**Supplementary Materials for Benefit-cost Ratios of Continuing Routine Immunization During the COVID-19 Pandemic in Africa**

**Appendix 1. List of African countries included in the model**

Table A1. Countries included in the analysis, WHO region and income level.

|  |  |  |
| --- | --- | --- |
| **Country** | **WHO Region** | **WB Income Group** |
| Algeria | AFRO | LMIC |
| Angola | AFRO | LMIC |
| Benin | AFRO | LIC |
| Botswana | AFRO | UMIC |
| Burkina Faso | AFRO | LIC |
| Burundi | AFRO | LIC |
| Cameroon | AFRO | LMIC |
| Cape Verde | AFRO | LMIC |
| Central African Republic | AFRO | LIC |
| Chad | AFRO | LIC |
| Comoros | AFRO | LIC |
| Congo - Brazzaville | AFRO | LMIC |
| Congo - Kinshasa | AFRO | LIC |
| Côte d'Ivoire | AFRO | LMIC |
| Djibouti | EMRO | LMIC |
| Egypt | EMRO | LMIC |
| Equatorial Guinea | AFRO | UMIC |
| Eritrea | AFRO | LIC |
| Eswatini | AFRO | LMIC |
| Ethiopia | AFRO | LIC |
| Gabon | AFRO | UMIC |
| Gambia | AFRO | LIC |
| Ghana | AFRO | LMIC |
| Guinea | AFRO | LIC |
| Guinea-Bissau | AFRO | LIC |
| Kenya | AFRO | LMIC |
| Lesotho | AFRO | LMIC |
| Liberia | AFRO | LIC |
| Libya | EMRO | UMIC |
| Madagascar | AFRO | LIC |
| Malawi | AFRO | LIC |
| Mali | AFRO | LIC |
| Mauritania | AFRO | LMIC |
| Mauritius | AFRO | UMIC |
| Morocco | EMRO | LMIC |
| Mozambique | AFRO | LIC |
| Namibia | AFRO | UMIC |
| Niger | AFRO | LIC |
| Nigeria | AFRO | LMIC |
| Rwanda | AFRO | LIC |
| São Tomé and Principe | AFRO | LMIC |
| Senegal | AFRO | LMIC |
| Seychelles | AFRO | UMIC |
| Sierra Leone | AFRO | LIC |
| Somalia | EMRO | LIC |
| South Africa | AFRO | UMIC |
| South Sudan | AFRO | LIC |
| Sudan | EMRO | LMIC |
| Tanzania | AFRO | LIC |
| Togo | AFRO | LIC |
| Tunisia | AFRO | LMIC |
| Uganda | AFRO | LIC |
| Zambia | AFRO | LMIC |
| Zimbabwe | AFRO | LIC |

**Appendix 2. Descriptive statistics of inputs for estimating cost of illness**

Table A2. Key inputs for cost of illness approach

|  |  |  |
| --- | --- | --- |
| **Input** | **Median (Range)** | **Source** |
| Round-trip transportation cost (2018 USD) | $1.39  ($0.18-$11.34) | [1] |
| Care-seeking rates | 50%  (5%-98%) | [2] |
| Length of inpatient stay (days) | 6  (1.3-14) | [3-8] |
| Per diem facility fee (2018 USD) | $8.82  ($0.04-$101.13) | [9] |
| Caregiver wage (2018 USD) | $1.96  ($0.14-$8.50) | [10-11] |
| COVID-19 per diem treatment costs (inpatient) (2018 USD) | $201.31  ($0.62-$3135.31) | [9, 12] |
| COVID-19 per diem treatment costs (ICU) (2018 USD) | $421.14  ($1.30-$6559.21) | [9, 12] |
| GDP per capita (2018 USD) | $1202.13  ($275.22-$16,390.80) | [13] |

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**Appendix 3. Modeled treatment pathway for fatal cases of COVID-19 in African countries.**

Figure A3. Modeled treatment pathway for fatal COVID-19 cases

Total COVID-19 Fatal Cases\*

COVID-19 Care-seeking cases

COVID-19 Cases admitted to inpatient setting (5 days)

COVID-19 Cases transferred to ICU setting (7 days)

Care-seeking rate for acute respiratory infection\*

100% admission rate (estimates only include fatal cases)

Proportion of patients alive, transferred to ICU (50%)\*

Non care-seeking COVID-19 cases\*

\*Included in sensitivity analysis

**Appendix 4. Distributions and assumptions for parameters included in sensitivity analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Distribution and assumptions** | **Included in COI** | **Included in VSLY** | **Source** |
| Excess VPD Deaths | Lognormal distribution derived from point estimates and confidence intervals from Abbas et al | Yes | Yes | Abbas K, Procter SR, van Zandvoort K, Clark A, Funk S, Mengistu T, et al. Routine childhood immunisation during the COVID-19 pandemic in Africa: a benefit-risk analysis of health benefits versus excess risk of SARS-CoV-2 infection. The Lancet Global Health 2020. |
| Excess COVID Deaths | Lognormal distribution derived from point estimates and confidence intervals from Abbas et al | Yes | Yes | (same as above) |
| GDP per capita | GDP per capita varied at the country-level using normal distribution and assuming standard deviation of 3% of the point estimate | Yes | Yes | U.S. Department of State. Country reports on human rights practices. 2017 March 3, 2017.  The World Bank. The World Bank DataBank: GDP per capita (current US$). [Dataset] 2019 |
| Facility costs | Lognormal distribution derived from all estimates for African countries. | Yes | No | Stenberg K, Lauer JA, Gkountouras G, Fitzpatrick C, Stanciole A. Econometric estimation of WHO-CHOICE country-specific costs for inpatient and outpatient health service delivery. Cost Eff Resour Alloc 2018;16(11). |
| ICU admittance | 50% transfer rate applied as baseline assumption for all countries. Sensitivity analysis Normal distribution fit to using standard deviation of 16% to ensure 98% of draws fall within 0 and 100% | Yes | No | Assumption |
| Care-seeking rates | Normal distribution derived from all point estimates, minimum and maximum bounds imposed at 0 and 100% | Yes | No | Demographic and Health Survey Program. Demographic and health surveys [DHS]. In. various years [cited 15 Aug 2020]. |

Table A4. Parameters included in sensitivity analysis.

