV1 levels at approximately the country average of 86%. As defined in the sections above, the transmission model yielded average mortality figures for 2000 of 25 deaths (range: 17 – 33), which corresponds with estimated mortality provided by WHO. Comparing model results for simulated district-level incidence of the period from 1990 to 2009 with reported incidence over the same period (based on country-level data from Tajikistan) results in an average correlation coefficient of 0.8229 (range: 0.8055 – 0.8525).

Table A.5.1. Vaccination assumptions and simulation outcomes for mortality reduction scenarios, Tajikistan.

Scenario	Goal	Target Year	Initial Vaccination Assumptions							Ramp-Up Vaccination Assumptions								Target (and post-target) Vaccination Assumptions							Average % Mortality Reduction
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
1	90% Mortality Reduction	2013	86%	12 mo	83%	72 mo	95%	9 mo - 59 mo	4 yrs	N/A	N/A	N/A	72 mo	N/A	95%	9 mo - 59 mo	4 yrs	86%	12 mo	83%	72 mo	95%	9 mo - 59 mo	4 yrs	50%
2	No SIA		86%	12 mo	83%	72 mo	95% (until 2010)	9 mo - 59 mo	4 yrs	N/A	N/A	N/A	72 mo	N/A	N/A	N/A	N/A	86%	12 mo	83%	72 mo	N/A	N/A	N/A	38%
3	95% Mortality Reduction	2015	86%	12 mo	83%	72 mo	95%	9 mo - 59 mo	4 yrs	0.5	N/A		72 mo	N/A	95%	9 mo - 59 mo	4 yrs	90.5%	12 mo	90.0%	72 mo	95%	9 mo - 59 mo	4 yrs	82%
4	98% Mortality Reduction	2020	86%	12 mo	83%	72 mo	95%	9 mo - 59 mo	4 yrs	0.5	N/A		72 mo	N/A	95%	9 mo - 59 mo	4 yrs	92.0%	12 mo	90.0%	72 mo	95%	9 mo - 59 mo	4 yrs	83%

Data were collected in Tajikistan in April 2010 on the costs of measles vaccination for routine immunization and SIAs. During the visit, three districts in the country were visited to collect data on epidemiologic and operational costs. The three districts were Faizabad, Yavon, and Varzob. Information on societal costs, the cost of obtaining vaccination, was taken from published studies.

Table A.5.2. Assumptions for Costs of Measles Vaccination in Tajikistan

Parameter	Value (costs in US$)
Initial Coverage	86%
Cost per dose of routine immunization	$1.68
Added Cost per additional percent of coverage for routine immunization	$0.62
Cost per dose of measles vaccination given through SIA	$0.75 until 90%; $0.15 after 90%
Cost to Household of Obtaining Vaccination	$0.72
Cost of Treating Case of Measles	$12.95

Source: Data Collection in Tajikistan

Table A.5.3. Transmission and cost results for reduction in mortality scenarios, Tajikistan (all totals discounted by 3%).

