

Supplementary Material

COVID-19 vaccination implementation in 52 African countries:
trajectory and Implications for future pandemic preparedness

Data Sources

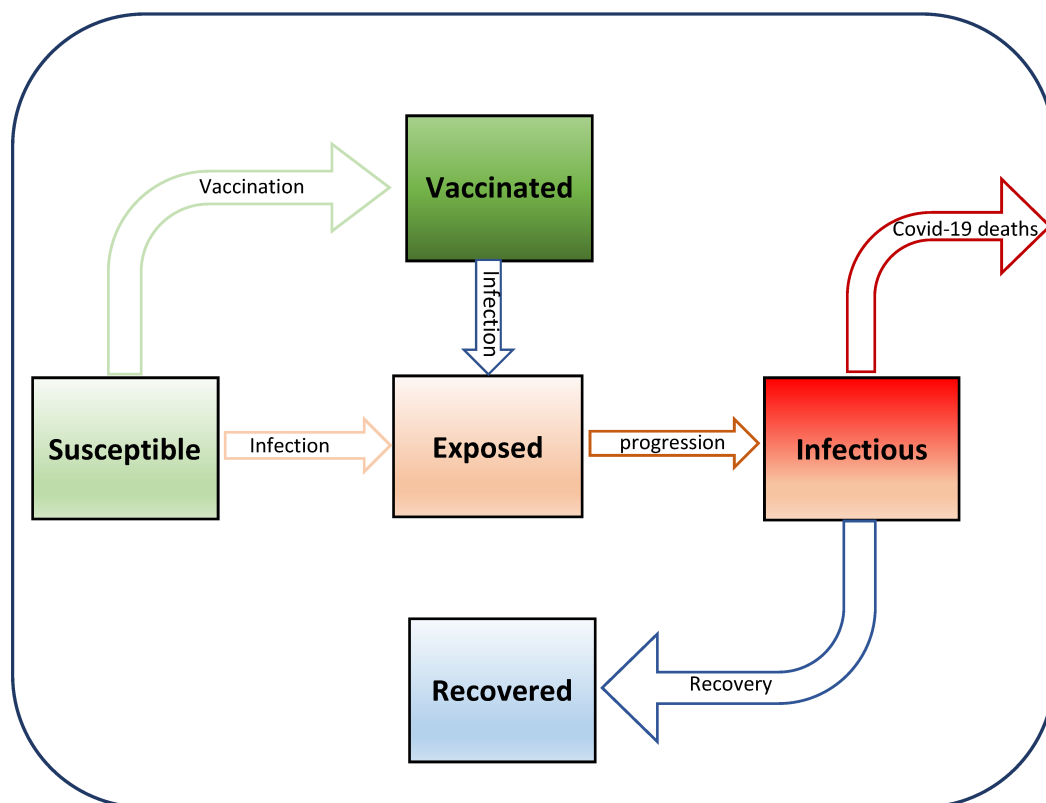
We extracted daily COVID-19 vaccination data covering the initial nine months of vaccine deployment from Our World in Data online database,¹ while data on the population of each included country were extracted from the UN World Population Prospects 2020.² Data on the number of COVID-19 cases and mortality per country were obtained from Our World in Data,³ while life expectancy per country was extracted from the World Bank life expectancy database.⁴

Table S1: Summary of data sources, including the variables extracted, year, and date of extraction

Data source (reference)	Data extracted and period covered	Date of extraction
Our World in Data ¹	Country-level COVID-19 vaccination data in the initial nine months of vaccine deployment	15 Feb. 2022
UN World Population Prospects 2020 ²	Country-level total population (2020)	15 Feb. 2022
Our World in Data COVID-19 database ³	COVID-19 cases and mortality per country in the initial nine months of vaccine deployment	16 Feb. 2022
The World Bank life expectancy database ⁴	Country-level life expectancy at birth (2020)	22 Feb. 2022
UN Development Programme database ²	Country-level human development index (2020)	22 Feb. 2022
The World Bank Country lending groups database ⁵	Country income category (2020)	22 Feb. 2022

Table S2. Model parameters and values used in the analysis with their references

Parameter description	Parameter symbol	Range/value	Reference
Effective contact rate	β	Model fitting	-
Incubation period	$1/\rho$	3-7 days	6,7
Infectious period	$1/\kappa$	2-5 days	6
Life expectancy	$1/\mu$	Country specific	4
Vaccination rate	ω	Model fitting	8
Vaccine effectiveness	ε	0.86	9
Death rate due to COVID-19	δ	Country specific	3

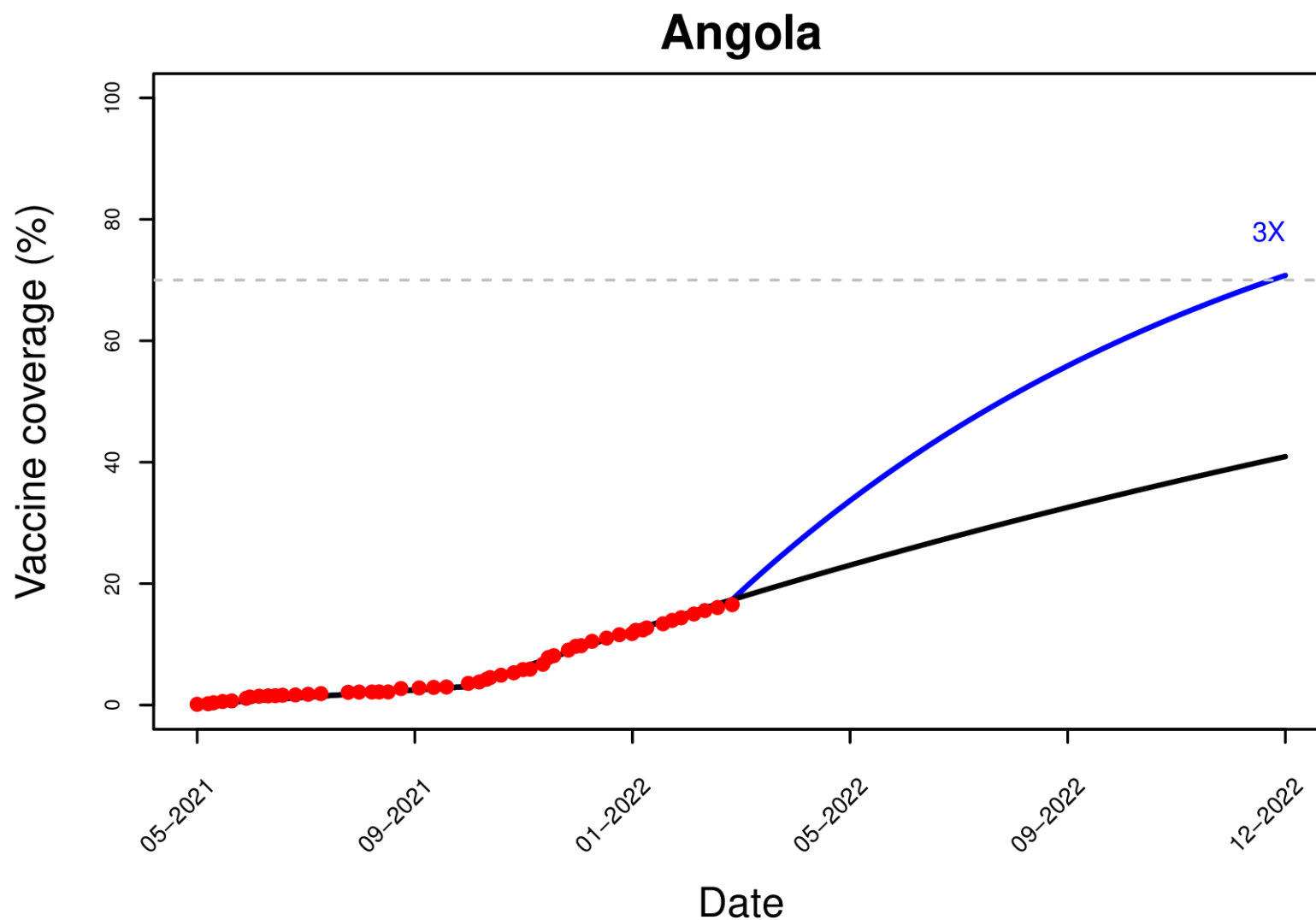


Supplementary Figure S1: Model flow diagram showing how individuals move from the susceptible, vaccinated, exposed, infectious and recovered states.

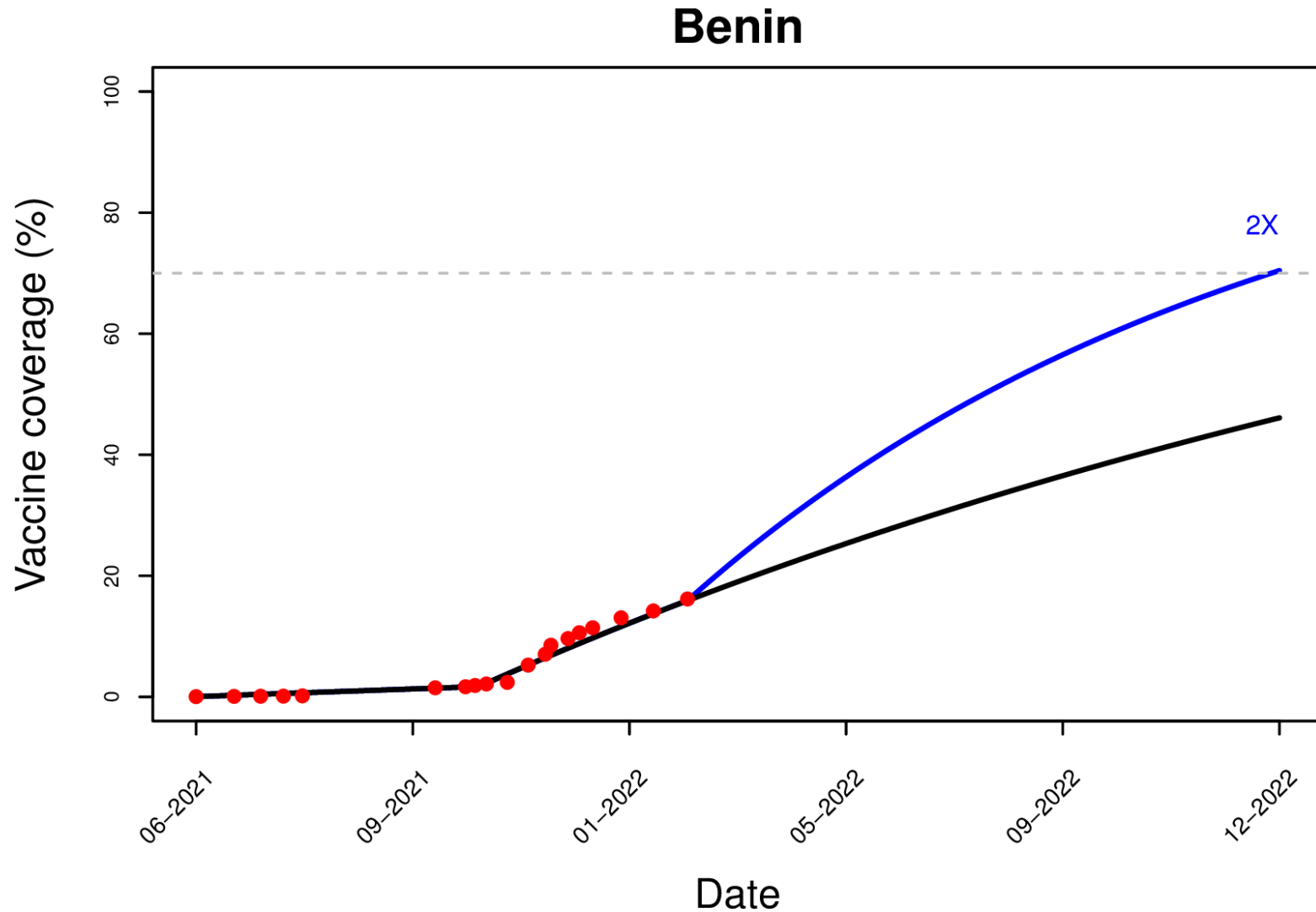
Table S3: Predicted (modelled), observed, and the percent points difference between the modelled or projected and observed/actual vaccination coverage achieved as of December 2022.

Country	Observed Coverage (OC)	Predicted Coverage (PC) [95% credible interval]	Difference (OC-PC)
Burundi	0.23	2 [1.27, 5.24]	-1.77
Chad	20.5	2 (1.12, 11.39)	18.5
Democratic Republic of the Congo	6.9	2 [1.56, 12.53]	4.9
Niger	20.3	7 [2.98, 9.96]	13.3
Nigeria	27.4	7 [3.80, 18.91]	20.4
Madagascar	7.1	8 [3.38, 10.17]	-0.9
South Sudan	20.4	8 [0.60, 20.74]	12.4
Mali	11.8	9 [1.35, 13.24]	2.8
Tanzania	44.7	9 [2.53, 14.70]	35.7
Cameroon	9.8	10 [1.07, 16.10]	-0.2
Malawi	15.2	10 [4.94, 24.90]	5.2
Somalia	35.9	10 [4.36, 15.04]	25.9
Senegal	8.3	12 [6.22, 18.32]	-3.7
Burkina Faso	14.7	12 [4.07, 25.02]	2.7
Sudan	17.7	12 [6.86, 22.35]	5.7
Guinea Bissau	17.2	13 [2.17, 25.12]	4.2
Congo	11	15 [2.04, 22.69]	-4
Zambia	42.7	16 [11.50, 23.58]	26.7
Djibouti	26.5	17 [8.81, 21.59]	9.5
Uganda	27.4	17 [5.77, 22.56]	10.4
Gabon	10.8	19 [7.75, 22.17]	-8.2
Togo	16.5	21 [14.20, 35.11]	-4.5
Equatorial Guinea	13	23 [13.55, 35.96]	-10
Guinea	23.7	23 [20.08, 26.47]	0.7
Sierra Leone	40	26 [17.79, 38.41]	14
Gambia	16.8	27 [12.78, 36.53]	-10.2
Cote d'Ivoire	41.4	28 [13.62, 36.07]	13.4
Kenya	20	29 [15.84, 33.94]	-9
Ethiopia	30.3	30 [15.99, 35.73]	0.3
Libya	18.2	33 [29.97, 37.12]	-14.8
Namibia	20.5	36 [31.12, 38.15]	-15.5
Central African Republic	34.7	37 [26.37, 51.09]	-2.3
Zimbabwe	29.1	38 [33.37, 46.49]	-8.9
Angola	23.3	41 [34.40, 54.60]	-17.7
Benin	20.5	46 [38.06, 48.47]	-25.5
Ghana	27.4	46 [32.71, 51.40]	-18.6
South Africa	35.1	48 [40.11, 51.40]	-12.9
Comoros	47.5	56 [49.77, 66.21]	-8.5
Mauritania	32.5	56 [45.72, 67.09]	-23.5
Sao Tome and Principe	45.7	57 [49.60, 69.46]	-11.3
Eswatini	34.4	58 [52.41, 71.39]	-23.6
Liberia	70.4	58 [54.58, 62.87]	12.4