**Appendix 5. Benefits, risks, and BCRs of sustained routine immunization in Africa using the VSL approach**

The VSL approach places equal value on all lives saved regardless of age. The VSL BCRs are slightly lower than the benefit-risk ratios that compare the total number of deaths from VPDs to deaths from COVID-19 because the economic value associated with vaccine-preventable child deaths is discounted from the year of death (occurring between one and five years in the future). All COVID-19 deaths are all modeled for the year 2020. Despite the impact of discounting, the BCRs using the VSL approach also demonstrate that benefits of continuing routine immunization exceed the risks.

Table A5. Benefits, risks, and BCRs of sustained routine immunization in Africa using the VSL approach

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **VSL** | | |
| Vaccine | Benefit-risk ratio  *(VPD death: COVID-19 death)* | VPD  *(millions)* | COVID-19  *(millions)* | BCR (VSL) |
| HepB3 | 1 (0-2) | $173  (133 – 359) | $258  (217 – 468) | 1  (0 – 1) |
| Hib3 | 9 (1-31) | $2,546  (2,280 – 2,981) | $258  (217 – 472) | 10  (5 – 12) |
| PCV3 | 9 (1-29) | $2,184  (1,864 – 2,796) | $225  (180 – 421) | 10  (5 – 13) |
| RotaC | 4 (1-14) | $551  (471 – 679) | $102  (81 – 203) | 5  (3 – 7) |
| MCV1 | 99 (14-327) | $10,092  (9,141 – 11,627) | $87  (73 – 162) | 116  (62 – 144) |
| RCV | 2 (0-5) | $58  (45 – 128) | $37  (30 – 68) | 2  (1 – 3) |
| MenA | 2 (0-5) | $7  (5 – 13) | $6  (4 – 14) | 1  (0 – 2) |
| YFV | 26 (4-90) | $830  (644 – 1,330) | $31  (22 – 72) | 27  (12 – 27) |
| MCV2 (EPI-3) | 13 (2-44) | $242  (210 – 296) | $54  (41 – 111) | 4  (2 – 6) |
| EPI-1  (HepB3, Hib3, PCV3, RotaC) | 80 (13-262)\* | $5,453  (5,088 – 6,314) | $259  (216 – 464) | 21  (12 – 27) |
| EPI-2  (MCV1, RCV1, MenA, YFV) | 112 (18-372) | $10,987  (10,084 – 12,681) | $87  (72 – 164) | 127  (68 – 159) |
| EPI  (all vaccines) | 82 (13-265)\* | $16,682  (15,810 - 18,755) | $400  (334 – 737) | 42  (23 – 52) |

**Notes**: Abbreviations: HepB3 (hepatitis B), Hib3 (Haemophilus influenzae type b), PCV3 (Streptococcus pneumoniae), RotaC (rotavirus), MCV1 (measles first dose), MCV2 (measles second dose), RCV (rubella), MenA (Neisseria meningitidis serogroup A). Benefit-risk ratios comparing vaccine-preventable deaths to COVID-19 deaths extracted from Abbas et al (2020).1

\*Includes averted deaths from diphtheria, tetanus, pertussis, which are excluded from the economic analysis

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Figure A5. Benefit-cost ratios by vaccine using COI, VSL, and VSLY approaches