Tajikistan	Baseline (90% RM by 2013)	No SIA	95% RM by 2015	98% RM by 2020
Correlation Coefficient	0.8055	0.8193	0.8096	0.8316
2000 Mortality	24.13	28.81	29.65	32.51
Target Year Mortality	13.76	22.56	7.66	3.99
% Reduction in Mortality through 2050	50%	38%	82%	83%
Total Cost 2010 - 2030	$ 19,849,988.25	$ 14,976,635.17	$ 42,033,448.05	$ 41,368,462.37
Incremental Cost over Baseline, 2010 - 2030	$ -	$ (4,873,353.08)	$ 22,183,459.80	$ 21,518,474.12
Total DALYs, 2010 - 2030	5,727.68	8,905.97	3,231.45	2,745.18
Total Deaths, 2010 - 2030	187.19	284.57	99.13	84.10
Total Cases, 2010 - 2030	45,624.93	69,805.23	19,068.42	15,920.09
DALYs Averted over Baseline, 2010 - 2030	-	(3,178.29)	2,496.23	2,982.50
Deaths Averted over Baseline, 2010 - 2030	-	(97.38)	88.06	103.09
Cases Averted over Baseline, 2010 - 2030	-	(24,180.30)	26,556.51	29,704.84
Cost per DALY, 2010 - 2030	$ -	$ 1,533.33	$ 8,886.79	$ 7,214.91
Cost per Death, 2010 - 2030	$ -	$ 50,044.70	$ 251,913.01	$ 208,734.83
Cost per Case, 2010 - 2030	$ -	$ 201.54	$ 835.33	$ 724.41
Total Cost 2010 - 2050	$ 30,133,327.80	$ 23,023,491.95	$ 60,730,926.90	$ 60,450,676.90
Incremental Cost over Baseline, 2010 - 2050	$ -	$ (7,109,835.85)	$ 30,597,599.10	$ 30,317,349.10
Total DALYs, 2010 - 2050	8,843.02	13,345.46	4,662.18	4,276.31
Total Deaths, 2010 - 2050	286.61	425.79	141.86	126.69
Total Cases, 2010 - 2050	69,278.82	105,781.57	26,419.80	23,823.29
DALYs Averted over Baseline, 2010 - 2050	-	(4,502.44)	4,180.84	4,566.71
Deaths Averted over Baseline, 2010 - 2050	-	(139.18)	144.75	159.92
Cases Averted over Baseline, 2010 - 2050	-	(36,502.75)	42,859.02	45,455.53
Cost per DALY, 2010 - 2050	$ -	$ 1,579.11	$ 7,318.53	$ 6,638.77
Cost per Death, 2010 - 2050	$ -	$ 51,083.75	$ 211,382.38	$ 189,578.22
Cost per Case, 2010 - 2050	$ -	$ 194.78	$ 713.91	$ 666.97

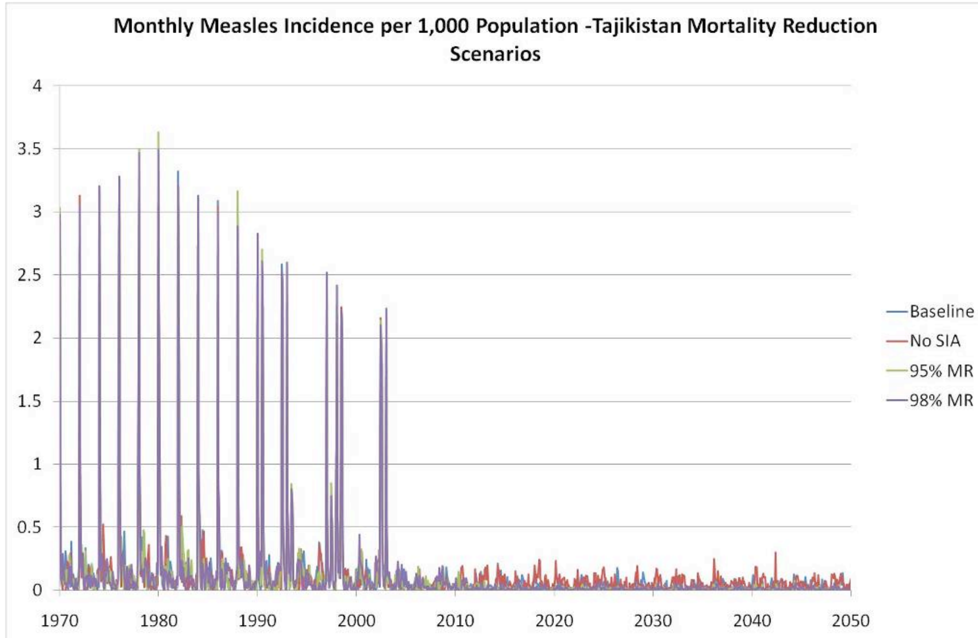

Figure A.5.1. Country-level monthly incidence for 5-district simulations for Uganda, reduction in mortality scenarios.

Table A.5.4. Vaccination assumptions and simulation outcomes for eradication scenarios, Tajikistan.