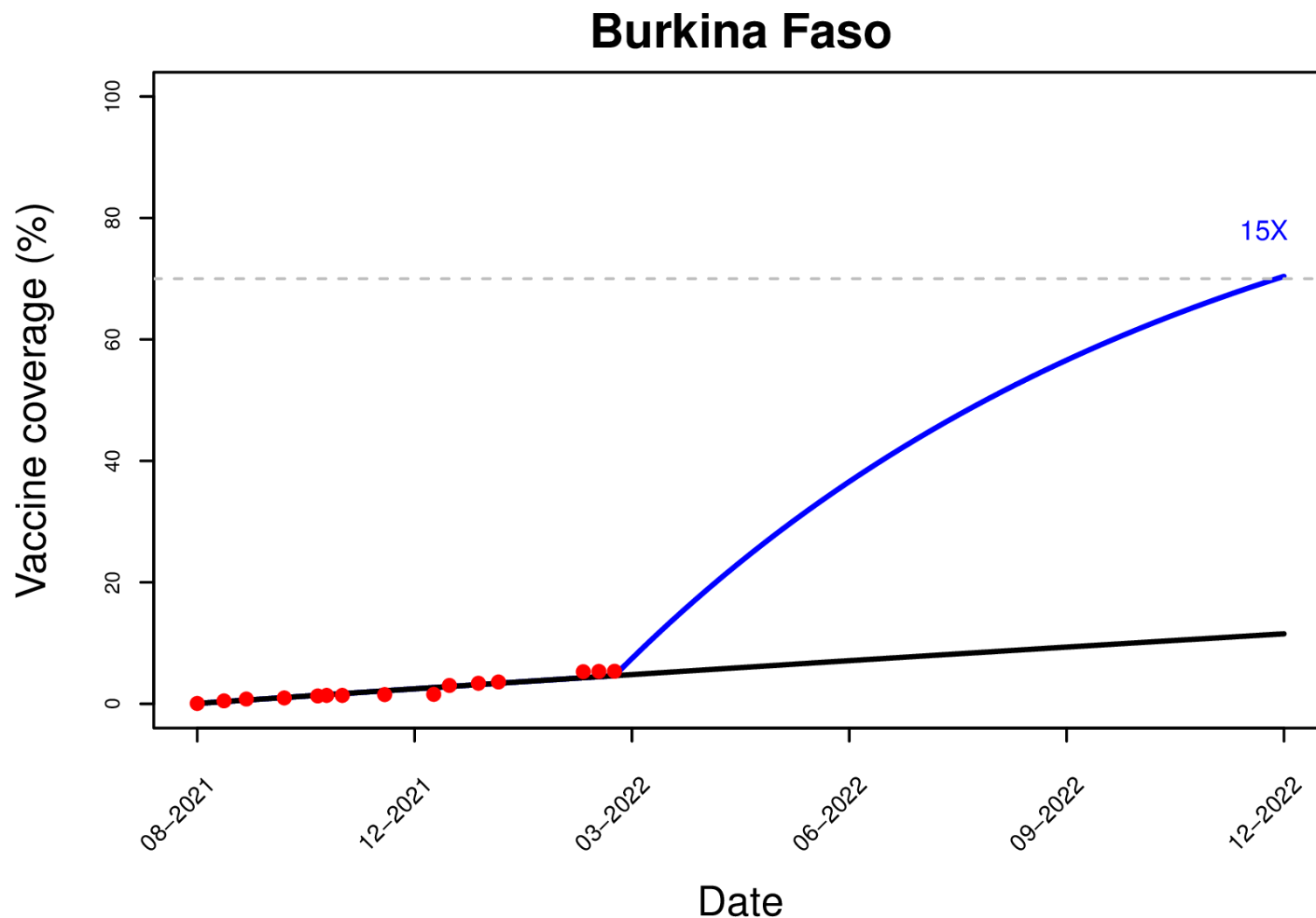
Egypt	36.1	59 [52.68, 63.19]	-22.9
Tunisia	51.7	72 [66.25, 77.23]	-20.3
Cape Verde	52.1	74 [61.89, 83.27]	-21.9
Lesotho	40.2	74 [71.96, 86.15]	-33.8
Mozambique	56	74 [67.20, 88.86]	-18
Rwanda	71.8	78 [64.12, 92.53]	-6.2
Seychelles	76.2	83 [73.43, 95.38]	-6.8
Morocco	62.8	84 [78.34, 91.93]	-21.2
Botswana	54.2	87 [75.01, 95.33]	-32.8
Mauritius	83.7	97 [91.39, 99.10]	-13.3



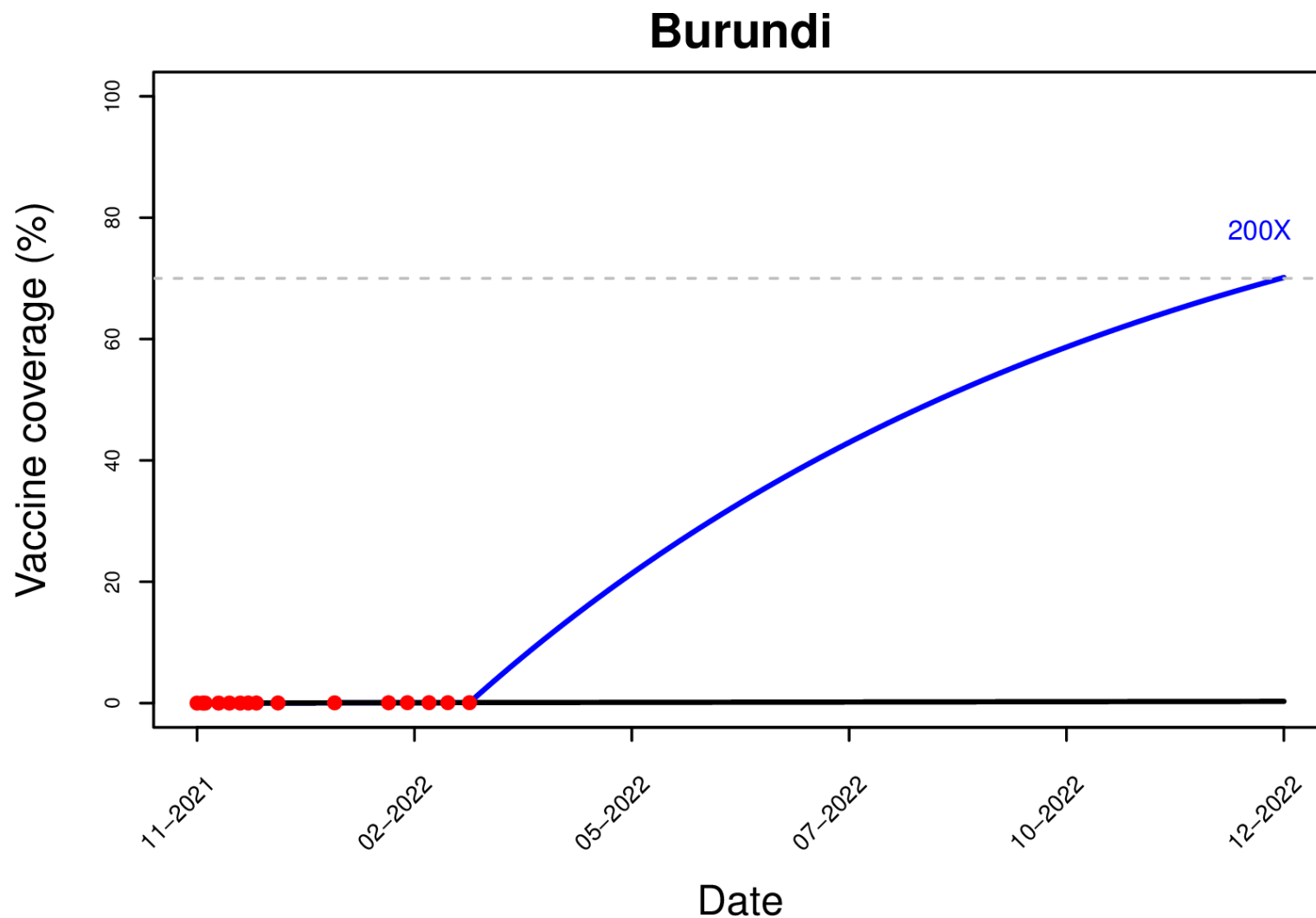
Supplementary Figure S2: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target.



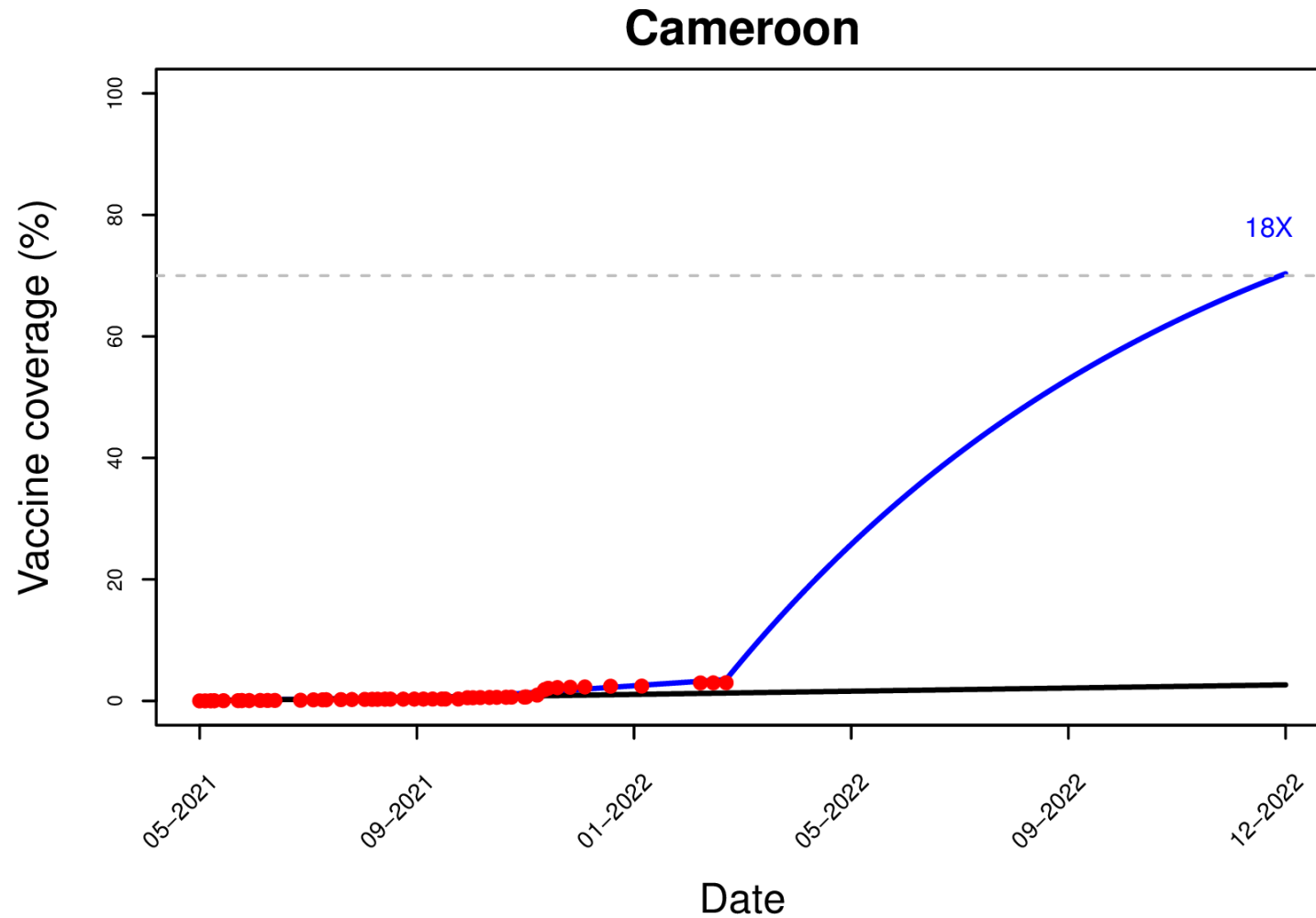
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Supplementary Figure S4: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