**Appendix 6. COI BCRs for each country and vaccine**

Table A6. COI BCRs by country, vaccine, and EPI visit. Confidence intervals calculated based off benefit-risk ratios from Abbas et al. (2020)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Country** | **HepB3** | **Hib3** | **PCV3** | **RotaC** | **MCV1** | **MCV2** | **MenA** | **RCV** | **YFV** | **EPI-1** | **EPI-2** | **All EPI** |
| Algeria | 2 (0-22) | 33 (8-208) | 31 (7-201) | - | 439 (108-2872) | 20 (5-133) | - | 4 (1-54) | - |  |  |  |
| Angola | 3 (0-18) | 64 (17-233) | 61 (16-225) | 52 (13-196) | 534 (134-2074) | 25 (6-92) | - | 9 (1-65) | 30 (7-138) | 157 (44-578) | 571 (154-2135) | 235 (64-891) |
| Benin | 2 (0-12) | 37 (5-114) | 34 (4-112) | - | 286 (34-1046) | - | - | - | 64 (8-231) | 71 (10-224) | 336 (44-1187) | 136 (19-442) |
| Botswana | 1 (0-7) | 17 (5-70) | 16 (5-68) | 8 (3-35) | 224 (63-982) | 10 (3-43) | - | 2 (1-10) | - | 36 (12-146) | 226 (64-986) |  |
| Burkina Faso | 1 (0-6) | 20 (2-63) | 19 (2-61) | 10 (1-32) | 299 (34-991) | 14 (2-43) | 5 (1-21) | 1 (0-5) | 79 (9-303) | 47 (6-144) | 350 (40-1140) | 109 (12-344) |
| Burundi | 1 (0-3) | 77 (4-199) | 69 (3-199) | 34 (2-87) | 642 (26-1641) | 29 (1-76) | - | 7 (0-30) | - | 170 (9-444) | 649 (27-1673) | 244 (12-617) |
| Cameroon | 1 (0-3) | 23 (5-75) | 22 (4-78) | 14 (3-45) | 204 (39-704) | - | - | 2 (0-14) | 40 (6-170) | 55 (11-185) | 239 (47-792) | 99 (21-329) |
| Cape Verde | 3 (0-15) | 33 (3-85) | 30 (3-82) | - | 384 (31-1030) | - | 0 (0-1) | - | 53 (5-173) | 67 (7-177) | 436 (38-1169) | 159 (14-421) |
| Central African Republic | 2 (0-6) | 43 (5-129) | - | - | 328 (40-979) | - | 5 (1-15) | - | 7 (1-25) | 45 (6-134) | 327 (40-992) | 114 (15-333) |
| Chad | 1 (0-5) | 22 (3-77) | - | - | 290 (34-1047) | - | - | - | - | 22 (3-79) | 290 (36-1043) | 90 (11-314) |
| Comoros | 1 (0-3) | 34 (3-89) | 31 (3-87) | - | 376 (27-1016) | - | - | - | 31 (2-120) | 66 (5-177) | 407 (31-1134) | 152 (12-393) |
| Congo - Kinshasa | 2 (0-10) | 21 (2-66) | 18 (2-67) | 11 (1-38) | 673 (70-2159) | - | 4 (0-19) | - | 48 (5-195) | 48 (6-156) | 725 (81-2320) | 221 (27-693) |
| Congo - Brazzaville | 3 (0-19) | 13 (3-45) | 13 (2-45) | 9 (2-32) | 252 (43-914) | - | 0 (0-3) | 3 (0-11) | 242 (39-1058) | 34 (7-114) | 491 (87-1858) | 147 (28-530) |
| Cote d Ivoire | 1 (0-7) | 21 (6-208) | 20 (5-199) | 16 (4-173) | 213 (52-2223) | 10 (2-98) | - | - | - | 53 (15-521) | 213 (52-2134) | 77 (20-772) |
| Djibouti | 1 (0-3) | 12 (2-51) | 11 (2-47) | 6 (1-28) | 324 (59-1379) | 15 (3-61) | - | 3 (0-33) | - | 27 (6-112) | 327 (59-1419) | 87 (17-366) |
| Egypt | 1 (0-5) | 26 (3-85) | 23 (3-81) | 7 (1-23) | 297 (35-923) | - | - | - | - | 55 (7-174) | 297 (33-897) | 113 (13-342) |
| Equatorial Guinea | 1 (0-8) | 17 (5-71) | - | - | 220 (66-935) | - | - | - | 77 (20-402) | 18 (6-75) | 297 (96-1338) | 81 (27-343) |
| Eritrea | 1 (0-4) | 15 (2-30) | 16 (2-37) | 8 (1-28) | 307 (27-1063) | 14 (1-50) | - | 1 (0-4) | 145 (13-598) | 37 (5-74) | 453 (41-1629) | 121 (12-439) |
| Eswatini | 1 (0-8) | 10 (2-37) | 11 (2-42) | 6 (1-24) | 488 (98-1902) | 22 (5-87) | 1 (0-5) | 4 (1-27) | 73 (13-365) | 26 (6-98) | 565 (127-2245) | 133 (30-510) |
| Ethiopia | 2 (0-9) | 16 (2-53) | - | - | 264 (32-837) | - | - | - | 219 (26-794) | 18 (2-60) | 482 (67-1562) | 137 (19-443) |
| Gabon | 2 (0-12) | 23 (7-103) | - | - | 306 (94-1429) | - | - | - | 107 (28-584) | 25 (8-112) | 413 (131-1944) | 112 (39-520) |
| Gambia | 4 (0-19) | 23 (3-71) | 22 (3-70) | 12 (1-37) | 537 (61-1622) | - | - | - | 154 (18-550) | 57 (8-169) | 684 (83-2039) | 214 (26-653) |
| Ghana | 0 (0-1) | 14 (3-52) | 14 (3-54) | 7 (1-26) | 258 (55-1013) | 12 (2-45) | - | 4 (0-23) | 2 (0-8) | 32 (7-118) | 263 (56-1031) | 80 (18-304) |
| Guinea | 1 (0-4) | 9 (2-31) | 8 (2-31) | 4 (1-18) | 210 (36-801) | 10 (2-37) | - | 2 (0-7) | - | 21 (4-73) | 212 (36-784) | 53 (10-188) |
| Guinea-Bissau | 3 (0-13) | 20 (2-53) | 17 (2-49) | 10 (1-26) | 406 (38-1129) | - | - | - | 255 (28-733) | 46 (5-124) | 642 (66-1640) | 191 (21-491) |