Scenario	Goal	Target Year	Initial Vaccination Assumptions							Ramp-Up Vaccination Assumptions								Post-Goal Vaccination Assumptions							Average % Mortality Reduction
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
5	Eradication	2020	86%	12 mo	83	72 mo	95%	9 mo - 59 mo	4 yrs	0.5	N/A		72 mo	N/A	95%	9 mo - 59 mo	4 yrs	92.0%	12 mo	90.0%	72 mo	95%	9 mo - 59 mo	4 yrs	100%
																		92.0%	12 mo	90.0%	72mo	-	-	-	100%
																		92.0%	12 mo	-	-	-	-	-	100%
6	Eradication	2025	86%	12 mo	83	72 mo	95%	9 mo - 59 mo	4 yrs	0.5	N/A		72 mo	N/A	95%	9 mo - 59 mo	4 yrs	94.0%	12 mo	90.0%	72 mo	95%	9 mo - 59 mo	4 yrs	100%
																		94.0%	12 mo	90.0%	72mo	-	-	-	100%
																		94.0%	12 mo	-	-	-	-	-	100%

Table A.5.5. Transmission and cost results for eradication scenarios, Tajikistan (all totals discounted by 3%).

Tajikistan	E2020 - MCV1+MCV2+SIA	E2020 - MCV1+MCV2	E2020 - MCV1	E2025 - MCV1+MCV2+SIA	E2025 - MCV1+MCV2	E2025 - MCV1
Correlation Coefficient	0.8218	0.8150	0.8237	0.8525	0.8377	0.8120
2000 Mortality	28.77	17.33	27.50	21.89	18.93	19.37
Target Year Mortality	0.31	0.30	0.45	0.39	0.59	0.57
% Reduction in Mortality through 2050	100%	100%	100%	100%	100%	100%
Total Cost 2010 - 2030	$ 31,325,552.19	$ 31,261,047.48	$ 28,372,341.05	$ 34,308,530.39	$ 34,156,901.43	$ 34,151,385.96
Incremental Cost over Baseline, 2010 - 2030	$ 11,475,563.94	$ 11,411,059.23	$ 8,522,352.80	$ 14,458,542.14	$ 14,306,913.18	$ 14,301,397.71
Total DALYs, 2010 - 2030	1,220.68	1,174.08	1,188.00	1,909.77	1,871.12	1,791.91
Total Deaths, 2010 - 2030	38.43	36.99	37.62	59.97	58.44	56.01
Total Cases, 2010 - 2030	8,083.67	7,843.06	8,063.96	12,557.85	12,134.44	11,522.31
DALYs Averted over Baseline, 2010 - 2030	4,507.00	4,553.60	4,539.68	3,817.91	3,856.56	3,935.77
Deaths Averted over Baseline, 2010 - 2030	148.76	150.20	149.57	127.22	128.75	131.18
Cases Averted over Baseline, 2010 - 2030	37,541.26	37,781.87	37,560.97	33,067.08	33,490.49	34,102.62
Cost per DALY, 2010 - 2030	$ 2,546.16	$ 2,505.94	$ 1,877.30	$ 3,787.03	$ 3,709.76	$ 3,633.70
Cost per Death, 2010 - 2030	$ 77,141.46	$ 75,972.43	$ 56,979.03	$ 113,649.91	$ 111,121.66	$ 109,021.17
Cost per Case, 2010 - 2030	$ 305.68	$ 302.02	$ 226.89	$ 437.25	$ 427.19	$ 419.36
Total Cost 2010 - 2050	$ 42,808,641.85	$ 40,525,203.87	$ 34,003,417.85	$ 45,959,779.19	$ 43,636,126.37	$ 39,898,496.75
Incremental Cost over Baseline, 2010 - 2050	$ 12,675,314.05	$ 10,391,876.07	$ 3,870,090.05	$ 15,826,451.39	$ 13,502,798.57	$ 9,765,168.95
Total DALYs, 2010 - 2050	1,220.68	1,174.08	1,188.00	1,909.77	1,871.12	1,791.91
Total Deaths, 2010 - 2050	38.43	36.99	37.62	59.97	58.44	56.01
Total Cases, 2010 - 2050	8,083.67	7,843.06	8,063.96	12,557.85	12,134.44	11,522.31
DALYs Averted over Baseline, 2010 - 2050	7,622.34	7,668.94	7,655.02	6,933.25	6,971.90	7,051.11
Deaths Averted over Baseline, 2010 - 2050	248.18	249.62	248.99	226.64	228.17	230.60
Cases Averted over Baseline, 2010 - 2050	61,195.15	61,435.76	61,214.86	56,720.97	57,144.38	57,756.51
Cost per DALY, 2010 - 2050	$ 1,662.92	$ 1,355.06	$ 505.56	$ 2,282.69	$ 1,936.75	$ 1,384.91
Cost per Death, 2010 - 2050	$ 51,073.07	$ 41,630.78	$ 15,543.15	$ 69,830.80	$ 59,178.68	$ 42,346.79
Cost per Case, 2010 - 2050	$ 207.13	$ 169.15	$ 63.22	$ 279.02	$ 236.29	$ 169.07