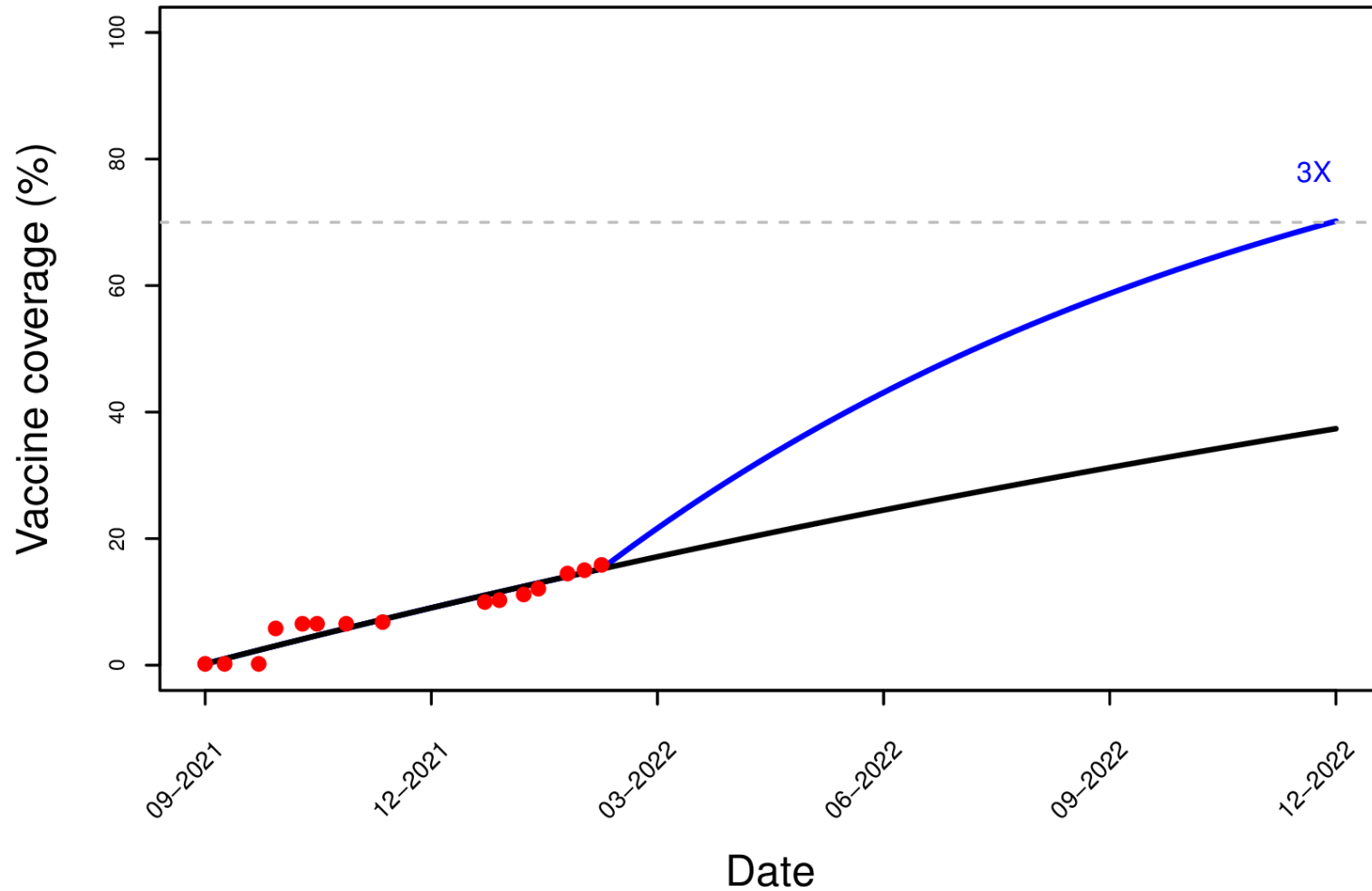


Supplementary Figure S5: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

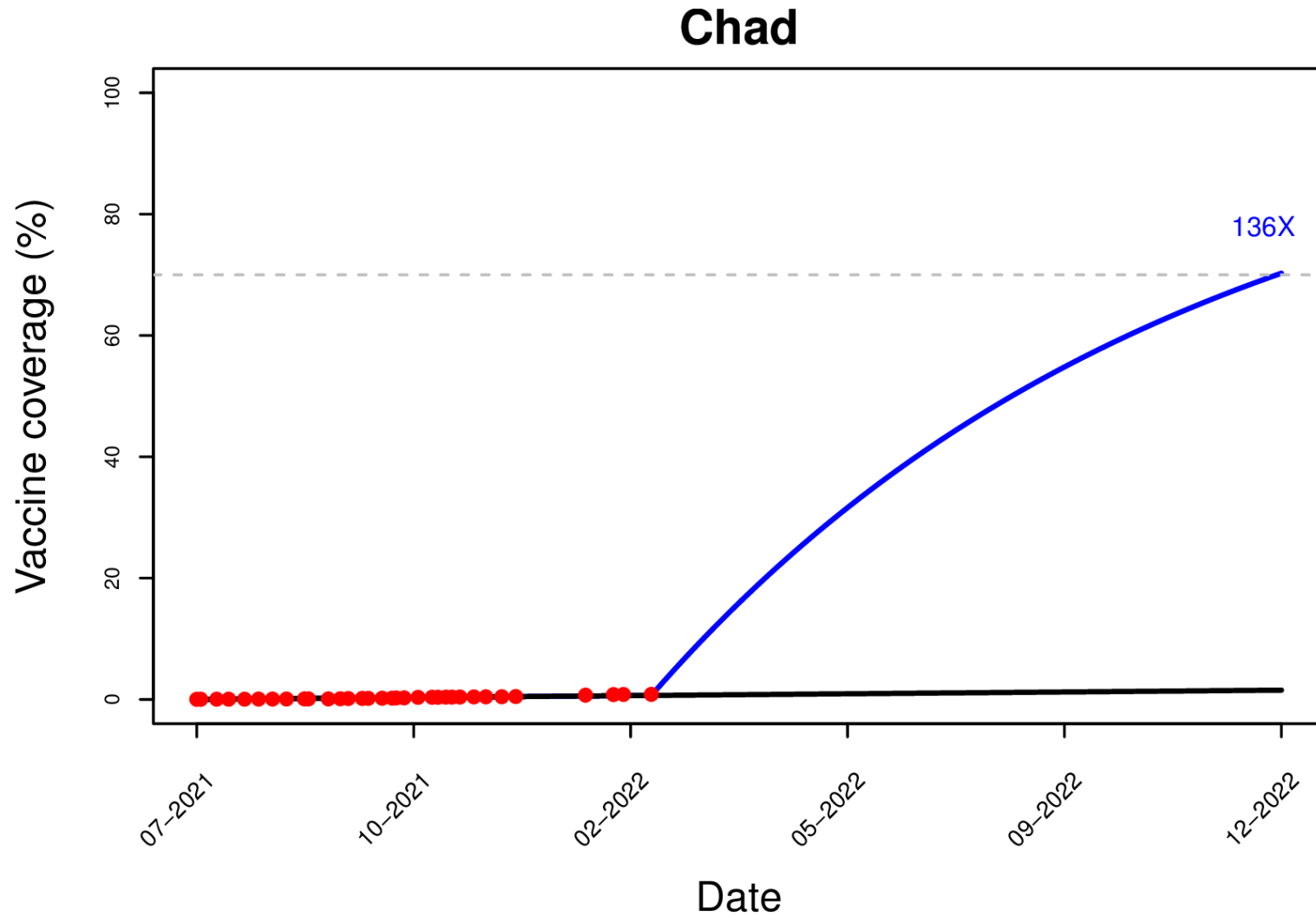


Supplementary Figure S6: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

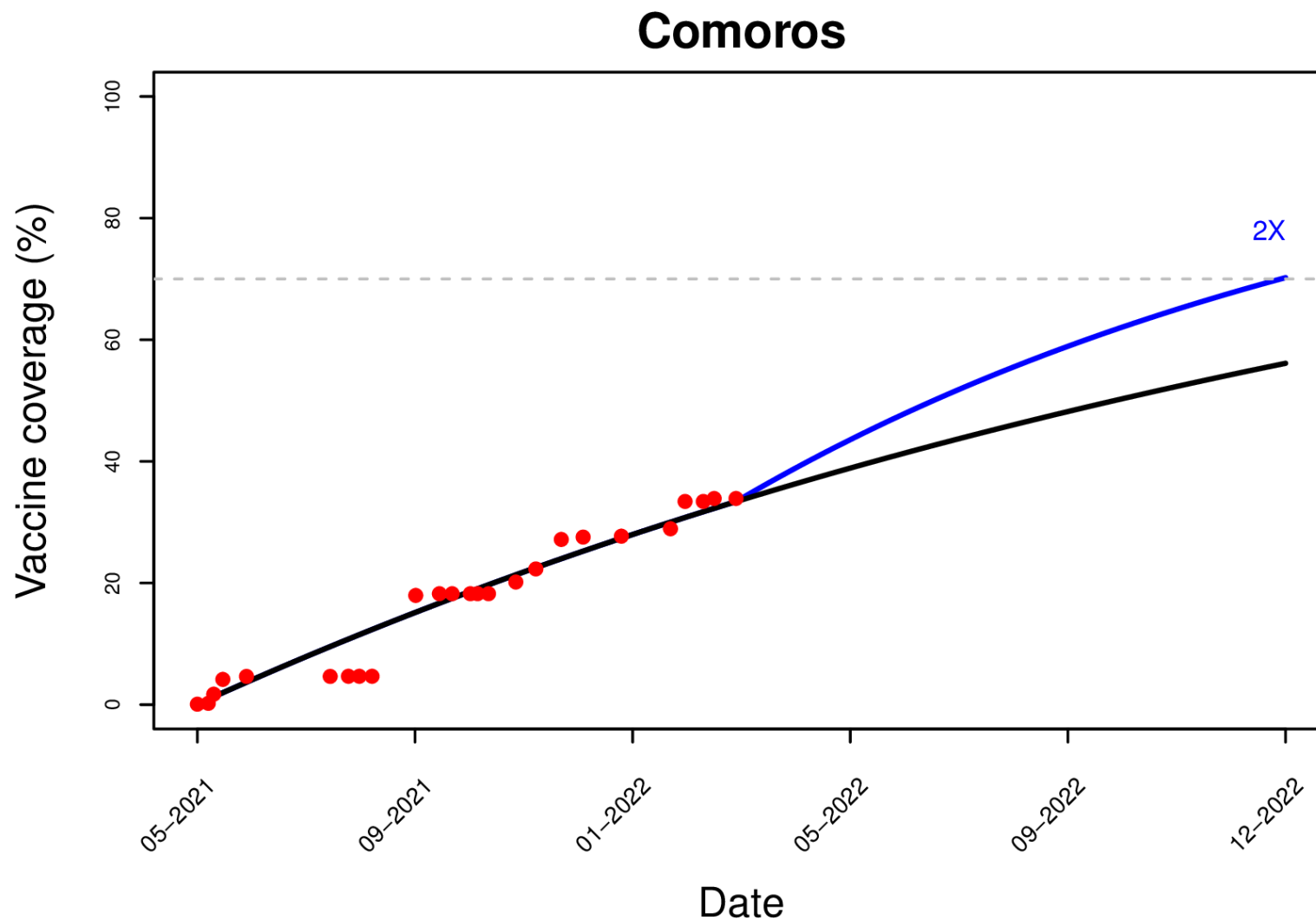
Central African Republic



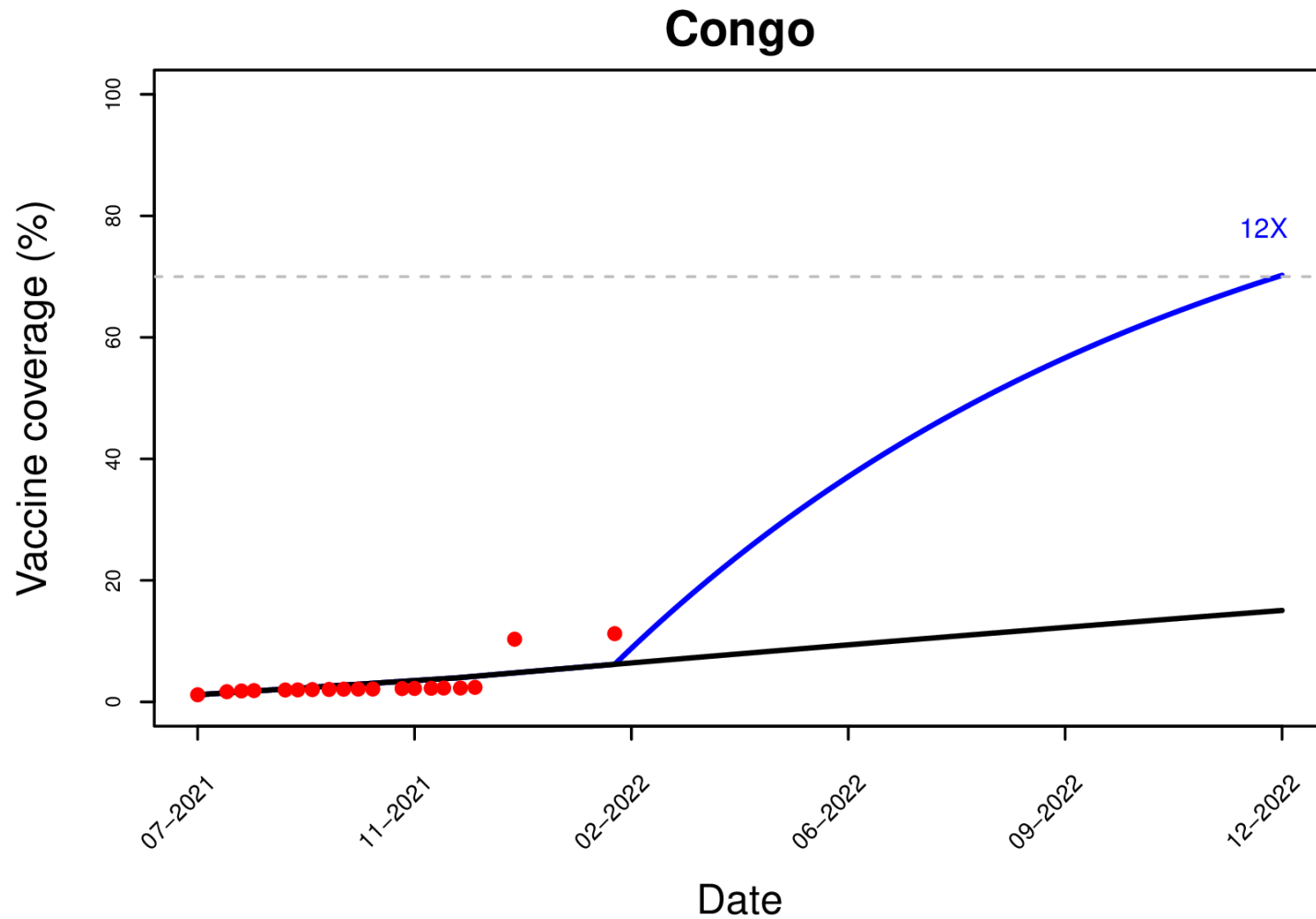
Supplementary Figure S7: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



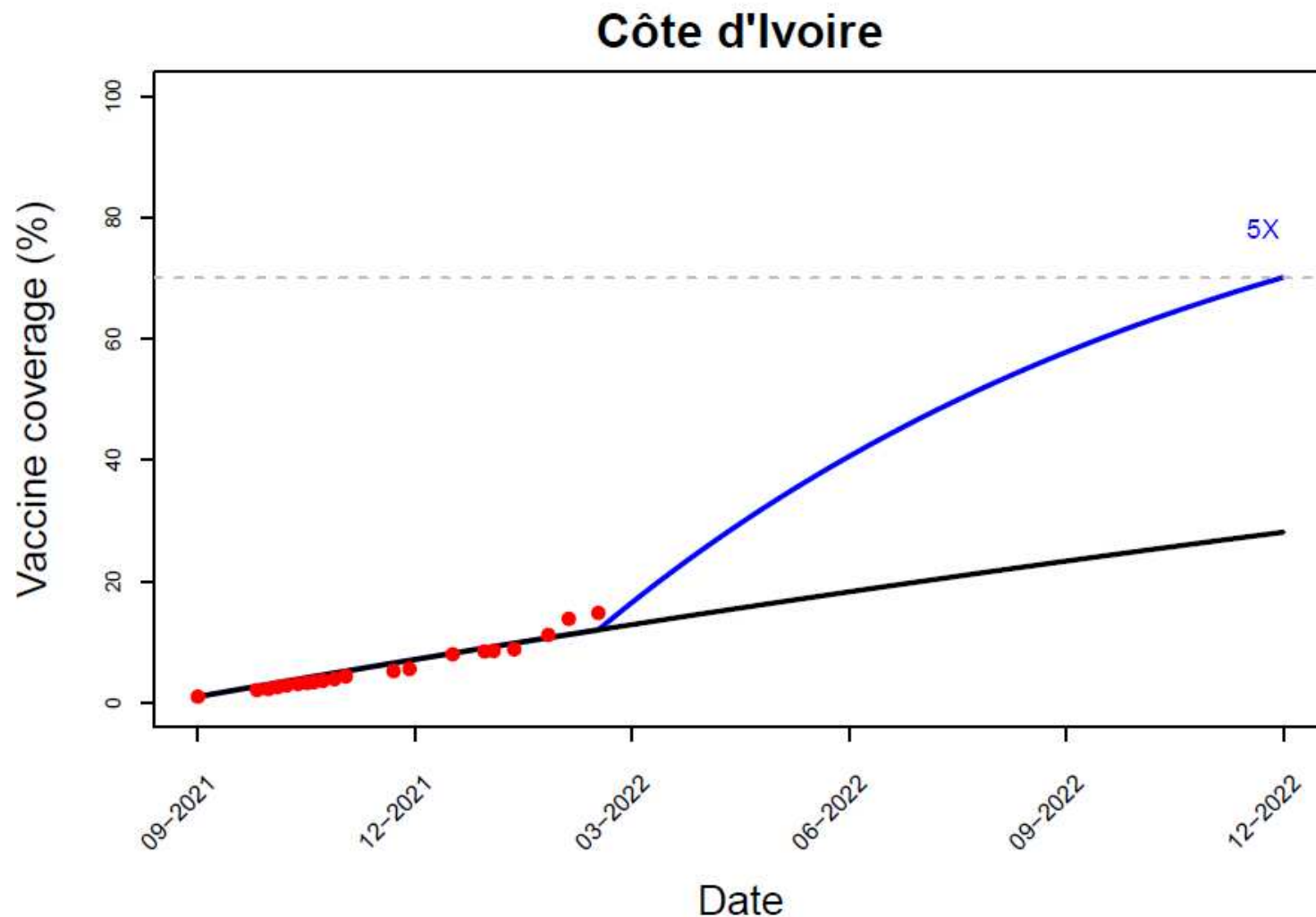
Supplementary Figure S8: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