| Kenya | 2 (0-7) | 25 (3-75) | 22 (3-76) | 10 (1-30) | 265 (31-763) | - | - | - | - | 55 (8-163) | 265 (32-744) | 106 (14-301) |
| Lesotho | 0 (0-1) | 16 (2-47) | 16 (2-46) | 9 (1-26) | 138 (12-443) | 6 (1-20) | - | 3 (0-16) | - | 38 (4-107) | 141 (12-444) | 54 (6-158) |
| Liberia | 2 (0-13) | 25 (4-79) | 24 (3-76) | 14 (2-43) | 337 (42-1061) | - | 4 (0-18) | - | 80 (9-307) | 56 (8-173) | 416 (57-1366) | 148 (21-462) |
| Libya | 3 (0-34) | 43 (16-331) | 39 (14-321) | 21 (8-163) | 569 (215-4490) | 26 (9-202) | - | 5 (1-87) | - | 99 (38-750) | 574 (214-4614) | 180 (71-1401) |
| Madagascar | 1 (0-24) | 10 (4-101) | 9 (3-102) | 5 (2-57) | 152 (46-1648) | - | - | 1 (0-18) | - | 24 (8-250) | 153 (46-1705) | 56 (18-577) |
| Malawi | 2 (0-8) | 29 (3-83) | 26 (3-86) | 12 (1-35) | 341 (33-1006) | 16 (1-47) | - | 2 (0-6) | - | 65 (7-191) | 329 (31-992) | 117 (12-341) |
| Mali | 2 (0-11) | 43 (4-130) | 38 (3-132) | 23 (2-70) | 334 (27-988) | 15 (1-44) | 6 (1-17) | - | 7 (1-26) | 95 (9-286) | 334 (28-992) | 135 (13-400) |
| Mauritania | 4 (0-21) | 31 (6-113) | 30 (6-114) | - | 351 (68-1296) | - | - | - | 40 (6-187) | 65 (14-239) | 389 (77-1426) | 153 (32-553) |
| Mauritius | 1 (0-8) | 17 (6-73) | 15 (5-68) | 8 (3-36) | 222 (69-1008) | 10 (3-47) | - | 2 (0-21) | - | 38 (13-167) | 224 (68-985) | 71 (24-308) |
| Morocco | 1 (0-5) | 46 (6-164) | 40 (4-146) | 17 (2-59) | 450 (55-1520) | 21 (2-68) | - | 3 (0-18) | - | 99 (13-329) | 454 (52-1489) | 157 (20-527) |
| Mozambique | 2 (0-15) | 11 (3-46) | 11 (3-48) | 4 (1-18) | 189 (43-999) | 9 (2-45) | - | 1 (0-12) | 97 (21-528) | 27 (7-114) | 287 (70-1449) | 79 (21-374) |
| Namibia | 1 (0-8) | 17 (5-71) | 16 (4-69) | 8 (2-36) | 223 (63-1013) | 10 (3-46) | - | 2 (0-19) | - | 37 (11-155) | 225 (64-993) | 77 (22-328) |
| Niger | 2 (0-12) | 15 (2-60) | 13 (1-57) | 6 (1-27) | 218 (26-832) | 10 (1-38) | - | 1 (0-3) | 116 (14-536) | 32 (4-127) | 324 (41-1274) | 91 (12-365) |
| Nigeria | 2 (0-10) | 18 (2-57) | 17 (2-56) | 11 (1-33) | 286 (27-914) | 13 (1-41) | - | - | 129 (13-498) | 45 (5-141) | 415 (41-1390) | 119 (13-372) |
| Rwanda | 1 (0-4) | 36 (3-114) | - | - | 406 (25-1334) | - | - | - | - | 37 (3-119) | 406 (26-1355) | 132 (9-430) |
| Sao Tome and Principe | 1 (0-6) | 26 (3-102) | 25 (4-107) | 13 (2-48) | 188 (24-749) | 9 (1-35) | 4 (0-21) | - | - | 61 (9-241) | 192 (25-776) | 79 (11-313) |
| Senegal | 1 (0-4) | 22 (3-152) | - | - | 117 (13-955) | - | - | - | - | 23 (3-157) | 117 (12-999) | 47 (7-341) |
| Seychelles | 1 (0-7) | 15 (5-67) | 14 (4-64) | 8 (2-33) | 203 (61-871) | 9 (3-41) | - | 2 (0-19) | 72 (19-370) | 24 (8-98) | 270 (85-1193) | 71 (24-311) |
| Sierra Leone | 1 (0-6) | 17 (3-58) | 15 (3-58) | 8 (1-29) | 203 (33-702) | 9 (2-32) | - | 3 (0-16) | - | 39 (7-136) | 206 (34-729) | 69 (12-236) |
| Somalia | 2 (0-13) | 13 (2-41) | 13 (2-40) | 7 (1-23) | 352 (40-1258) | - | - | 3 (0-30) | 55 (7-208) | 34 (5-103) | 397 (47-1412) | 127 (16-432) |
| South Africa | 1 (1-6) | 12 (4-58) | 11 (4-57) | 6 (2-29) | 162 (54-817) | 7 (2-37) | - | - | - | 28 (10-134) | 162 (54-813) | 51 (19-252) |
| Sudan - North | 1 (0-5) | 18 (2-58) | 18 (2-60) | 7 (1-23) | 204 (25-724) | - | - | - | - | 36 (5-113) | 204 (24-714) | 79 (11-280) |
| Sudan - South | 1 (0-5) | 19 (4-70) | 18 (4-68) | 10 (2-37) | 320 (64-1280) | 15 (3-57) | - | 5 (1-31) | - | 44 (10-164) | 325 (65-1286) | 102 (23-393) |
| Tanzania | 2 (0-8) | 12 (2-37) | 13 (2-42) | 8 (1-26) | 442 (79-1381) | 20 (4-64) | - | 3 (0-16) | - | 32 (6-96) | 445 (79-1376) | 114 (22-342) |
| Togo | 1 (0-7) | 4 (1-17) | - | - | 135 (34-564) | 6 (2-25) | - | 2 (0-17) | - | 5 (1-22) | 137 (35-582) | 33 (9-133) |
| Tunisia | 1 (0-13) | 2 (1-14) | - | - | 19 (6-156) | 1 (0-7) | - | 1 (0-13) | - | 3 (1-25) | 21 (6-167) | 6 (2-48) |
| Uganda | 0 (0-1) | 7 (2-28) | - | - | 39 (10-169) | 2 (0-8) | - | - | - | 7 (2-29) | 39 (9-169) | 12 (3-51) |
| Zambia | 0 (0-1) | 5 (1-25) | 4 (1-24) | 2 (1-14) | 40 (9-267) | 2 (0-12) | - | 3 (1-21) | - | 11 (3-57) | 44 (10-286) | 16 (4-87) |
| Zimbabwe | 0 (0-2) | 8 (2-35) | 8 (2-33) | 4 (1-16) | 22 (6-97) | 1 (0-4) | - | - | - | 19 (5-77) | 22 (6-97) | 16 (5-67) |