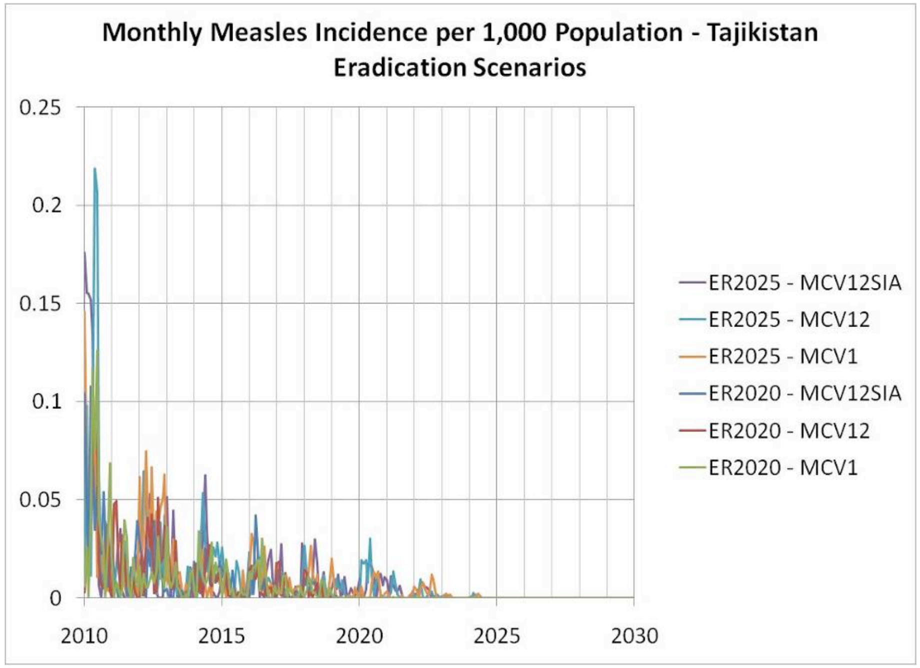

Figure A.5.2. Country-level monthly incidence for 5-district simulations for Tajikistan, eradication scenarios.

A.6. Uganda

Uganda currently implements a single routine opportunity for vaccination for infants 9 months of age with an average coverage rate of 68%, along with follow-up supplemental immunization activities every three years targeting children 9 months up to 47 months of age (though this target age group shows some variation in historical SIAs). A second routine dose is not presently included in the country's vaccination strategy, and the current vaccine formulation is single-antigen only.

Since the catch-up campaign performed in Uganda in 2003 measles incidence has dropped off dramatically, and has remained at significantly lower levels than previously, indicating a high likelihood that the country will be able to achieve 90% mortality reduction goals by the target date of 2013 by continuing its current vaccination strategy.