Supplementary Figure S9: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

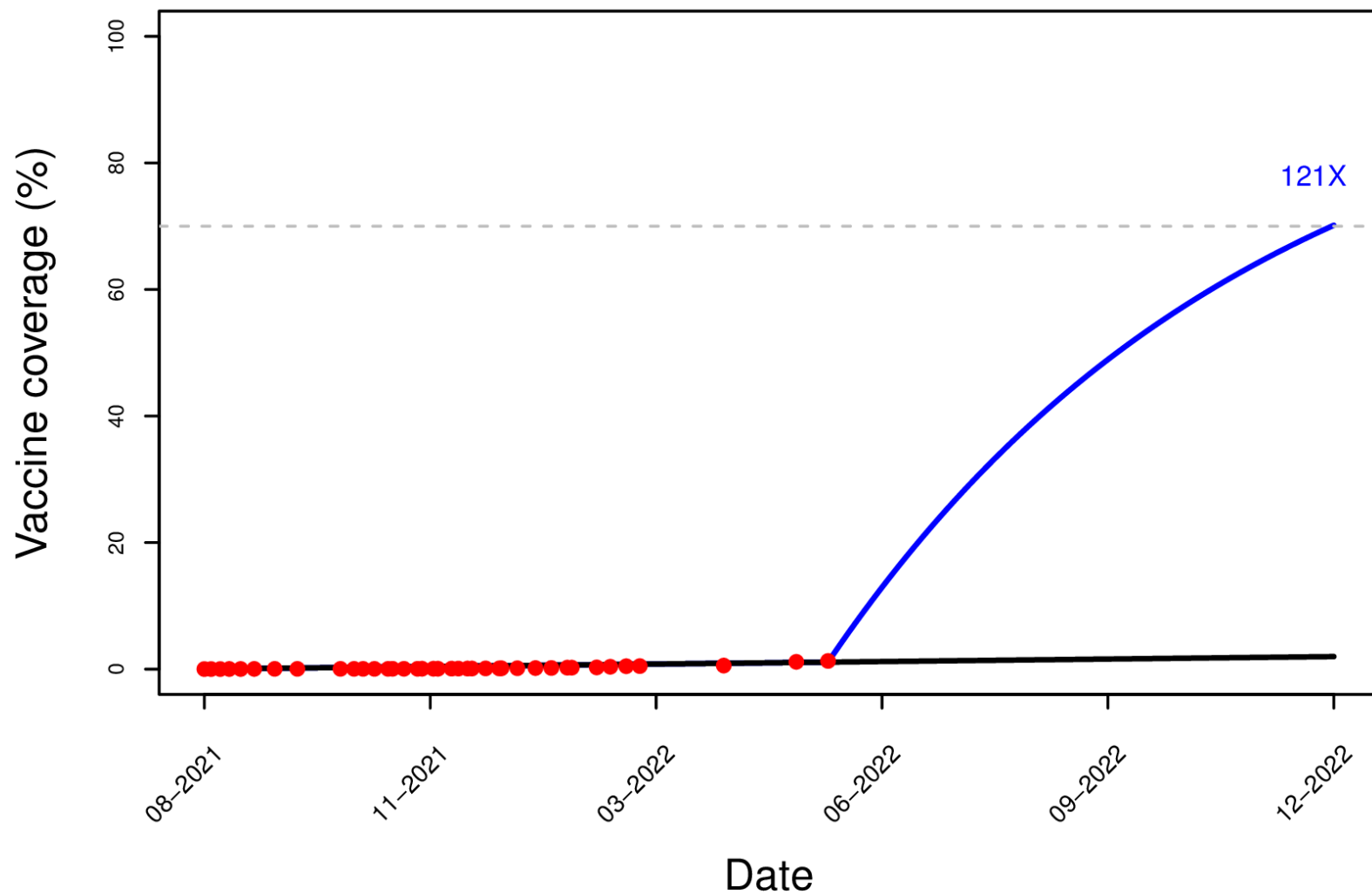


Supplementary Figure S10: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

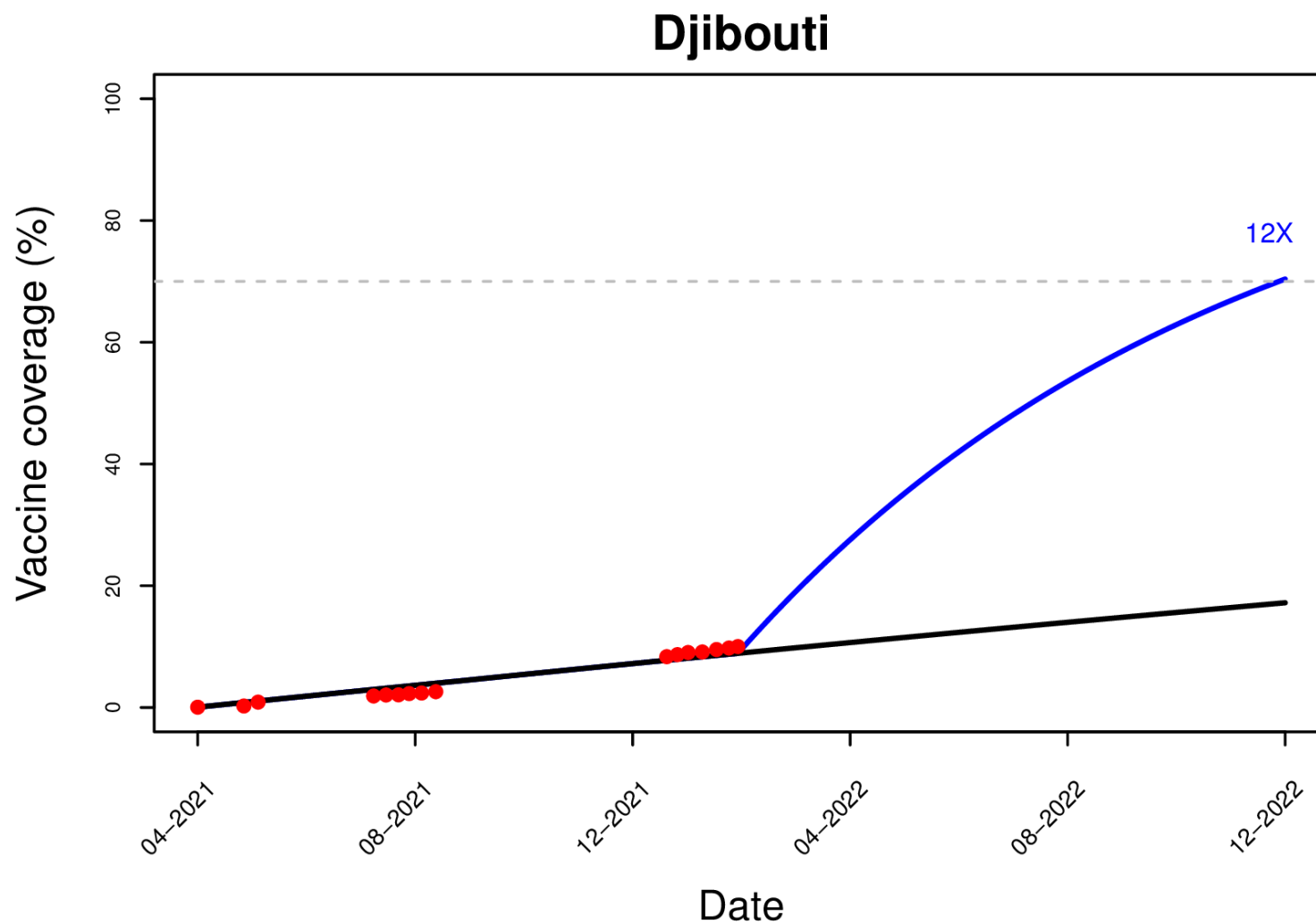


Supplementary Figure S11: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

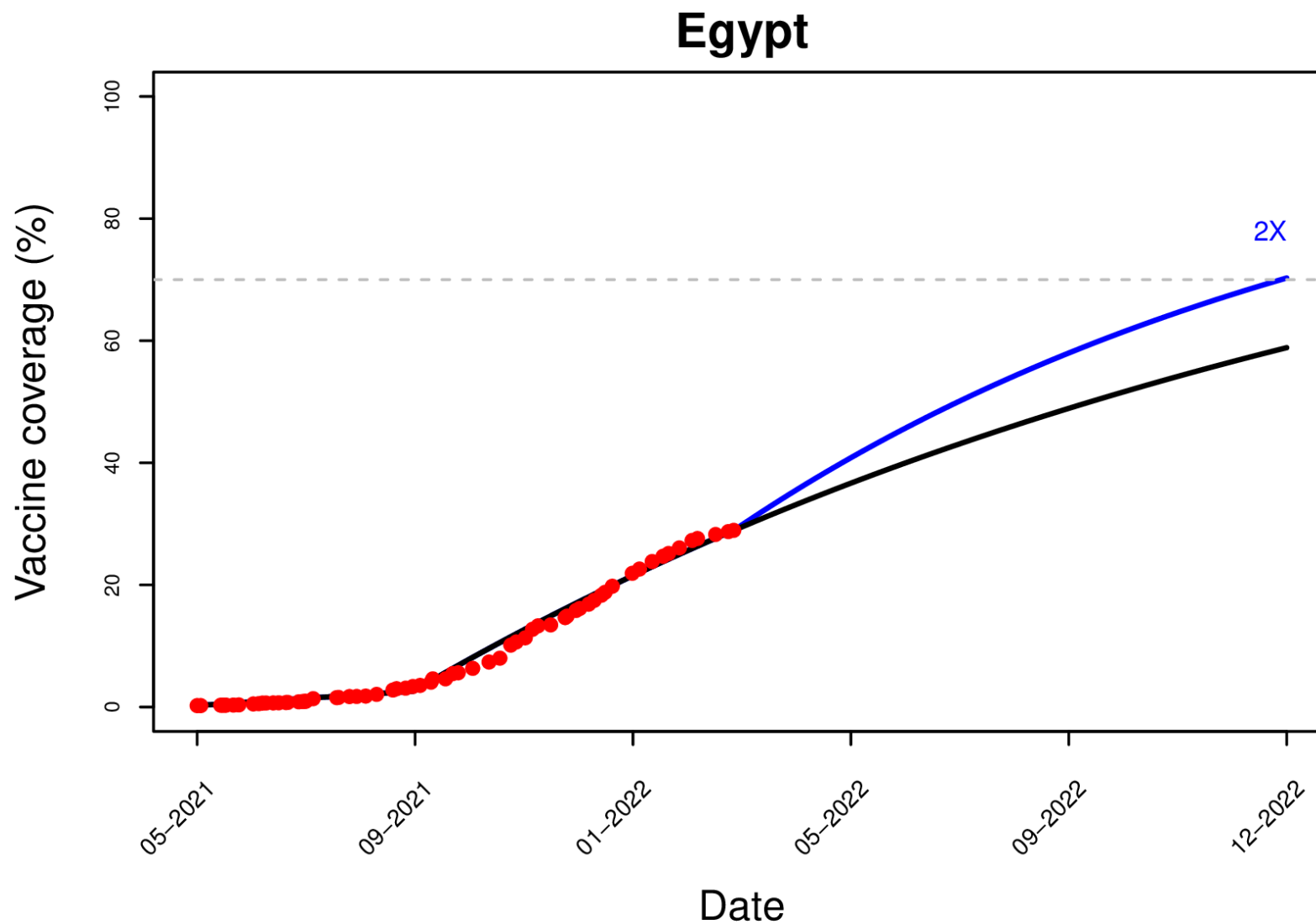
Democratic Republic of the Congo



Supplementary Figure S12: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

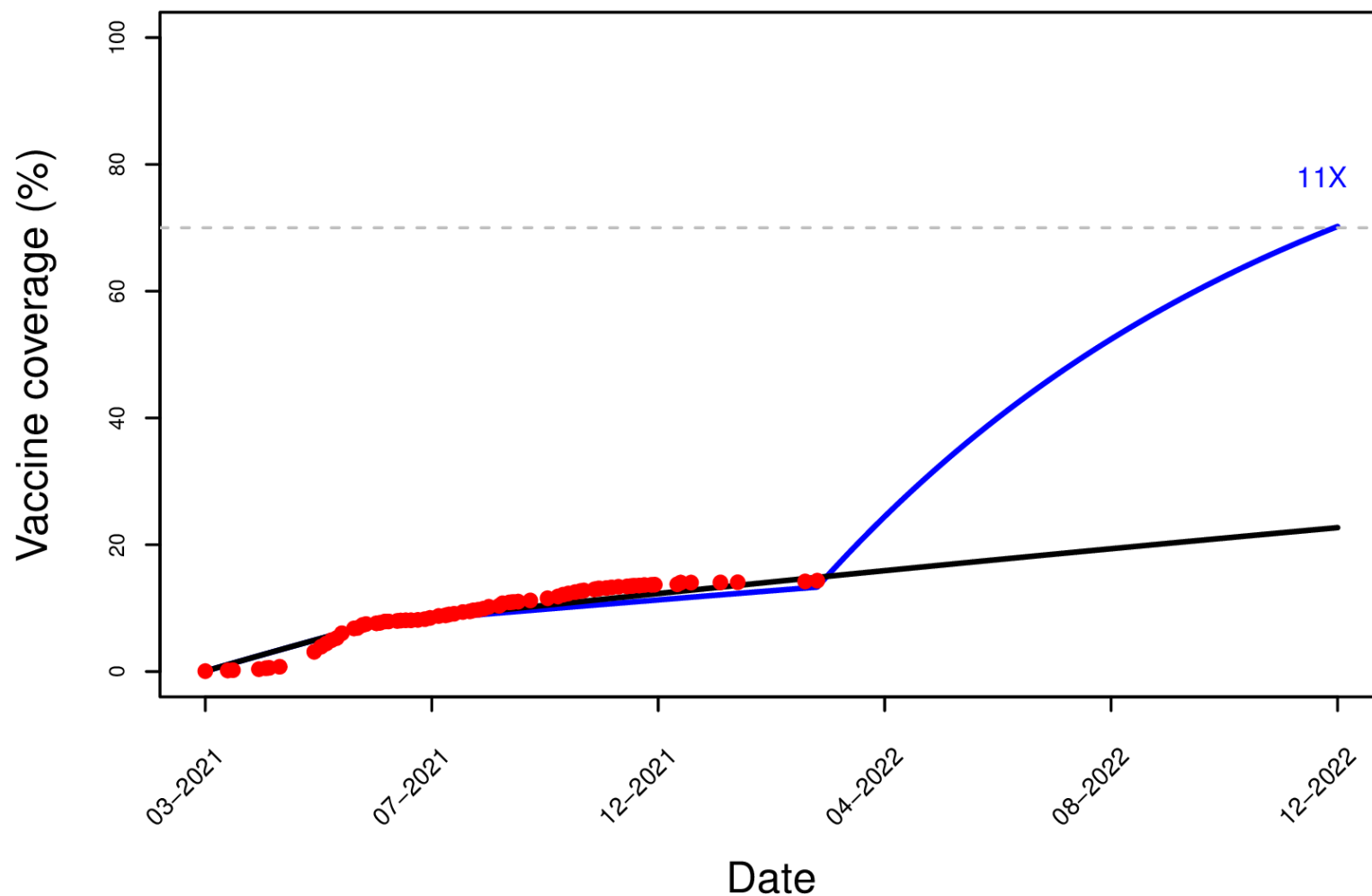


Supplementary Figure S13: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



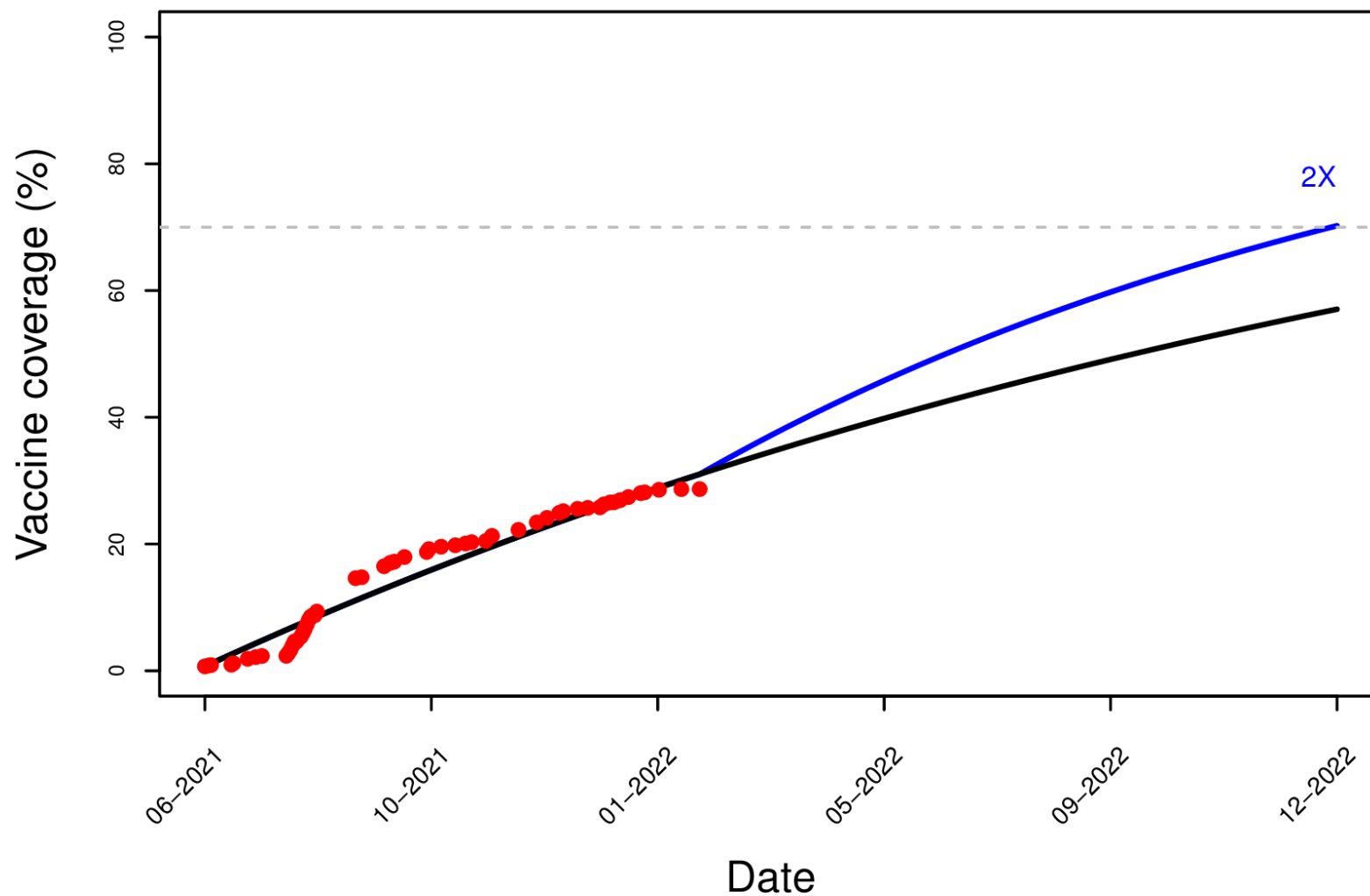
Supplementary Figure S14: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