**Appendix 7. VSL BCRs for each country and vaccine**

Table A7. VSL BCRs by country, vaccine, and EPI visit. Confidence intervals calculated based off benefit-risk ratios from Abbas et al. (2020)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Country** | **HepB3** | **Hib3** | **PCV3** | **RotaC** | **MCV1** | **MCV2** | **MenA** | **RCV** | **YFV** | **EPI-1** | **EPI-2** | **All EPI** |
| Algeria | 1 (0-3) | 10 (3-36) | 9 (2-34) | - | 123 (32-454) | 5 (1-21) | - | 1 (0-9) | - | 19 (5-71) | 124 (33-478) | 36 (10-133) |
| Angola | 1 (0-8) | 35 (10-125) | 33 (9-121) | 29 (8-106) | 284 (79-1018) | 13 (3-45) | - | 5 (1-33) | 16 (4-68) | 87 (27-308) | 304 (85-1095) | 127 (38-454) |
| Benin | 1 (0-6) | 17 (4-62) | 15 (4-60) | - | 124 (28-542) | - | - | - | 28 (6-121) | 32 (9-116) | 145 (37-617) | 59 (17-226) |
| Botswana | 1 (0-4) | 10 (3-36) | 9 (2-34) | 5 (1-18) | 126 (33-478) | 6 (1-21) | - | 1 (0-5) | - | 20 (6-74) | 127 (34-475) | 40 (12-145) |
| Burkina Faso | 0 (0-3) | 9 (3-33) | 8 (2-32) | 5 (1-17) | 134 (36-499) | 6 (2-21) | 2 (1-11) | 0 (0-3) | 35 (8-156) | 21 (6-74) | 156 (42-597) | 49 (14-181) |
| Burundi | 0 (0-1) | 22 (6-79) | 20 (5-78) | 10 (3-34) | 177 (49-660) | 8 (2-30) | - | 2 (0-12) | - | 49 (14-174) | 179 (51-656) | 69 (20-247) |
| Cameroon | 0 (0-2) | 10 (3-37) | 10 (2-37) | 6 (2-22) | 89 (24-328) | - | - | 1 (0-6) | 17 (4-77) | 24 (7-87) | 103 (28-389) | 44 (13-152) |
| Cape Verde | 1 (0-9) | 16 (5-52) | 14 (4-51) | - | 174 (48-639) | - | 0 (0-1) | - | 24 (6-103) | 31 (9-110) | 197 (57-742) | 73 (22-257) |
| Central African Republic | 1 (0-4) | 20 (6-73) | - | - | 149 (42-554) | - | 2 (1-8) | - | 3 (1-14) | 21 (6-76) | 148 (43-551) | 52 (15-187) |
| Chad | 0 (0-2) | 8 (2-31) | - | - | 101 (27-367) | - | - | - | - | 8 (2-30) | 101 (27-381) | 32 (9-109) |
| Comoros | 0 (0-2) | 15 (4-52) | 14 (4-52) | - | 162 (45-579) | - | - | - | 13 (3-64) | 29 (9-103) | 175 (51-619) | 66 (20-223) |
| Congo - Kinshasa | 1 (0-6) | 11 (3-40) | 10 (2-40) | 6 (1-22) | 339 (89-1291) | - | 2 (0-12) | - | 24 (5-112) | 25 (8-91) | 365 (100-1347) | 112 (33-407) |
| Congo - Brazzaville | 1 (0-9) | 6 (2-22) | 6 (2-23) | 4 (1-16) | 118 (31-434) | - | 0 (0-1) | 1 (0-5) | 112 (24-514) | 16 (5-58) | 229 (61-889) | 69 (20-256) |
| Cote d Ivoire | 0 (0-1) | 8 (2-28) | 7 (2-27) | 6 (1-24) | 77 (21-291) | 3 (1-13) | - | - | - | 20 (6-70) | 77 (21-291) | 28 (8-102) |
| Djibouti | 0 (0-1) | 6 (2-22) | 5 (1-21) | 3 (1-13) | 160 (41-593) | 7 (2-26) | - | 1 (0-15) | - | 14 (4-51) | 161 (44-593) | 43 (12-155) |
| Egypt | 0 (0-2) | 9 (3-36) | 8 (2-34) | 3 (1-10) | 105 (29-389) | - | - | - | - | 20 (6-74) | 105 (27-380) | 40 (11-149) |
| Equatorial Guinea | 1 (0-4) | 10 (3-34) | - | - | 120 (32-447) | - | - | - | 41 (9-190) | 10 (3-36) | 162 (44-601) | 44 (13-163) |
| Eritrea | 0 (0-1) | 5 (3-10) | 5 (2-12) | 3 (1-10) | 101 (28-380) | 4 (1-16) | - | 0 (0-1) | 47 (11-205) | 13 (7-23) | 148 (41-555) | 40 (12-150) |
| Eswatini | 1 (0-3) | 4 (1-14) | 5 (1-17) | 3 (1-10) | 207 (57-739) | 9 (3-32) | 0 (0-2) | 2 (0-10) | 31 (7-135) | 11 (3-39) | 240 (66-914) | 57 (16-203) |
| Ethiopia | 1 (0-4) | 7 (2-27) | - | - | 109 (29-409) | - | - | - | 89 (21-373) | 8 (2-29) | 198 (52-773) | 56 (16-204) |
| Gabon | 1 (0-5) | 12 (3-45) | - | - | 156 (41-576) | - | - | - | 54 (12-241) | 13 (4-48) | 210 (56-801) | 57 (16-207) |
| Gambia | 1 (0-8) | 9 (2-32) | 9 (2-32) | 5 (1-18) | 203 (56-731) | - | - | - | 58 (14-248) | 22 (7-79) | 259 (70-940) | 81 (24-296) |
| Ghana | 0 (0-1) | 8 (2-27) | 8 (2-30) | 4 (1-14) | 140 (37-517) | 6 (2-22) | - | 2 (0-12) | 1 (0-4) | 18 (5-65) | 142 (39-521) | 44 (12-157) |
| Guinea | 0 (0-3) | 5 (2-18) | 5 (1-19) | 3 (1-11) | 127 (35-476) | 6 (1-21) | - | 1 (0-4) | - | 13 (4-45) | 129 (34-482) | 32 (9-117) |
| Guinea-Bissau | 1 (0-8) | 9 (2-33) | 8 (2-31) | 4 (1-17) | 179 (48-665) | - | - | - | 111 (31-409) | 21 (6-76) | 281 (77-1035) | 84 (25-310) |