Uganda was simulated as consisting of ten districts (aggregated from a country total of 80 districts) based on average MCV1 coverage over the period 2001 – 2008, with values ranging from 32% to 95%. As defined in the sections above, the transmission model yielded average mortality figures for 2000 of 5,472 (range: 4,962 – 5,839), which falls within the range of estimated mortality provided by WHO. Comparing model results for simulated district-level incidence over the period from 2000 to 2008 with reported incidence over the same period (based on district-level case reports from Uganda) results in an average correlation coefficient of 0.7693 (range: 0.7513 – 0.7970).

Table A.6.1. Vaccination assumptions and simulation outcomes for mortality reduction scenarios, Uganda.

Scenario	Goal	Target Year	Initial Vaccination Assumptions							Ramp-Up Vaccination Assumptions								Target (and post-target) Vaccination Assumptions							Average % Mortality Reduction
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
1	90% Mortality Reduction	2013	68%	9 mo	-	-	90%	9 mo - 47 mo	3 yrs	N/A	N/A	N/A	-	N/A	90%	9 mo - 3 yr	3 yrs	68%	9 mo	-	-	90%	9 mo - 3 yr	3 yrs	91%
2	No SIA		68%	9 mo	-	-	90% (until 2010)	9 mo - 47 mo	3 yrs	N/A	N/A	N/A	-	N/A	N/A	N/A	N/A	68%	9 mo	-	-	N/A	N/A	N/A	-3%
3	95% Mortality Reduction	2015	68%	9 mo	-	-	90%	9 mo - 47 mo	3 yrs	1.5	2012		18 mo	2013	95%	9 mo - 59 mo	3 yrs	82.8%	12 mo	69.7%	18 mo	95%	9 mo - 59 mo	3 yrs	94%
4	98% Mortality Reduction	2020	68%	9 mo	-	-	90%	9 mo - 47 mo	3 yrs	1.5	2012		18 mo	2013	95%	9 mo - 59 mo	3 yrs	84.7%	12 mo	76.3%	18 mo	95%	9 mo - 59 mo	3 yrs	97%

Data were collected in Uganda in September 2009 on the costs of measles vaccination for routine immunization and SIAs. Four districts were visited in the country: Kalangala, Lira, Mubende, and Mbarara. Interviews were conducted with caretakers in each district on the cost of traveling to health facilities and waiting time. The WHO/Kampala provided data on expenditures on three measles campaigns that took place in the country. The cost of measles treatment was taken from a published study.

Table A.6.2. Assumptions for Costs of Measles Vaccination in Uganda

Parameter	Value (costs in US$)
Initial Coverage	68%
Cost per dose of routine immunization	$2.35
Added Cost per additional percent of coverage for routine immunization	$1.24
Cost per dose of measles vaccination given through SIA	+$0.04 until 80%; $0.08 80%+
Cost to Household of Obtaining Vaccination	$0.58
Cost of Treating Case of Measles	$6.00

Source: Data Collection in Uganda; WHO/Kampala; Dayan 2004

Table A.6.3. Transmission and cost results for reduction in mortality scenarios, Uganda (all totals discounted by 3%).