Equatorial Guinea

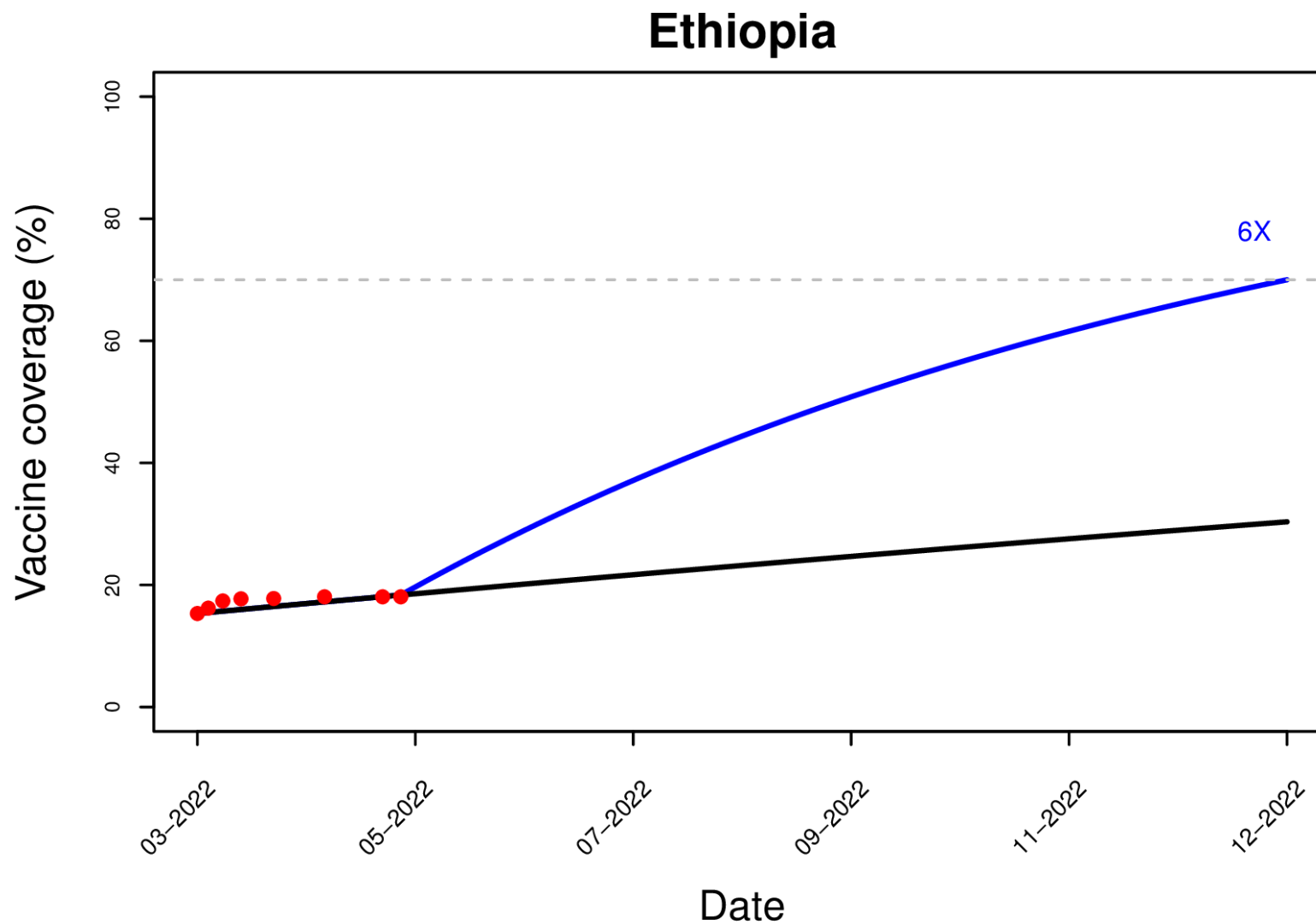


Supplementary Figure S15: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

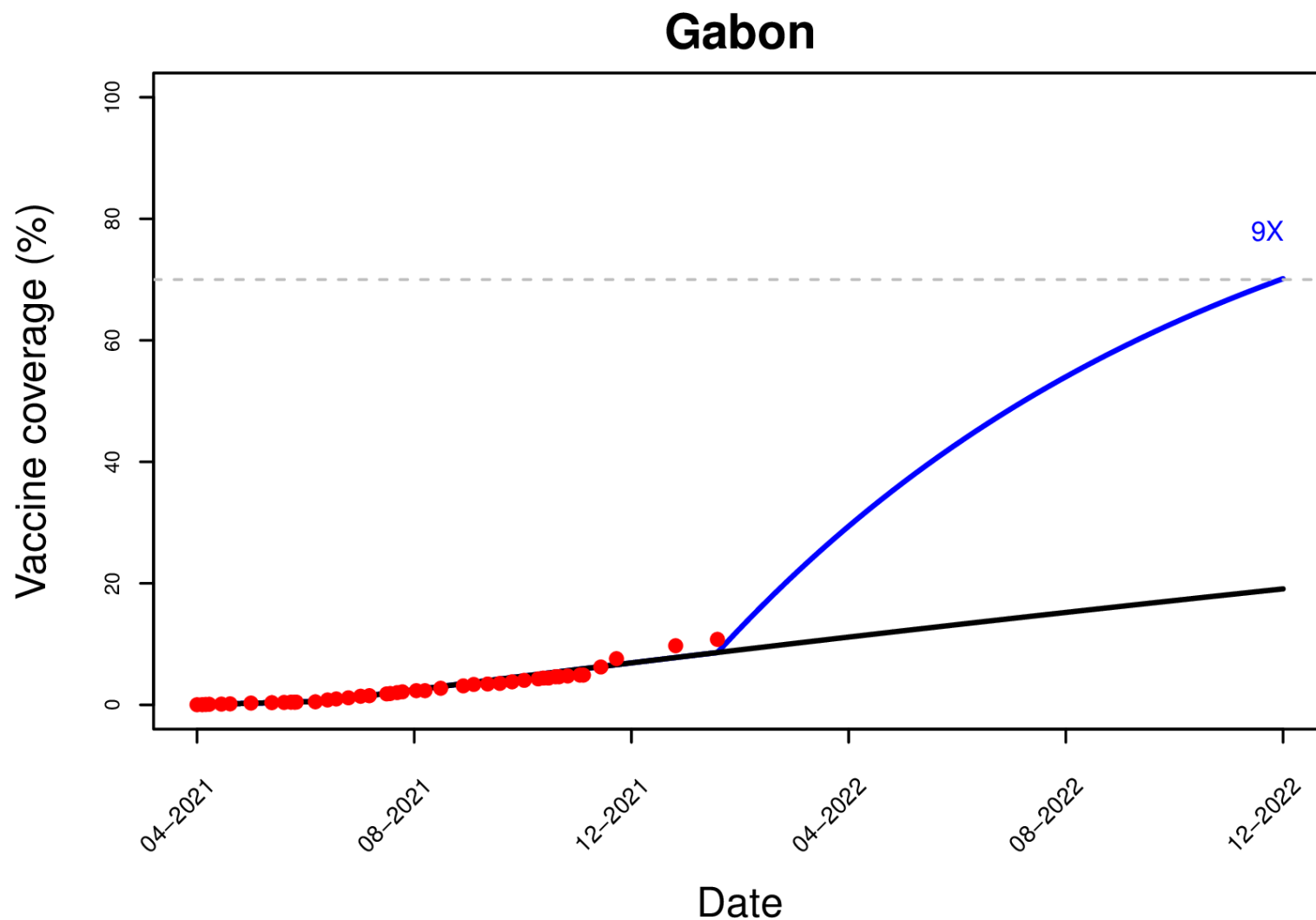
Eswatini (Swaziland)



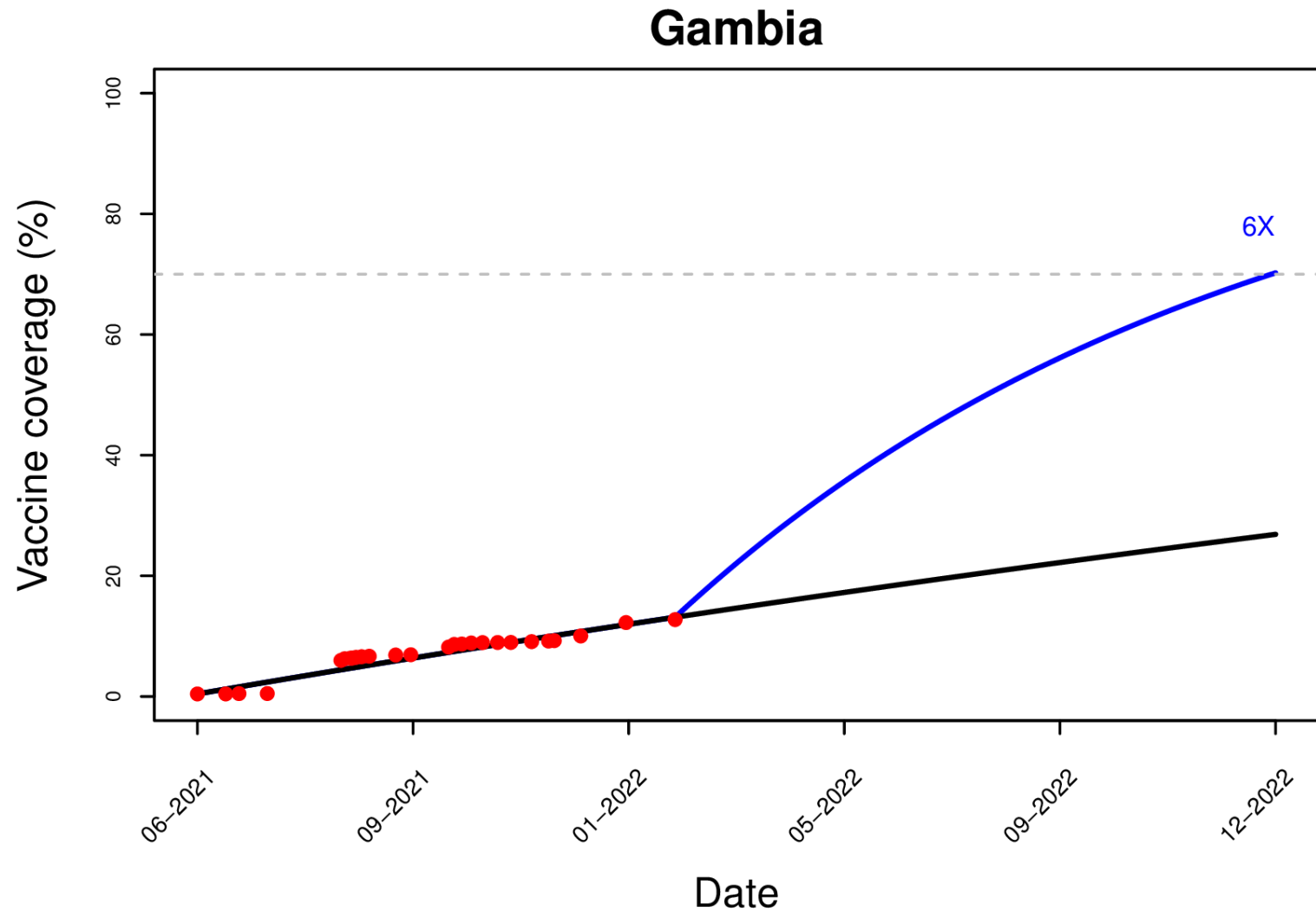
Supplementary Figure S16: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



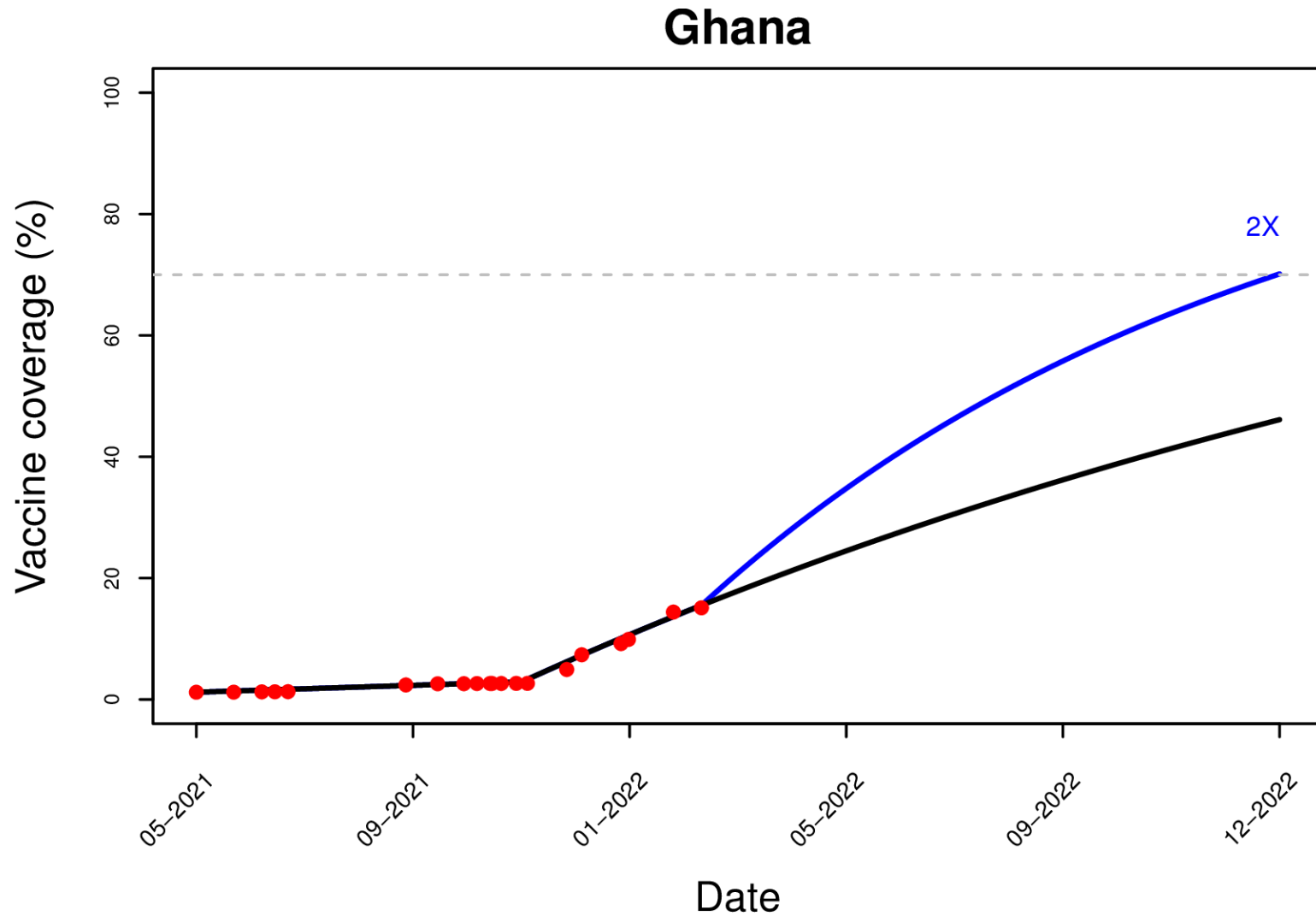
Supplementary Figure S17: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



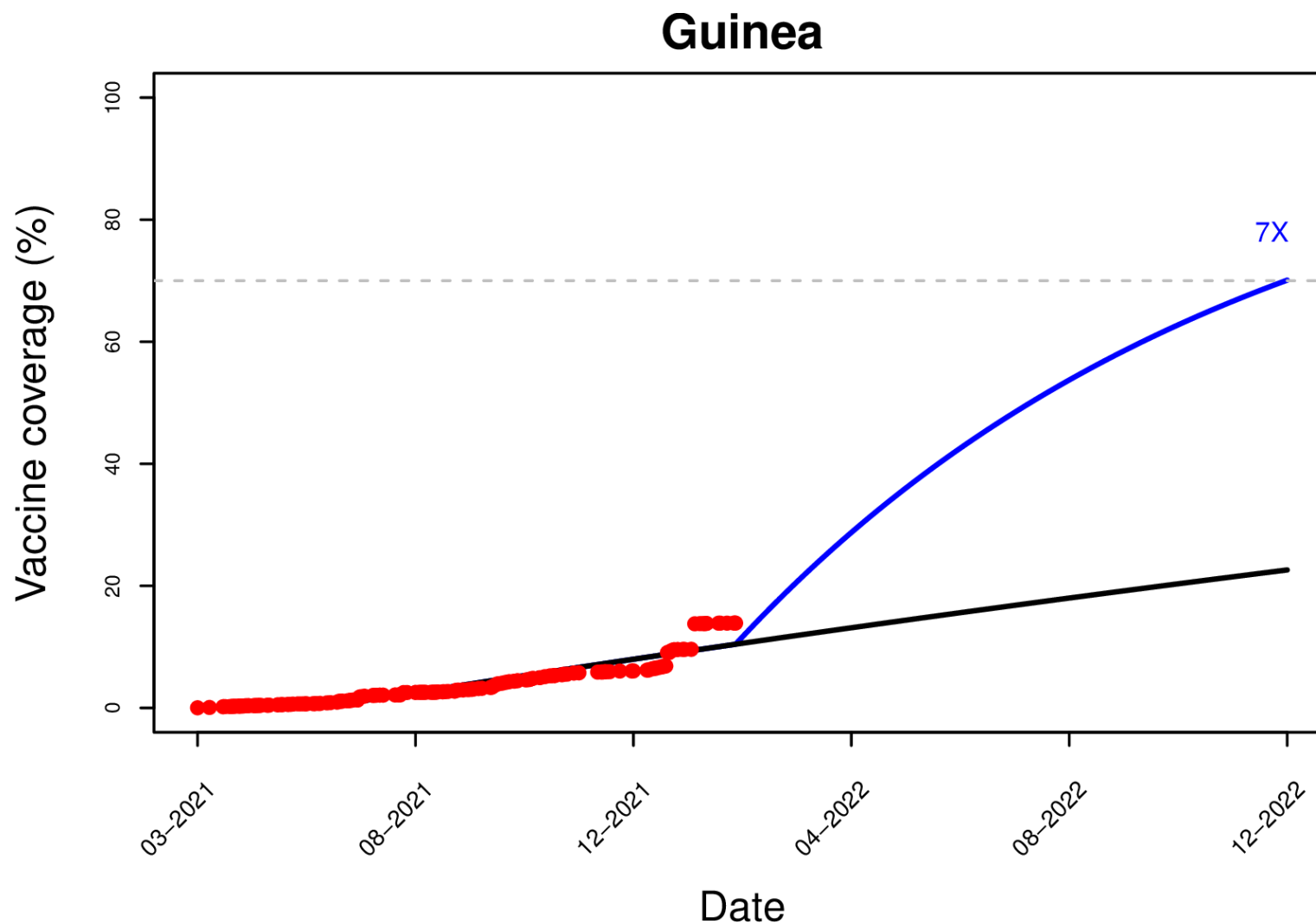
Supplementary Figure S18: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