| Kenya | 1 (0-5) | 14 (4-53) | 13 (3-53) | 6 (2-21) | 144 (40-524) | - | - | - | - | 31 (9-114) | 144 (40-515) | 58 (17-207) |
| Lesotho | 0 (0-1) | 9 (3-33) | 9 (3-33) | 5 (1-19) | 78 (20-298) | 3 (1-13) | - | 2 (0-11) | - | 22 (6-77) | 80 (21-317) | 31 (9-108) |
| Liberia | 1 (0-6) | 11 (3-42) | 11 (3-41) | 6 (2-22) | 146 (40-536) | - | 2 (0-9) | - | 35 (7-163) | 25 (7-95) | 181 (50-669) | 65 (19-234) |
| Libya | 1 (0-4) | 10 (3-35) | 9 (2-34) | 5 (1-19) | 126 (33-511) | 6 (1-21) | - | 1 (0-10) | - | 23 (6-80) | 127 (34-486) | 40 (12-143) |
| Madagascar | 1 (0-8) | 10 (3-38) | 10 (3-36) | 6 (2-21) | 158 (43-597) | - | - | 1 (0-7) | - | 25 (7-91) | 159 (43-594) | 58 (16-209) |
| Malawi | 1 (0-5) | 15 (4-54) | 14 (3-55) | 6 (2-23) | 174 (47-651) | 8 (2-29) | - | 1 (0-4) | - | 34 (10-120) | 168 (45-618) | 60 (17-209) |
| Mali | 1 (0-6) | 19 (5-73) | 17 (4-72) | 10 (3-39) | 145 (40-523) | 6 (2-24) | 3 (1-9) | - | 3 (1-14) | 42 (12-163) | 145 (39-517) | 59 (18-217) |
| Mauritania | 1 (0-8) | 13 (4-46) | 12 (3-47) | - | 140 (38-499) | - | - | - | 16 (3-74) | 27 (8-94) | 155 (43-581) | 61 (18-217) |
| Mauritius | 1 (0-4) | 10 (3-36) | 9 (2-35) | 5 (1-19) | 131 (35-502) | 6 (2-22) | - | 1 (0-10) | - | 23 (7-82) | 133 (36-488) | 42 (12-152) |
| Morocco | 0 (0-2) | 16 (4-63) | 14 (3-61) | 6 (2-24) | 158 (42-602) | 7 (2-26) | - | 1 (0-7) | - | 35 (10-133) | 159 (41-596) | 55 (17-202) |
| Mozambique | 1 (0-7) | 7 (2-24) | 7 (2-24) | 3 (1-10) | 118 (28-487) | 5 (1-22) | - | 1 (0-7) | 59 (13-266) | 17 (5-60) | 178 (46-716) | 49 (14-185) |
| Namibia | 1 (0-3) | 8 (2-31) | 8 (2-30) | 4 (1-15) | 105 (27-406) | 5 (1-18) | - | 1 (0-8) | - | 18 (5-68) | 106 (29-396) | 37 (10-131) |
| Niger | 1 (0-4) | 5 (1-20) | 5 (1-19) | 2 (0-9) | 73 (20-274) | 3 (1-12) | - | 0 (0-1) | 38 (8-175) | 11 (3-42) | 109 (31-430) | 31 (9-114) |
| Nigeria | 1 (0-6) | 10 (3-34) | 9 (2-33) | 6 (2-20) | 146 (41-517) | 6 (2-23) | - | - | 65 (15-292) | 23 (7-85) | 211 (59-788) | 61 (17-218) |
| Rwanda | 0 (0-2) | 18 (5-65) | - | - | 200 (55-734) | - | - | - | - | 19 (5-64) | 200 (54-755) | 65 (19-227) |
| Sao Tome and Principe | 0 (0-2) | 12 (3-44) | 12 (3-45) | 6 (2-21) | 84 (22-322) | 4 (1-14) | 2 (0-9) | - | - | 28 (8-101) | 86 (22-330) | 36 (10-128) |
| Seychelles | 1 (0-4) | 10 (3-35) | 9 (2-34) | 5 (1-18) | 123 (33-459) | 6 (1-21) | - | 1 (0-10) | 43 (10-189) | 15 (4-55) | 164 (45-636) | 43 (13-163) |
| Senegal | 0 (0-2) | 22 (5-91) | - | - | 118 (24-575) | - | - | - | - | 23 (6-92) | 118 (23-552) | 47 (12-199) |
| Sierra Leone | 0 (0-3) | 8 (2-30) | 8 (2-30) | 4 (1-15) | 100 (27-376) | 4 (1-17) | - | 1 (0-9) | - | 19 (6-72) | 101 (27-379) | 34 (10-125) |
| Somalia | 1 (0-6) | 6 (2-22) | 6 (2-22) | 3 (1-13) | 159 (37-670) | - | - | 1 (0-16) | 25 (6-111) | 16 (5-56) | 179 (44-736) | 57 (16-223) |
| South Africa | 1 (0-3) | 9 (2-32) | 8 (2-30) | 4 (1-16) | 110 (29-411) | 5 (1-18) | - | - | - | 20 (6-72) | 110 (29-418) | 35 (10-129) |
| Sudan - North | 1 (0-3) | 10 (3-34) | 9 (3-35) | 4 (1-14) | 106 (27-429) | - | - | - | - | 19 (6-67) | 106 (28-422) | 42 (12-154) |
| Sudan - South | 0 (0-3) | 10 (3-37) | 10 (2-36) | 5 (1-19) | 171 (45-640) | 8 (2-29) | - | 3 (0-16) | - | 24 (7-83) | 173 (46-652) | 55 (15-197) |
| Tanzania | 1 (0-4) | 6 (2-20) | 6 (2-23) | 4 (1-14) | 202 (56-740) | 9 (2-32) | - | 1 (0-8) | - | 15 (4-55) | 204 (56-736) | 52 (15-179) |
| Tunisia | 0 (0-3) | 1 (0-3) | - | - | 8 (2-36) | 0 (0-2) | - | 0 (0-3) | - | 1 (0-6) | 9 (2-38) | 3 (1-11) |
| Togo | 1 (0-4) | 3 (1-10) | - | - | 87 (22-333) | 4 (1-15) | - | 1 (0-10) | - | 3 (1-13) | 88 (23-329) | 21 (6-80) |
| Uganda | 0 (0-1) | 5 (1-18) | - | - | 28 (7-106) | 1 (0-5) | - | - | - | 5 (1-18) | 28 (7-108) | 9 (3-32) |
| Zambia | 0 (0-0) | 2 (1-8) | 2 (1-8) | 1 (0-5) | 18 (4-82) | 1 (0-4) | - | 1 (0-7) | - | 5 (1-18) | 20 (5-89) | 7 (2-28) |
| Zimbabwe | 0 (0-1) | 6 (2-20) | 5 (1-20) | 2 (1-9) | 15 (4-55) | 1 (0-2) | - | - | - | 13 (4-43) | 15 (4-56) | 11 (3-39) |