Uganda	Baseline (90% RM by 2013)	No SIA	95% RM by 2015	98% RM by 2020
Correlation Coefficient	0.7961	0.7663	0.7518	0.7657
2000 Mortality	5,604.82	5,552.34	4,961.77	5,668.11
Target Year Mortality	519.98	856.48	361.84	90.47
% Reduction in Mortality through 2050	91%	-3%	94%	97%
Total Cost 2010 - 2030	$ 134,111,220.41	$ 77,946,791.33	$ 325,958,785.40	$ 454,257,788.31
Incremental Cost over Baseline, 2010 - 2030	$ -	$ (56,164,429.08)	$ 191,847,564.99	$ 320,146,567.90
Total DALYs, 2010 - 2030	184,425.61	1,062,197.50	130,949.10	73,443.24
Total Deaths, 2010 - 2030	6,020.04	33,431.87	4,325.94	2,337.26
Total Cases, 2010 - 2030	230,428.27	1,325,609.33	156,828.02	70,657.84
DALYs Averted over Baseline, 2010 - 2030	-	(877,771.89)	53,476.51	110,982.37
Deaths Averted over Baseline, 2010 - 2030	-	(27,411.83)	1,694.10	3,682.78
Cases Averted over Baseline, 2010 - 2030	-	(1,095,181.06)	73,600.25	159,770.43
Cost per DALY, 2010 - 2030	$ -	$ 63.99	$ 3,587.51	$ 2,884.66
Cost per Death, 2010 - 2030	$ -	$ 2,048.91	$ 113,244.53	$ 86,930.68
Cost per Case, 2010 - 2030	$ -	$ 51.28	$ 2,606.62	$ 2,003.79
Total Cost 2010 - 2050	$ 228,702,222.89	$ 130,439,939.60	$ 577,918,530.63	$ 774,117,819.30
Incremental Cost over Baseline, 2010 - 2050	$ -	$ (98,262,283.29)	$ 349,216,307.74	$ 545,415,596.41
Total DALYs, 2010 - 2050	523,234.88	2,973,520.95	206,415.96	124,775.92
Total Deaths, 2010 - 2050	10,531.59	93,085.40	6,747.04	3,922.11
Total Cases, 2010 - 2050	413,112.15	3,832,251.97	244,168.12	118,243.86
DALYs Averted over Baseline, 2010 - 2050	-	(2,450,286.07)	316,818.92	398,458.96
Deaths Averted over Baseline, 2010 - 2050	-	(82,553.81)	3,784.55	6,609.48
Cases Averted over Baseline, 2010 - 2050	-	(3,419,139.82)	168,944.03	294,868.29
Cost per DALY, 2010 - 2050	$ -	$ 40.10	$ 1,102.26	$ 1,368.81
Cost per Death, 2010 - 2050	$ -	$ 1,190.28	$ 92,274.20	$ 82,520.20
Cost per Case, 2010 - 2050	$ -	$ 28.74	$ 2,067.05	$ 1,849.69

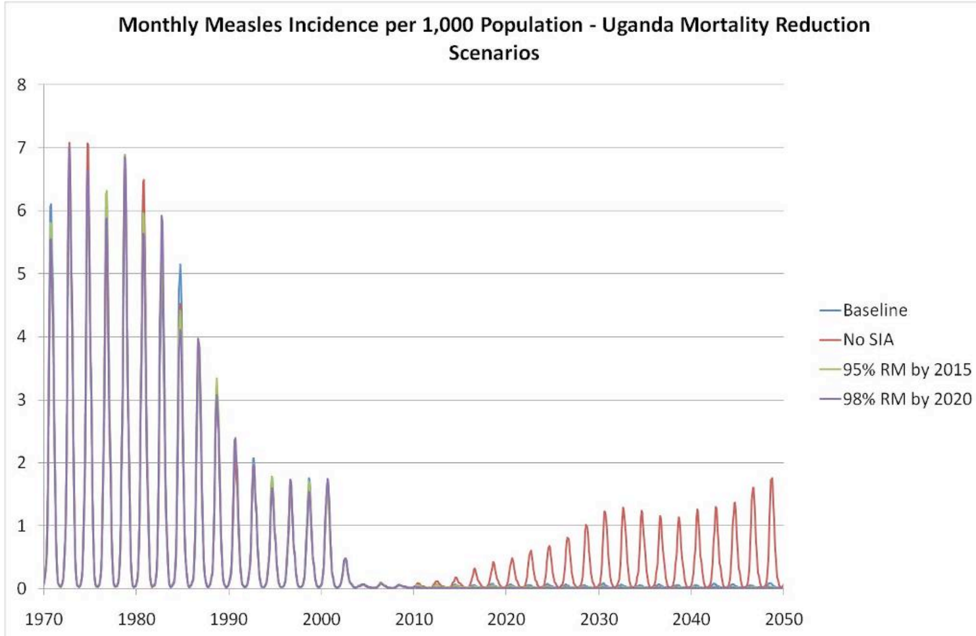

Figure A.6.1. Country-level monthly incidence for 10-district simulations for Uganda, reduction in mortality scenarios.