Supplementary Figure S19: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

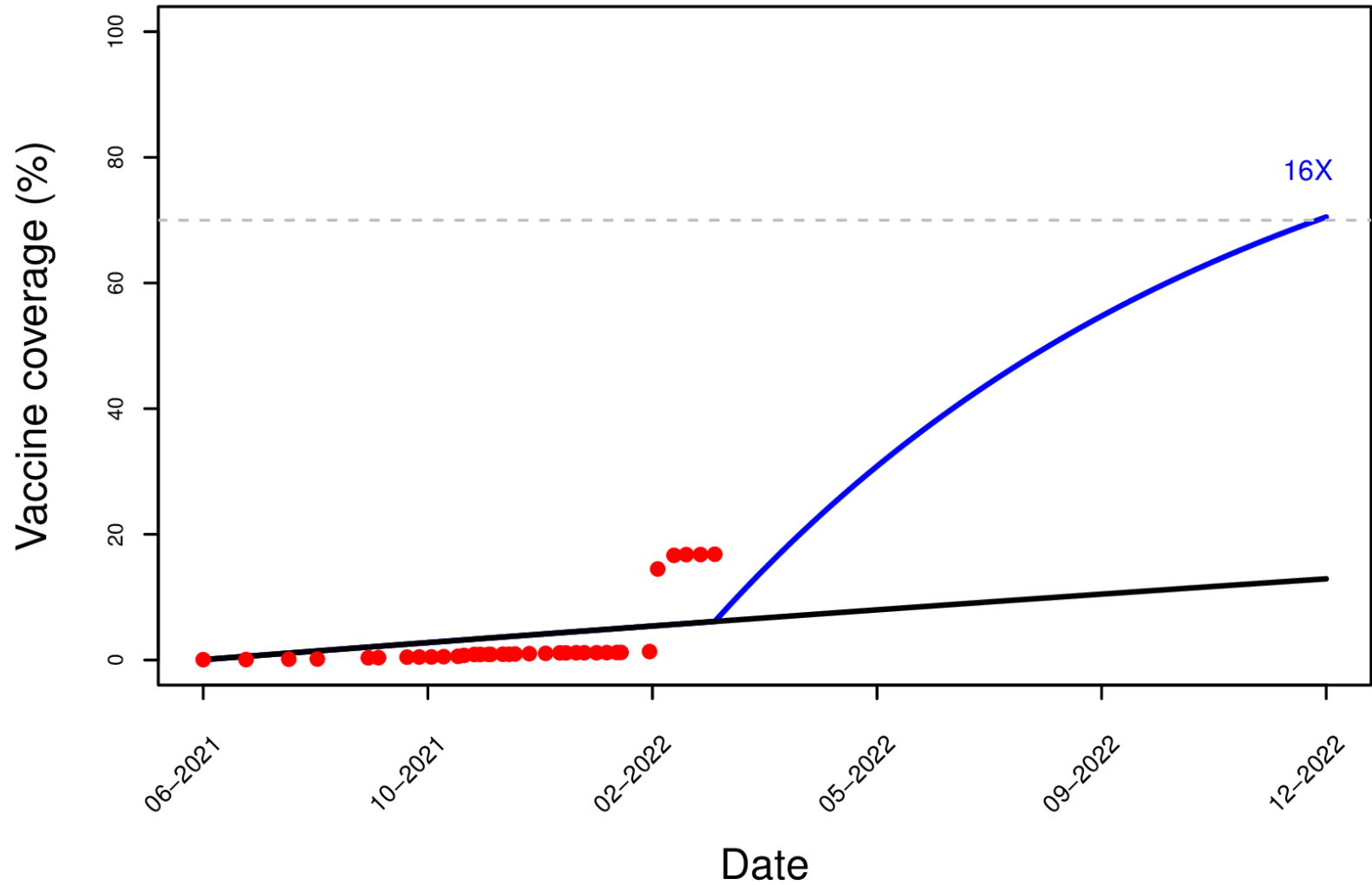


Supplementary Figure S20: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

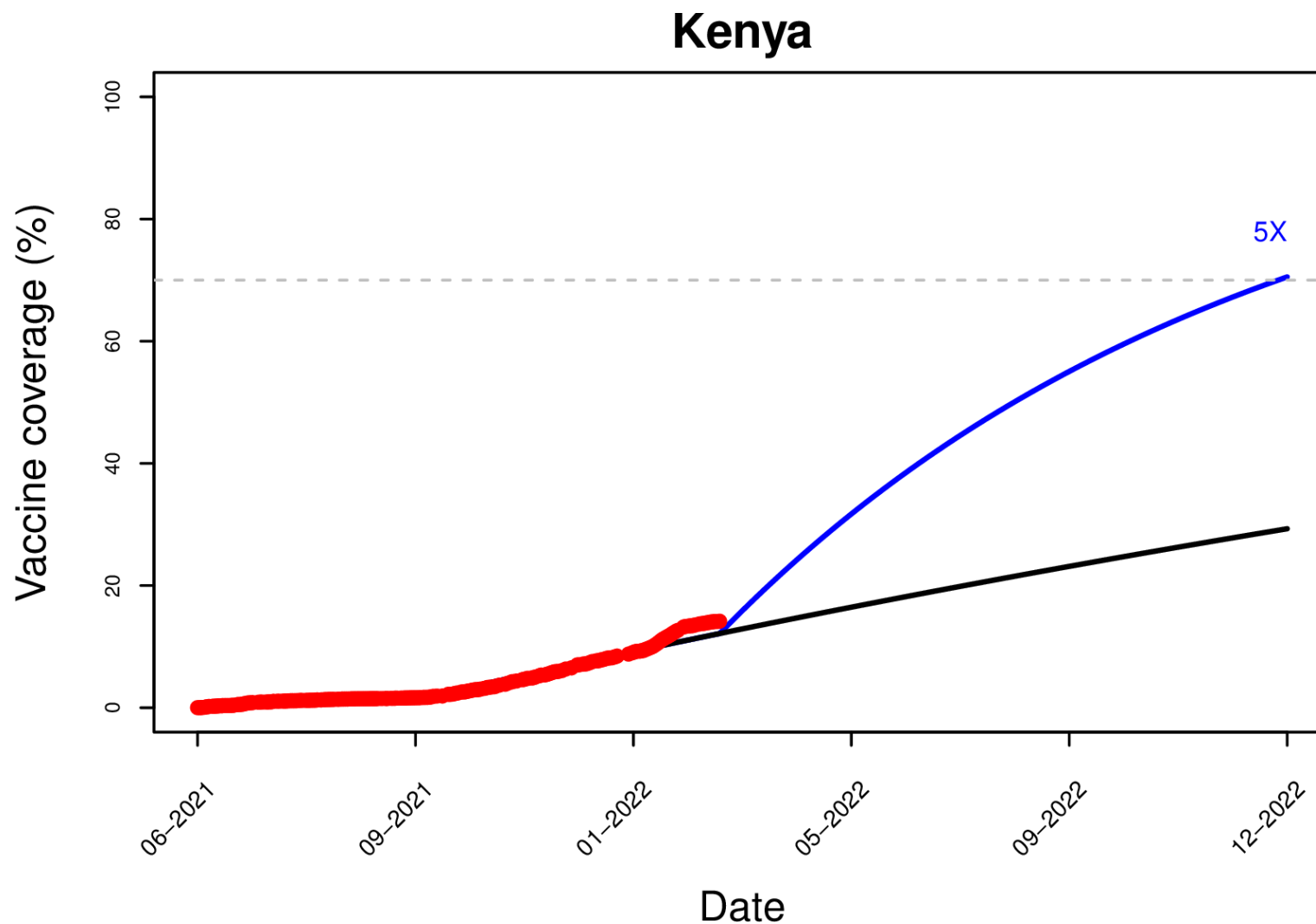


Supplementary Figure S21: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

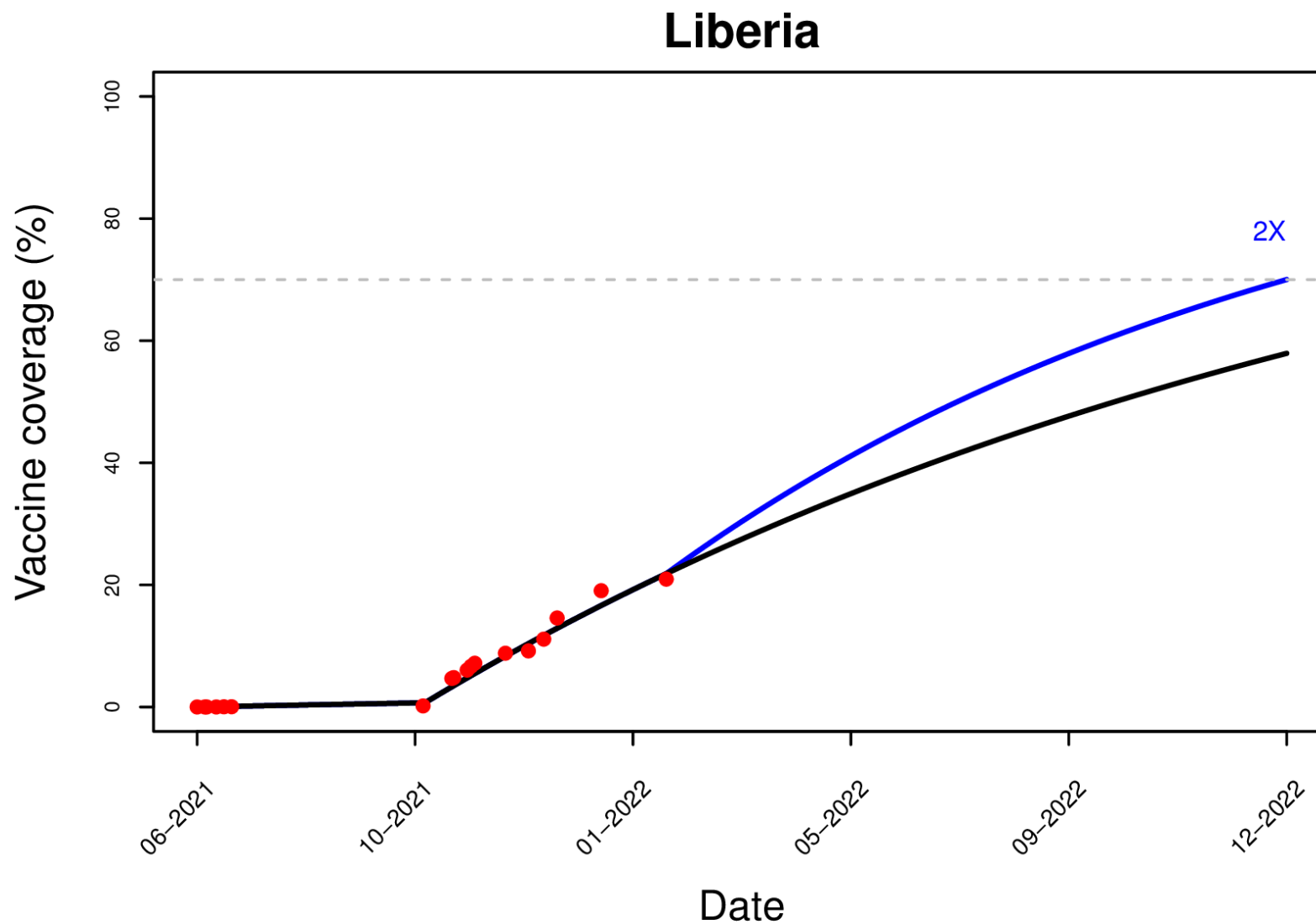
Guinea-Bissau



Supplementary Figure S22: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

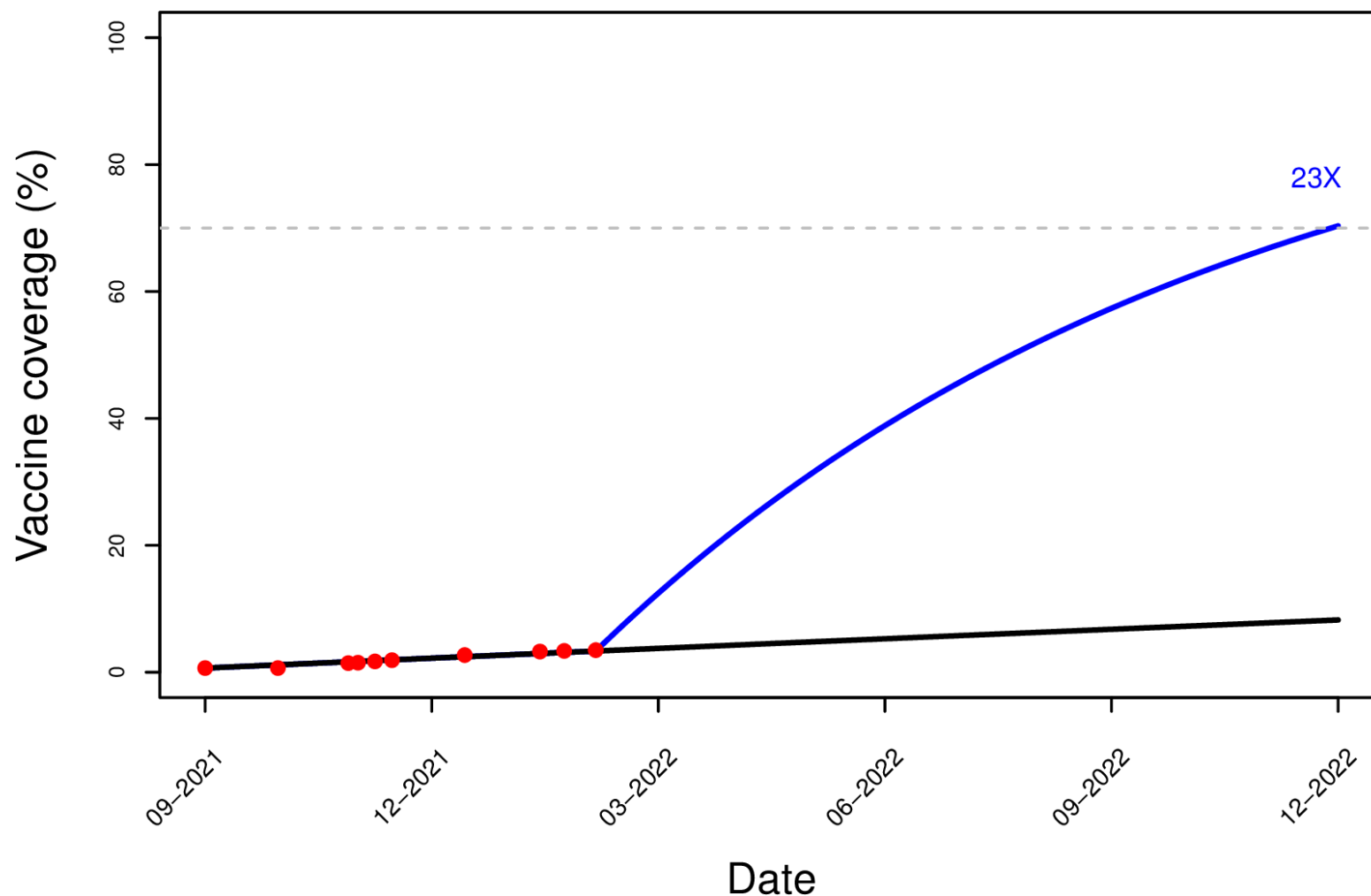


Supplementary Figure S23: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



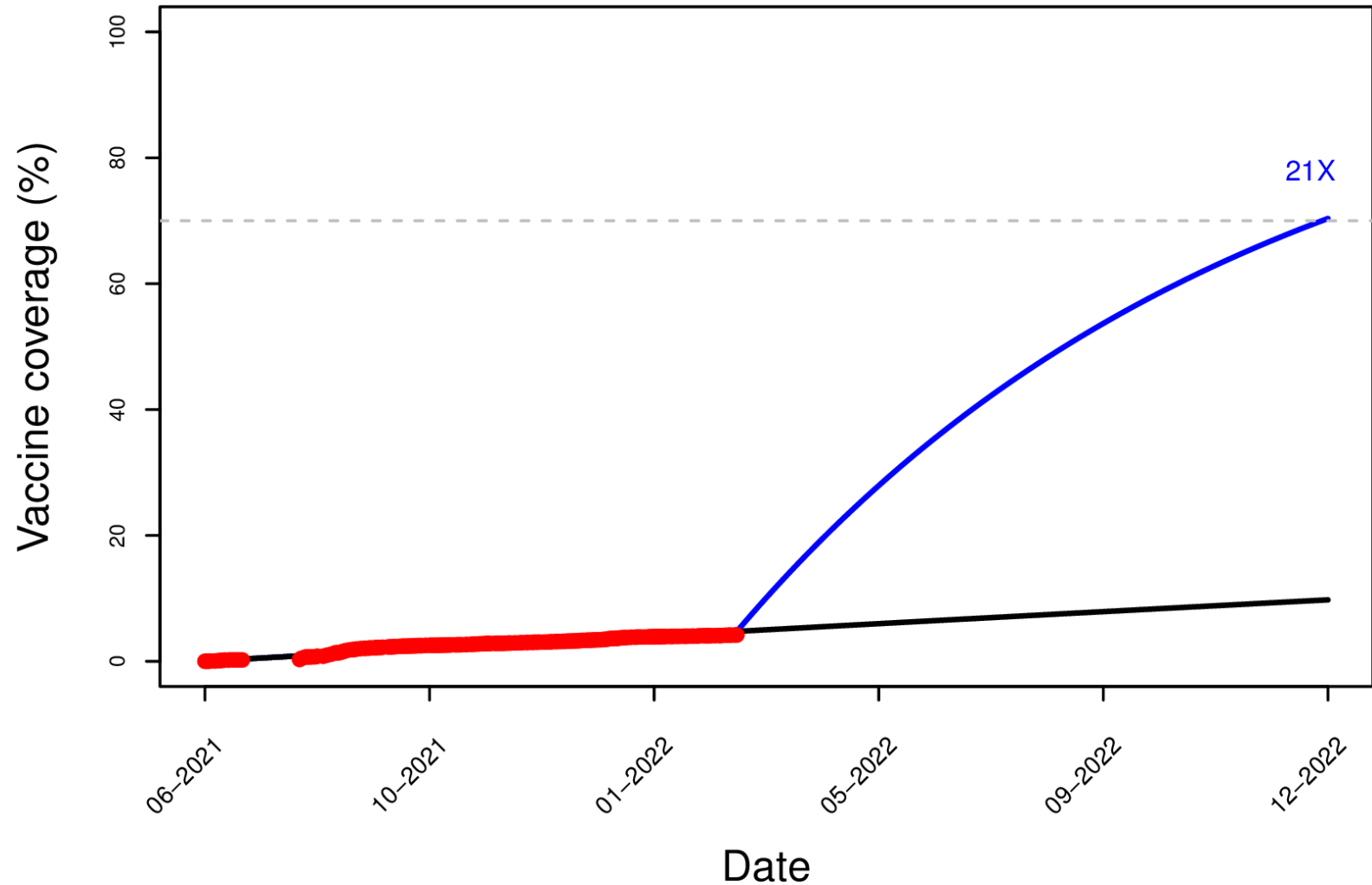
Supplementary Figure S24: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