**Appendix 8. VSLY BCRs for each country and vaccine**

Table A8. VSLY BCRs by country, vaccine, and EPI visit. Confidence intervals calculated based off benefit-risk ratios from Abbas et al. (2020)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Country** | **HepB3** | **Hib3** | **PCV3** | **RotaC** | **MCV1** | **MCV2** | **MenA** | **RCV** | **YFV** | **EPI-1** | **EPI-2** | **All EPI** |
| Algeria | 2 (0-11) | 31 (9-115) | 29 (7-109) | - | 393 (102-1449) | 17 (5-67) | - | 4 (0-29) | - | 62 (17-226) | 396 (104-1525) | 115 (33-424) |
| Angola | 4 (1-22) | 91 (26-321) | 86 (24-311) | 74 (21-273) | 730 (202-2615) | 33 (9-116) | - | 13 (2-85) | 40 (9-175) | 223 (69-790) | 781 (218-2814) | 327 (97-1168) |
| Benin | 3 (0-16) | 46 (12-172) | 43 (11-167) | - | 344 (79-1503) | - | - | - | 77 (18-335) | 88 (25-321) | 403 (103-1711) | 165 (46-626) |
| Botswana | 2 (0-10) | 27 (7-100) | 25 (7-96) | 14 (4-50) | 356 (92-1349) | 16 (4-59) | - | 3 (1-14) | - | 58 (17-208) | 359 (97-1340) | 114 (33-409) |
| Burkina Faso | 1 (0-9) | 27 (8-98) | 25 (7-94) | 14 (4-50) | 396 (106-1472) | 17 (5-63) | 7 (2-31) | 1 (0-8) | 104 (23-462) | 63 (19-219) | 462 (125-1761) | 144 (42-534) |
| Burundi | 1 (0-4) | 71 (19-252) | 64 (16-248) | 32 (9-109) | 568 (158-2112) | 25 (7-96) | - | 6 (1-39) | - | 157 (45-558) | 574 (162-2100) | 220 (64-790) |
| Cameroon | 1 (0-5) | 28 (8-101) | 27 (7-103) | 17 (5-61) | 244 (67-904) | - | - | 3 (0-18) | 48 (10-212) | 67 (19-241) | 285 (78-1073) | 120 (35-420) |
| Cape Verde | 4 (1-23) | 41 (12-137) | 37 (10-134) | - | 454 (124-1666) | - | 0 (0-2) | - | 62 (14-269) | 81 (24-287) | 515 (150-1935) | 190 (56-670) |
| Central African Republic | 2 (0-9) | 54 (15-192) | - | - | 390 (110-1453) | - | 6 (2-22) | - | 9 (2-36) | 55 (16-199) | 389 (112-1445) | 137 (39-490) |
| Chad | 1 (0-6) | 29 (8-115) | - | - | 378 (102-1374) | - | - | - | - | 30 (8-111) | 378 (102-1426) | 119 (33-409) |
| Comoros | 1 (0-4) | 40 (12-140) | 37 (10-139) | - | 434 (120-1553) | - | - | - | 35 (7-173) | 79 (23-276) | 469 (136-1660) | 177 (54-599) |
| Congo - Kinshasa | 3 (0-15) | 28 (8-104) | 25 (6-105) | 15 (4-58) | 890 (234-3391) | - | 6 (1-30) | - | 63 (14-295) | 67 (20-240) | 959 (263-3538) | 294 (86-1070) |
| Congo - Brazzaville | 4 (1-26) | 18 (5-64) | 18 (5-66) | 12 (3-45) | 341 (90-1255) | - | 1 (0-4) | 4 (1-16) | 324 (70-1486) | 47 (14-167) | 662 (176-2572) | 198 (57-740) |
| Cote d Ivoire | 1 (0-3) | 26 (7-94) | 25 (7-90) | 19 (5-79) | 258 (69-972) | 12 (3-42) | - | - | - | 65 (19-233) | 258 (71-971) | 94 (28-342) |
| Djibouti | 1 (0-4) | 18 (5-65) | 17 (4-65) | 9 (2-38) | 484 (126-1799) | 21 (6-80) | - | 4 (0-47) | - | 42 (12-154) | 489 (134-1800) | 130 (36-471) |
| Egypt | 1 (0-6) | 27 (7-102) | 23 (5-95) | 7 (2-28) | 294 (81-1093) | - | - | - | - | 55 (16-207) | 294 (77-1069) | 113 (32-419) |
| Equatorial Guinea | 2 (0-10) | 28 (8-101) | - | - | 354 (95-1316) | - | - | - | 122 (27-560) | 30 (8-105) | 476 (130-1770) | 130 (38-480) |
| Eritrea | 1 (0-5) | 19 (10-37) | 21 (9-47) | 11 (3-38) | 386 (108-1456) | 17 (5-63) | - | 1 (0-5) | 181 (40-786) | 48 (28-89) | 568 (156-2126) | 153 (45-575) |
| Eswatini | 2 (0-9) | 13 (4-43) | 14 (4-50) | 8 (2-29) | 614 (168-2188) | 27 (8-95) | 1 (0-6) | 5 (1-31) | 91 (21-401) | 33 (10-115) | 710 (196-2705) | 168 (48-602) |
| Ethiopia | 2 (0-12) | 22 (6-82) | - | - | 335 (88-1258) | - | - | - | 275 (65-1149) | 24 (6-90) | 609 (159-2378) | 174 (49-629) |
| Gabon | 2 (0-13) | 35 (10-128) | - | - | 445 (117-1639) | - | - | - | 154 (34-685) | 37 (10-137) | 599 (161-2283) | 164 (47-590) |
| Gambia | 4 (1-25) | 26 (7-93) | 25 (7-94) | 14 (4-51) | 591 (164-2128) | - | - | - | 169 (40-721) | 65 (19-229) | 753 (205-2736) | 237 (70-863) |
| Ghana | 0 (0-2) | 21 (6-73) | 21 (5-80) | 10 (3-37) | 378 (100-1400) | 17 (5-60) | - | 5 (1-32) | 2 (0-10) | 48 (14-176) | 385 (105-1409) | 118 (33-424) |
| Guinea | 1 (0-7) | 15 (4-52) | 15 (4-53) | 8 (2-32) | 364 (100-1357) | 16 (4-60) | - | 3 (1-13) | - | 36 (10-129) | 366 (96-1375) | 91 (27-335) |
| Guinea-Bissau | 4 (1-23) | 27 (7-98) | 23 (6-93) | 13 (4-50) | 533 (142-1986) | - | - | - | 333 (91-1223) | 62 (18-226) | 841 (230-3093) | 251 (73-927) |
| Kenya | 2 (0-13) | 39 (10-149) | 35 (8-148) | 16 (4-60) | 404 (112-1471) | - | - | - | - | 86 (24-319) | 404 (113-1445) | 164 (47-582) |
| Lesotho | 0 (0-2) | 26 (7-91) | 25 (7-91) | 14 (4-51) | 213 (54-816) | 9 (2-36) | - | 5 (1-29) | - | 60 (18-211) | 218 (57-868) | 84 (24-295) |