Table A.6.4. Vaccination assumptions and simulation outcomes for eradication scenarios, Uganda.

Scenario	Goal	Target Year	Initi al Vaccinati on Assumpti ons							Ramp-Up Vaccinati on Assumpti ons								Post-Goal Vaccinati on Assumpti ons							Average % Mortality Reducti on
			MCV1		MCV2		SIA			MCV1		MCV2			SIA			MCV1		MCV2		SIA			
			Covg	Age	Covg	Age	Covg	Age	Freq	Ramp up factor	Yr change to 12mo	Ramp up rate	Age	Yr Intro	Covg	Age	Freq	Covg	Age	Covg	Age	Covg	Age	Freq	
5	Eradicati on	2020	68%	9 mo	-	-	90%	9 mo - 47 mo	3 yrs	1.5	2012		18 mo	2013	95%	9 mo - 59 mo	3 yrs	84.7%	12 mo	76.3%	18 mo	95%	9 mo - 59 mo	3 yrs	100%
																		84.7%	12 mo	76.3%	18 mo	-	-	-	100%
																		84.7%	12 mo	-	-	-	-	-	100%
6	Eradicati on	2025	68%	9 mo	-	-	90%	9 mo - 47 mo	3 yrs	1.5	2012		18 mo	2013	95%	9 mo - 59 mo	3 yrs	85.3%	12 mo	76.8%	18 mo	95%	9 mo - 59 mo	3 yrs	100%
																		85.3%	12 mo	76.8%	18 mo	-	-	-	100%
																		85.3%	12 mo	-	-	-	-	-	100%

Table A.6.5. Transmission and cost results for eradication scenarios, Uganda (all totals discounted by 3%).

Uganda	E2020 – MCV1+MCV2+SIA	E2020 – MCV1+MCV2	E2020 – MCV1	E2025 – MCV1+MCV2+SIA	E2025 – MCV1+MCV2	E2025 – MCV1
Correlation Coefficient	0.7778	0.7586	0.7579	0.7513	0.7707	0.7970
2000 Mortality	5,394.01	5,553.03	5,839.90	5,140.25	5,410.25	5,600.01
Target Year Mortality	7.35	7.39	7.66	12.55	12.28	13.06
% Reduction in Mortality through 2050	100%	100%	100%	100%	100%	100%
Total Cost 2010 - 2030	$ 399,843,176.01	$ 385,094,242.87	$ 331,790,449.70	$ 408,687,060.73	$ 400,993,954.61	$ 379,446,431.80
Incremental Cost over Baseline, 2010 - 2030	$ 265,731,955.60	$ 250,983,022.46	$ 197,679,229.29	$ 274,575,840.32	$ 266,882,734.20	$ 245,335,211.39
Total DALYs, 2010 - 2030	24,460.37	24,619.08	25,370.81	36,097.21	33,847.71	35,560.80
Total Deaths, 2010 - 2030	799.23	805.70	832.98	1,176.12	1,097.85	1,157.86
Total Cases, 2010 - 2030	26,200.14	26,595.63	27,733.48	38,368.46	35,287.25	37,729.60
DALYs Averted over Baseline, 2010 - 2030	159,965.24	159,806.53	159,054.80	148,328.40	150,577.90	148,864.81
Deaths Averted over Baseline, 2010 - 2030	5,220.81	5,214.34	5,187.06	4,843.92	4,922.19	4,862.18
Cases Averted over Baseline, 2010 - 2030	204,228.13	203,832.64	202,694.79	192,059.81	195,141.02	192,698.67
Cost per DALY, 2010 - 2030	$ 1,661.19	$ 1,570.54	$ 1,242.84	$ 1,851.13	$ 1,772.39	$ 1,648.04
Cost per Death, 2010 - 2030	$ 50,898.61	$ 48,133.23	$ 38,110.07	$ 56,684.64	$ 54,220.32	$ 50,457.86
Cost per Case, 2010 - 2030	$ 1,301.15	$ 1,231.32	$ 975.26	$ 1,429.64	$ 1,367.64	$ 1,273.15
Total Cost 2010 - 2050	$ 692,813,800.90	$ 629,688,565.72	$ 471,966,252.64	$ 705,467,173.50	$ 650,433,859.18	$ 523,688,959.76
Incremental Cost over Baseline, 2010 - 2050	$ 464,111,578.01	$ 400,986,342.83	$ 243,264,029.75	$ 476,764,950.61	$ 421,731,636.29	$ 294,986,736.87
Total DALYs, 2010 - 2050	24,460.37	24,619.08	25,370.81	36,097.21	33,847.71	35,560.80
Total Deaths, 2010 - 2050	799.23	805.70	832.98	1,176.12	1,097.85	1,157.86
Total Cases, 2010 - 2050	26,200.14	26,595.63	27,733.48	38,368.46	35,287.25	37,729.60
DALYs Averted over Baseline, 2010 - 2050	498,774.51	498,615.80	497,864.07	487,137.67	489,387.17	487,674.08
Deaths Averted over Baseline, 2010 - 2050	9,732.36	9,725.89	9,698.61	9,355.47	9,433.74	9,373.73
Cases Averted over Baseline, 2010 - 2050	386,912.01	386,516.52	385,378.67	374,743.69	377,824.90	375,382.55
Cost per DALY, 2010 - 2050	$ 930.50	$ 804.20	$ 488.62	$ 978.71	$ 861.75	$ 604.89
Cost per Death, 2010 - 2050	$ 47,687.47	$ 41,228.76	$ 25,082.36	$ 50,961.09	$ 44,704.61	$ 31,469.52
Cost per Case, 2010 - 2050	$ 1,199.53	$ 1,037.44	$ 631.23	$ 1,272.24	$ 1,116.21	$ 785.83