Madagascar

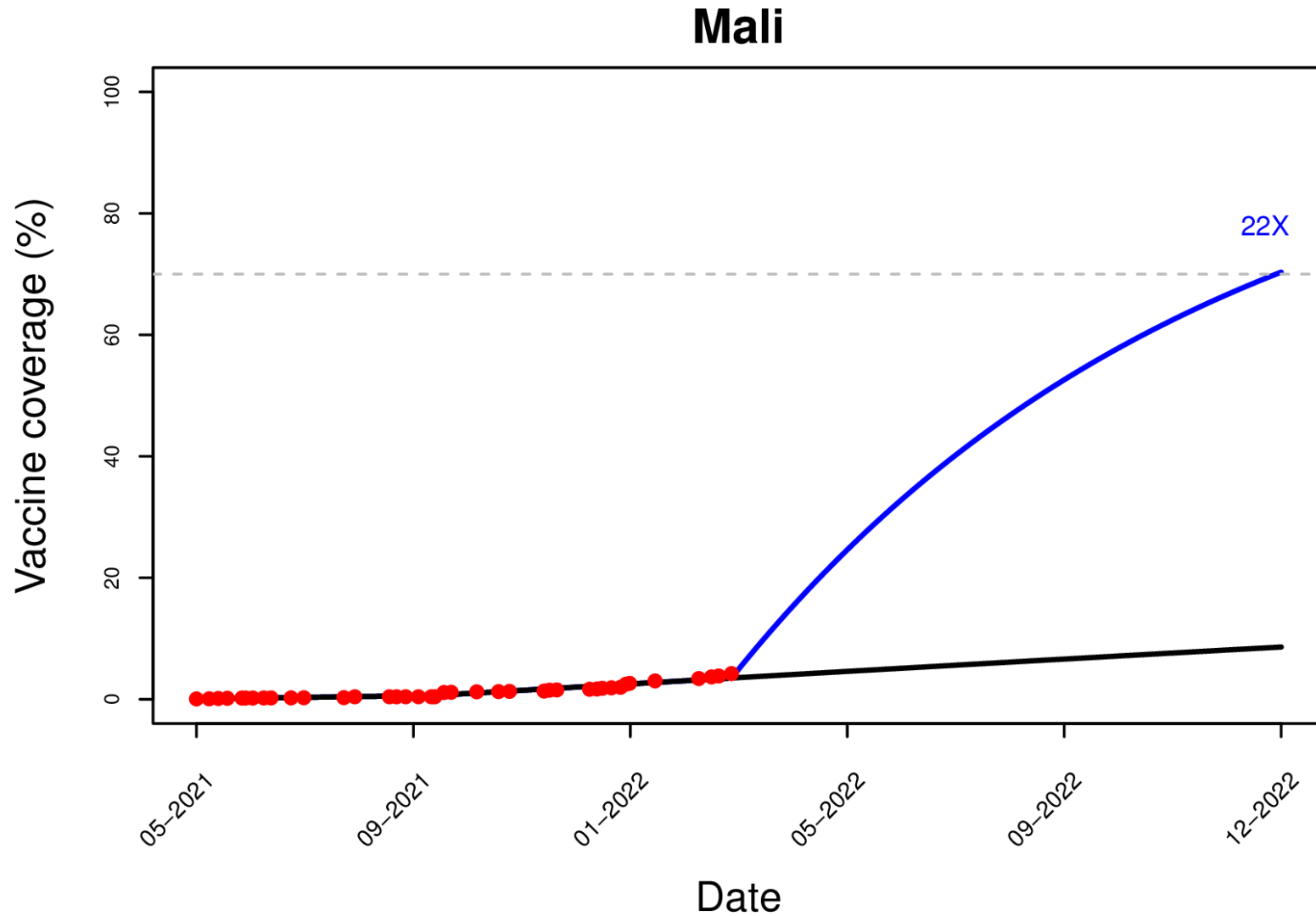


Supplementary Figure S25: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

Malawi

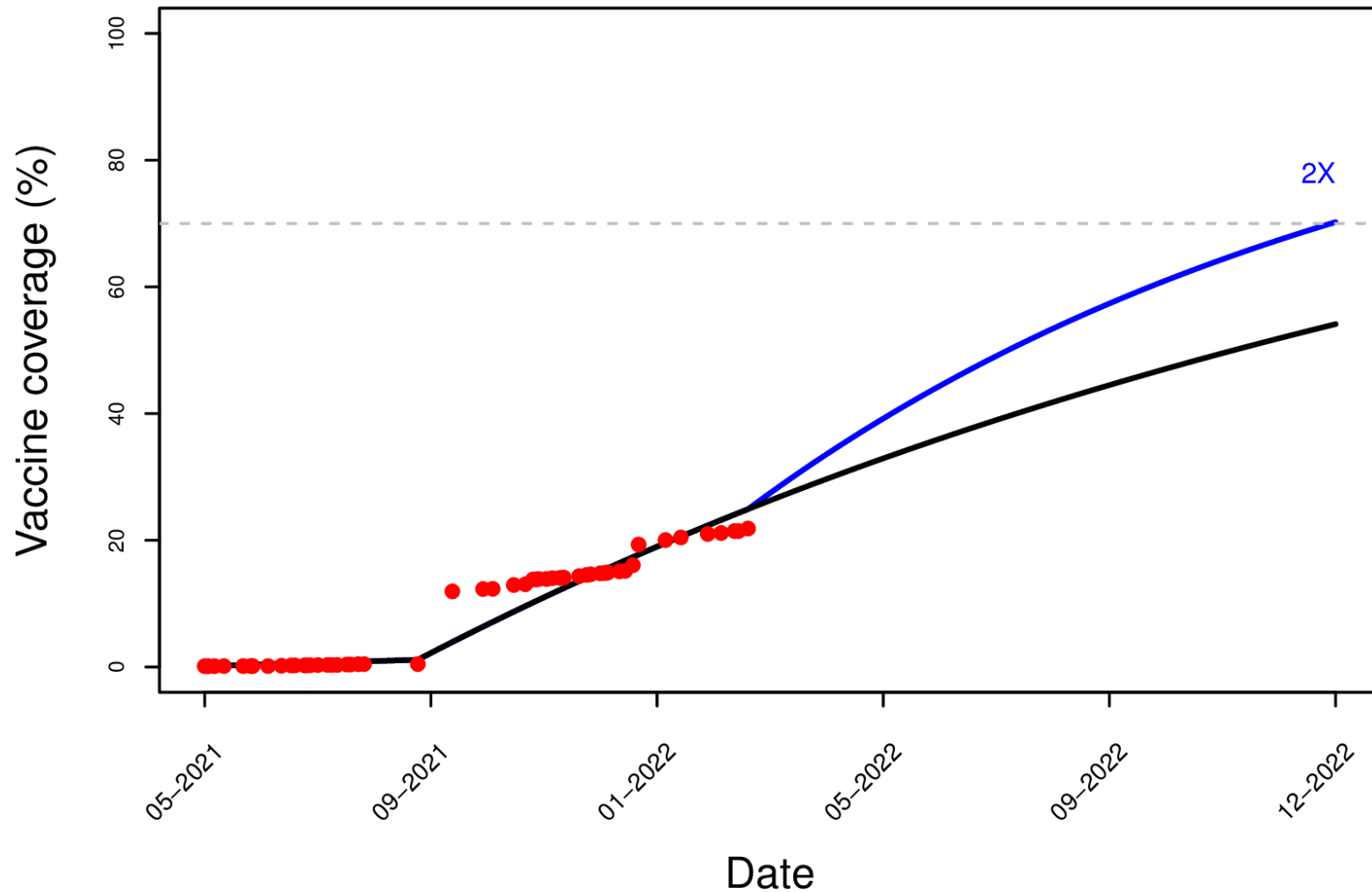


Supplementary Figure S26: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

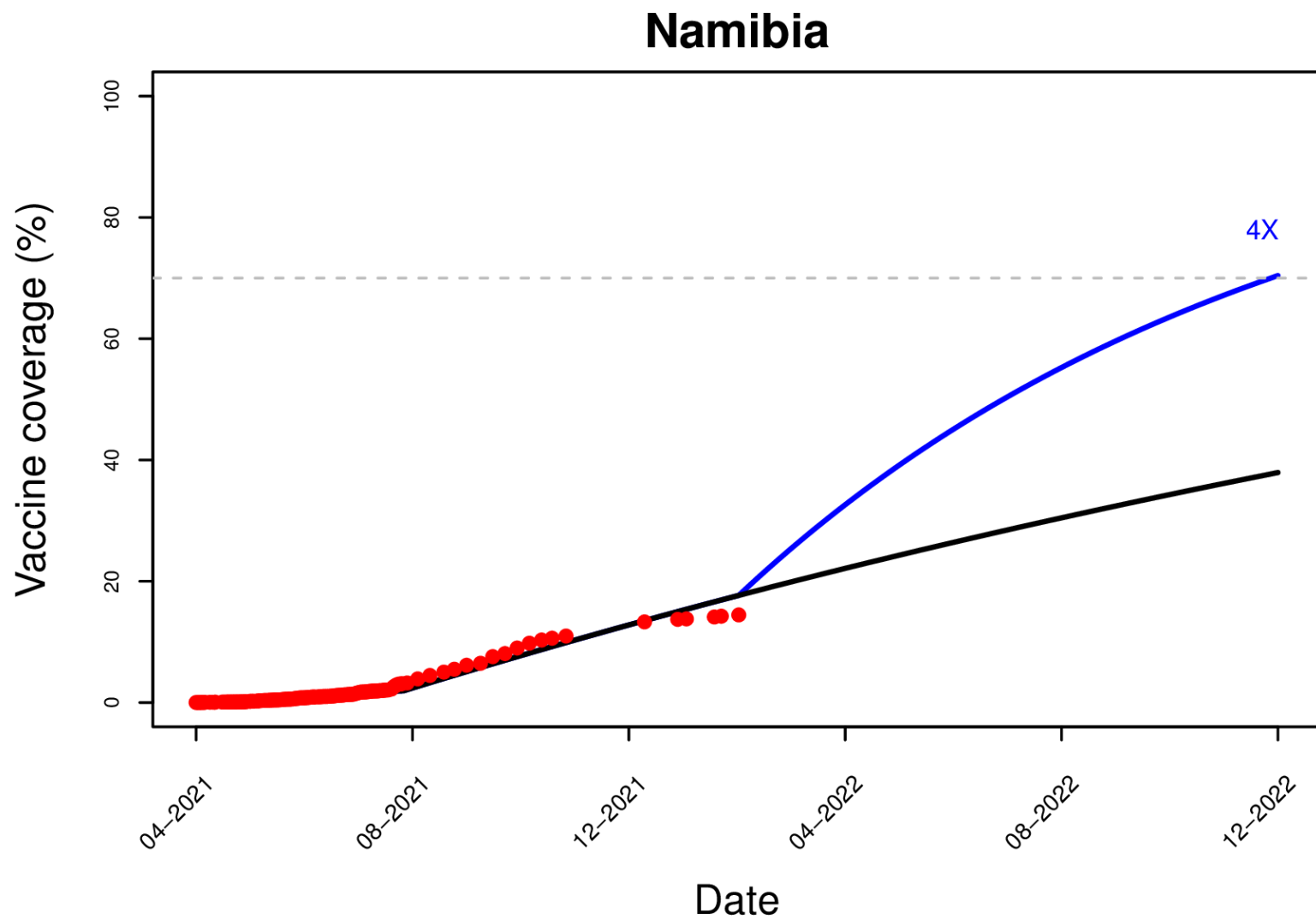


Supplementary Figure S27: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

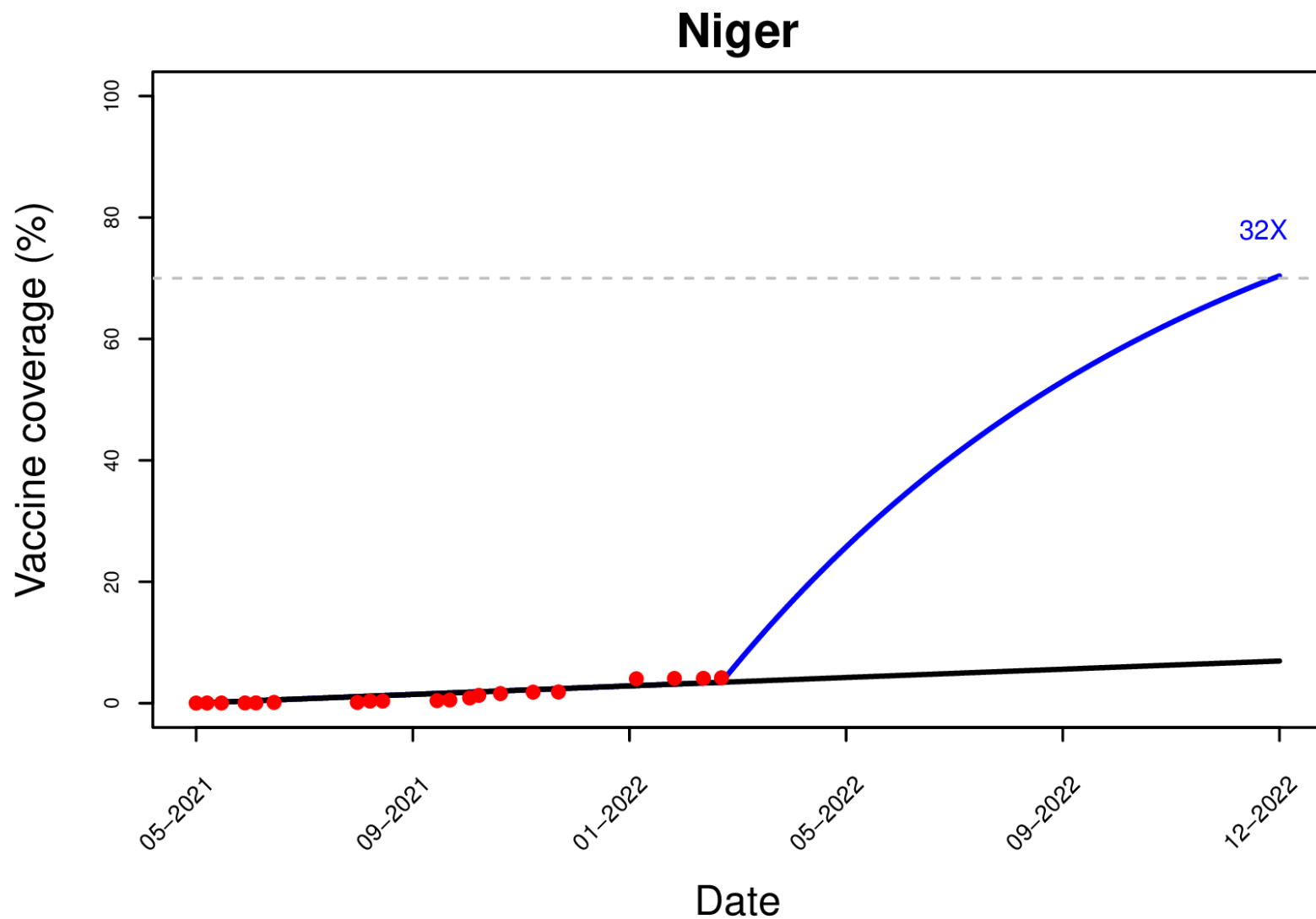
Mauritania



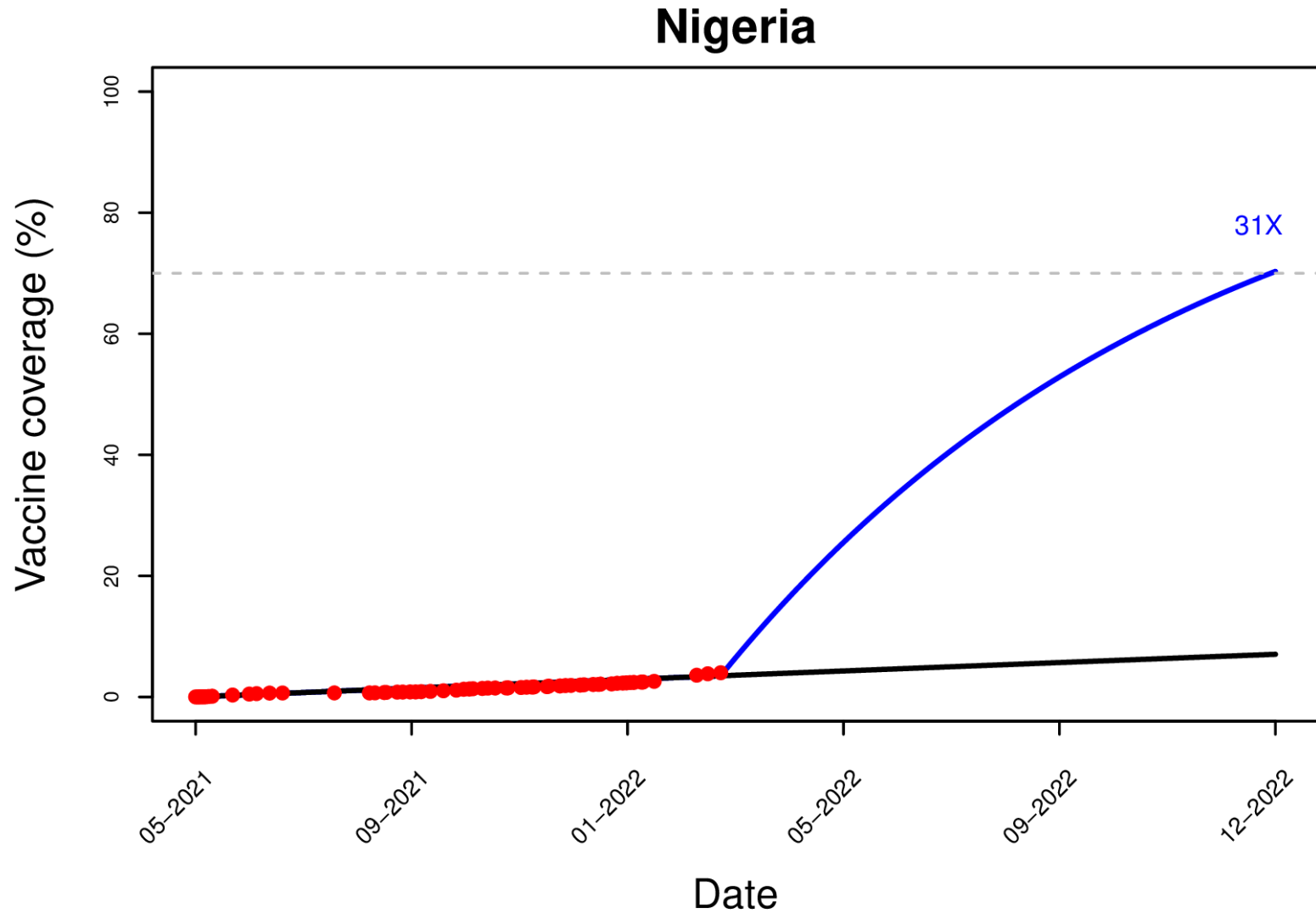
Supplementary Figure S28: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