| Liberia | 3 (0-18) | 33 (9-123) | 31 (8-120) | 18 (5-65) | 427 (116-1564) | - | 5 (1-25) | - | 101 (21-476) | 73 (21-278) | 528 (146-1951) | 189 (55-682) |
| Libya | 2 (0-13) | 35 (9-125) | 32 (8-121) | 17 (5-66) | 445 (115-1810) | 20 (5-75) | - | 4 (1-34) | - | 80 (23-285) | 449 (121-1723) | 142 (42-506) |
| Madagascar | 5 (1-31) | 37 (11-137) | 35 (9-129) | 21 (6-77) | 568 (154-2151) | - | - | 4 (1-24) | - | 90 (27-326) | 572 (155-2139) | 209 (59-753) |
| Malawi | 2 (0-13) | 40 (11-143) | 36 (9-144) | 17 (5-60) | 460 (124-1719) | 20 (6-76) | - | 2 (0-10) | - | 89 (26-317) | 443 (119-1633) | 158 (45-551) |
| Mali | 3 (0-17) | 56 (15-211) | 50 (11-209) | 29 (8-113) | 419 (115-1507) | 19 (5-68) | 7 (2-26) | - | 9 (2-41) | 122 (35-471) | 420 (114-1492) | 172 (51-625) |
| Mauritania | 4 (1-23) | 37 (10-133) | 36 (9-135) | - | 403 (111-1441) | - | - | - | 45 (9-215) | 77 (22-272) | 446 (125-1676) | 177 (52-627) |
| Mauritius | 2 (0-11) | 27 (8-100) | 25 (7-98) | 14 (4-52) | 364 (97-1391) | 16 (4-60) | - | 3 (0-27) | - | 63 (18-229) | 367 (100-1353) | 116 (35-422) |
| Morocco | 1 (0-6) | 54 (14-206) | 46 (11-198) | 20 (5-78) | 515 (136-1964) | 23 (6-85) | - | 4 (1-23) | - | 115 (33-434) | 519 (134-1946) | 181 (55-658) |
| Mozambique | 3 (0-20) | 19 (5-66) | 19 (5-66) | 7 (2-26) | 320 (77-1324) | 14 (3-61) | - | 2 (0-18) | 161 (36-723) | 46 (14-164) | 483 (126-1947) | 133 (37-503) |
| Namibia | 2 (0-9) | 25 (7-92) | 23 (6-91) | 12 (3-45) | 317 (82-1224) | 14 (4-55) | - | 3 (0-25) | - | 55 (16-206) | 320 (86-1193) | 110 (31-396) |
| Niger | 2 (0-14) | 19 (5-77) | 17 (4-75) | 8 (2-34) | 282 (77-1054) | 12 (3-47) | - | 1 (0-4) | 148 (32-673) | 43 (12-161) | 418 (117-1652) | 118 (35-439) |
| Nigeria | 3 (0-18) | 30 (9-105) | 28 (8-102) | 17 (5-61) | 451 (126-1602) | 20 (5-72) | - | - | 202 (45-906) | 72 (22-263) | 653 (182-2440) | 189 (54-677) |
| Rwanda | 1 (0-6) | 50 (14-178) | - | - | 549 (152-2018) | - | - | - | - | 52 (15-177) | 549 (148-2074) | 180 (53-623) |
| Sao Tome and Principe | 1 (0-8) | 40 (11-147) | 39 (10-150) | 20 (6-70) | 282 (73-1081) | 13 (3-47) | 6 (1-29) | - | - | 94 (27-340) | 288 (74-1109) | 120 (35-430) |
| Senegal | 1 (0-6) | 60 (14-242) | - | - | 315 (65-1536) | - | - | - | - | 61 (15-246) | 315 (63-1474) | 126 (32-533) |
| Seychelles | 2 (0-10) | 28 (8-100) | 26 (7-97) | 14 (4-51) | 351 (94-1307) | 16 (4-59) | - | 3 (0-28) | 123 (28-539) | 43 (12-156) | 467 (128-1811) | 124 (36-463) |
| Sierra Leone | 1 (0-9) | 23 (6-82) | 21 (5-84) | 11 (3-43) | 277 (75-1046) | 12 (3-47) | - | 4 (1-24) | - | 53 (16-199) | 281 (76-1053) | 95 (28-346) |
| Somalia | 3 (0-19) | 19 (5-66) | 19 (5-67) | 10 (3-39) | 474 (112-2001) | - | - | 4 (0-47) | 73 (17-331) | 47 (14-166) | 534 (132-2199) | 171 (47-666) |
| South Africa | 2 (0-9) | 26 (7-95) | 24 (6-89) | 13 (3-47) | 328 (87-1223) | 15 (4-54) | - | - | - | 59 (18-215) | 328 (86-1246) | 105 (29-384) |
| Sudan - North | 1 (0-8) | 26 (7-90) | 25 (7-95) | 10 (3-36) | 284 (73-1147) | - | - | - | - | 51 (15-180) | 284 (75-1129) | 111 (32-412) |
| Sudan - South | 1 (0-7) | 27 (7-99) | 26 (7-97) | 14 (4-52) | 455 (119-1709) | 20 (5-77) | - | 7 (1-44) | - | 64 (19-221) | 463 (123-1741) | 146 (41-526) |
| Tanzania | 2 (0-12) | 16 (4-54) | 17 (4-63) | 10 (3-37) | 550 (152-2011) | 24 (7-88) | - | 4 (1-22) | - | 41 (12-148) | 553 (152-2000) | 142 (42-487) |
| Togo | 2 (0-10) | 7 (2-25) | - | - | 219 (54-839) | 10 (2-37) | - | 3 (0-25) | - | 8 (2-34) | 221 (57-829) | 53 (15-202) |
| Tunisia | 2 (0-10) | 3 (1-11) | - | - | 28 (7-121) | 1 (0-5) | - | 2 (0-10) | - | 5 (1-19) | 30 (7-127) | 9 (3-36) |
| Uganda | 1 (0-2) | 14 (4-50) | - | - | 79 (21-299) | 3 (1-13) | - | - | - | 14 (4-52) | 79 (21-305) | 25 (7-91) |
| Zambia | 0 (0-1) | 7 (2-27) | 7 (2-27) | 4 (1-16) | 62 (13-282) | 3 (1-13) | - | 5 (1-23) | - | 17 (5-61) | 67 (15-305) | 24 (7-96) |
| Zimbabwe | 1 (0-2) | 16 (5-58) | 15 (4-58) | 7 (2-26) | 42 (11-158) | 2 (0-7) | - | - | - | 36 (11-123) | 42 (11-163) | 31 (9-113) |

**Appendix 9. One-way sensitivity analysis for costs of VPD and COVID-19 deaths.**

Using the COI approach, total cost of illness was sensitive to the number of excess deaths from vaccine-preventable disease. COVID-19 COI was also sensitive to facility costs. Using VSLY, deaths had a significant impact on uncertainty and GDP per capita had a moderate effect.

Figures A9a-b. Sensitivity analysis for COI of excess vaccine-preventable deaths and COVID-19 deaths

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Figures A9c-d. Sensitivity analysis for VSLY of excess vaccine-preventable deaths and COVID-19 deaths.