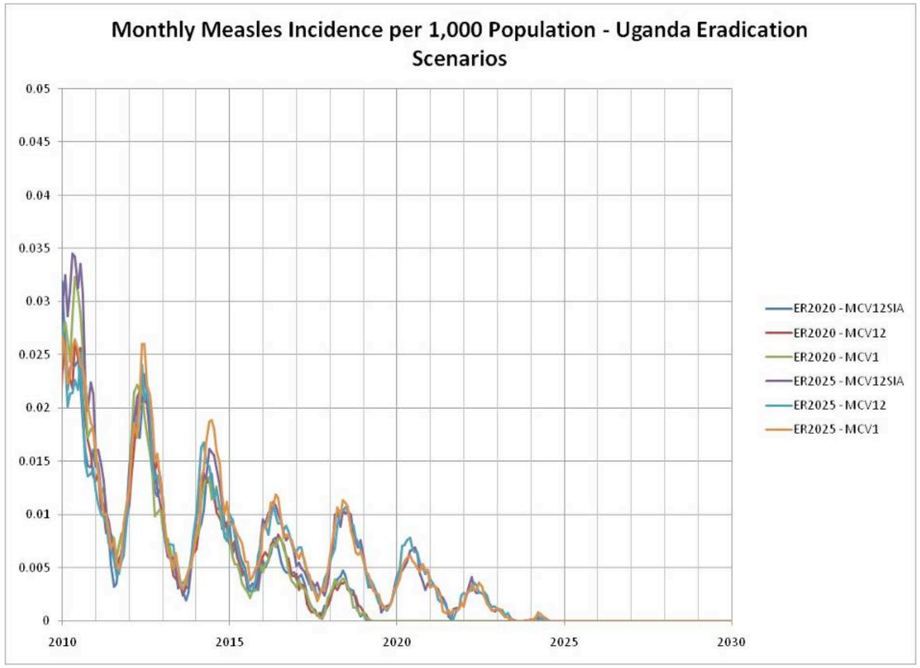

Figure A.6.2. Country-level monthly incidence for 10-district simulations for Uganda, eradication scenarios.