Supplementary Figure S29: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

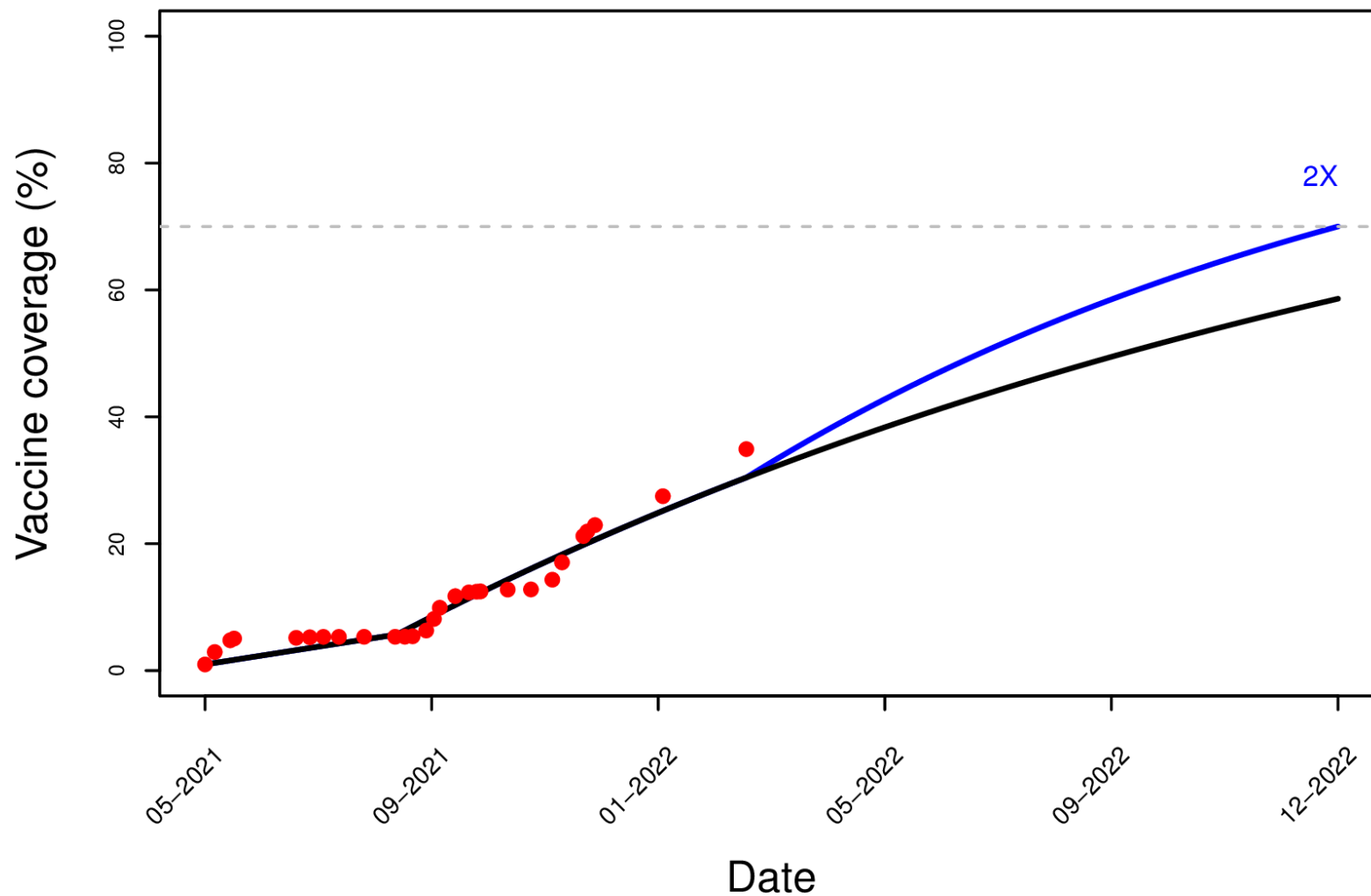


Supplementary Figure S30: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

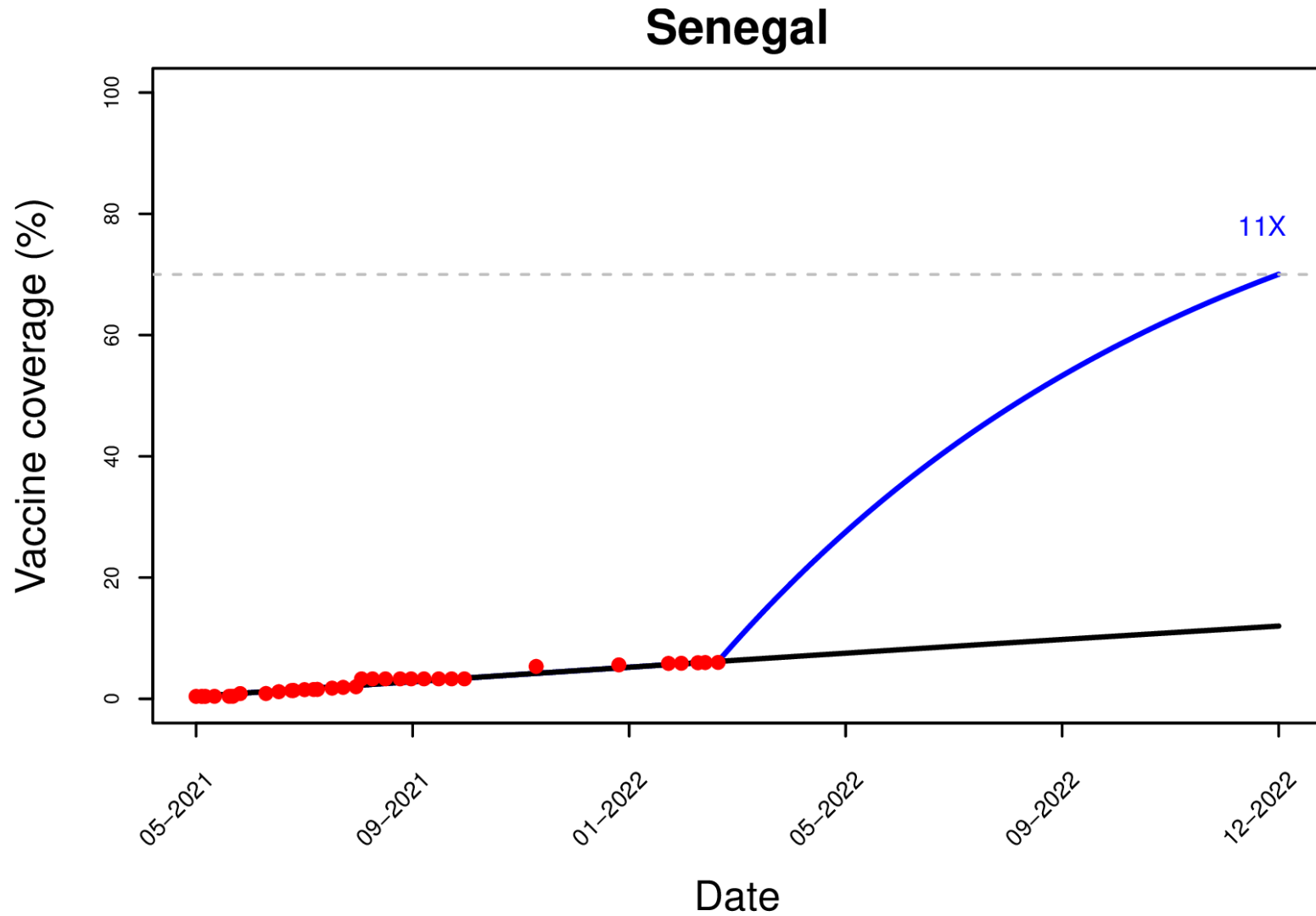


Supplementary Figure S31: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

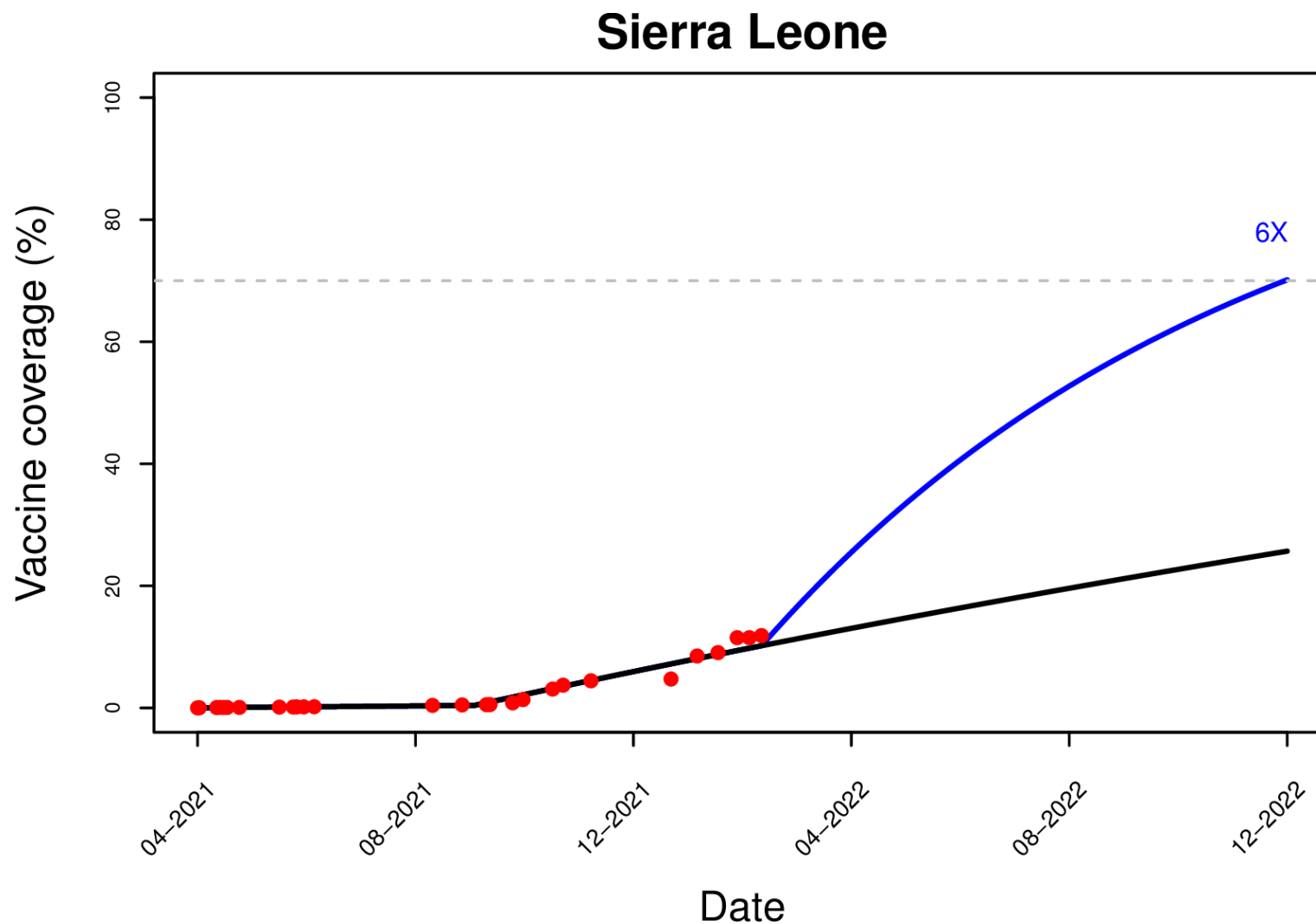
Sao Tome and Principe



Supplementary Figure S32: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

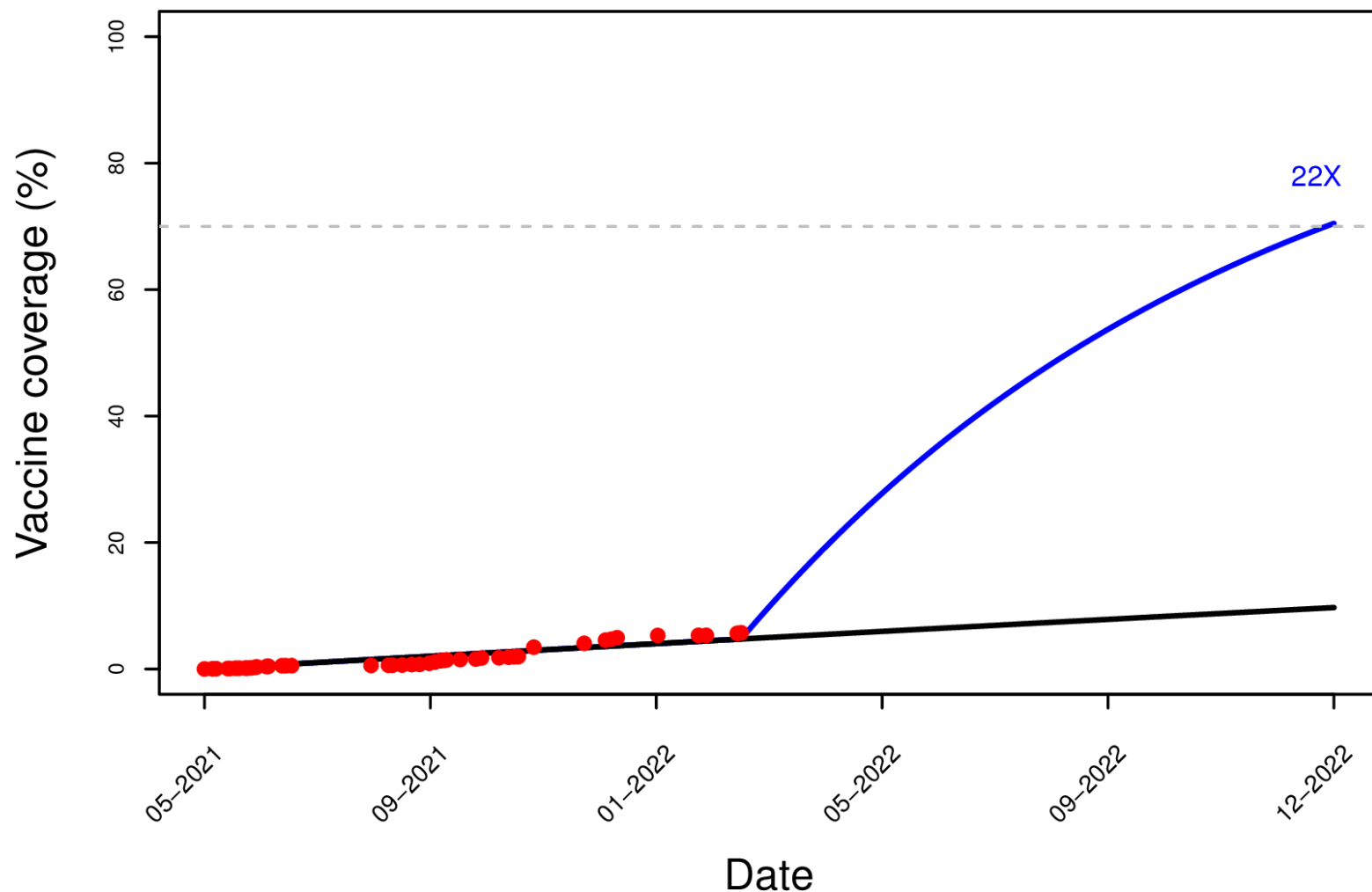


Supplementary Figure S33: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



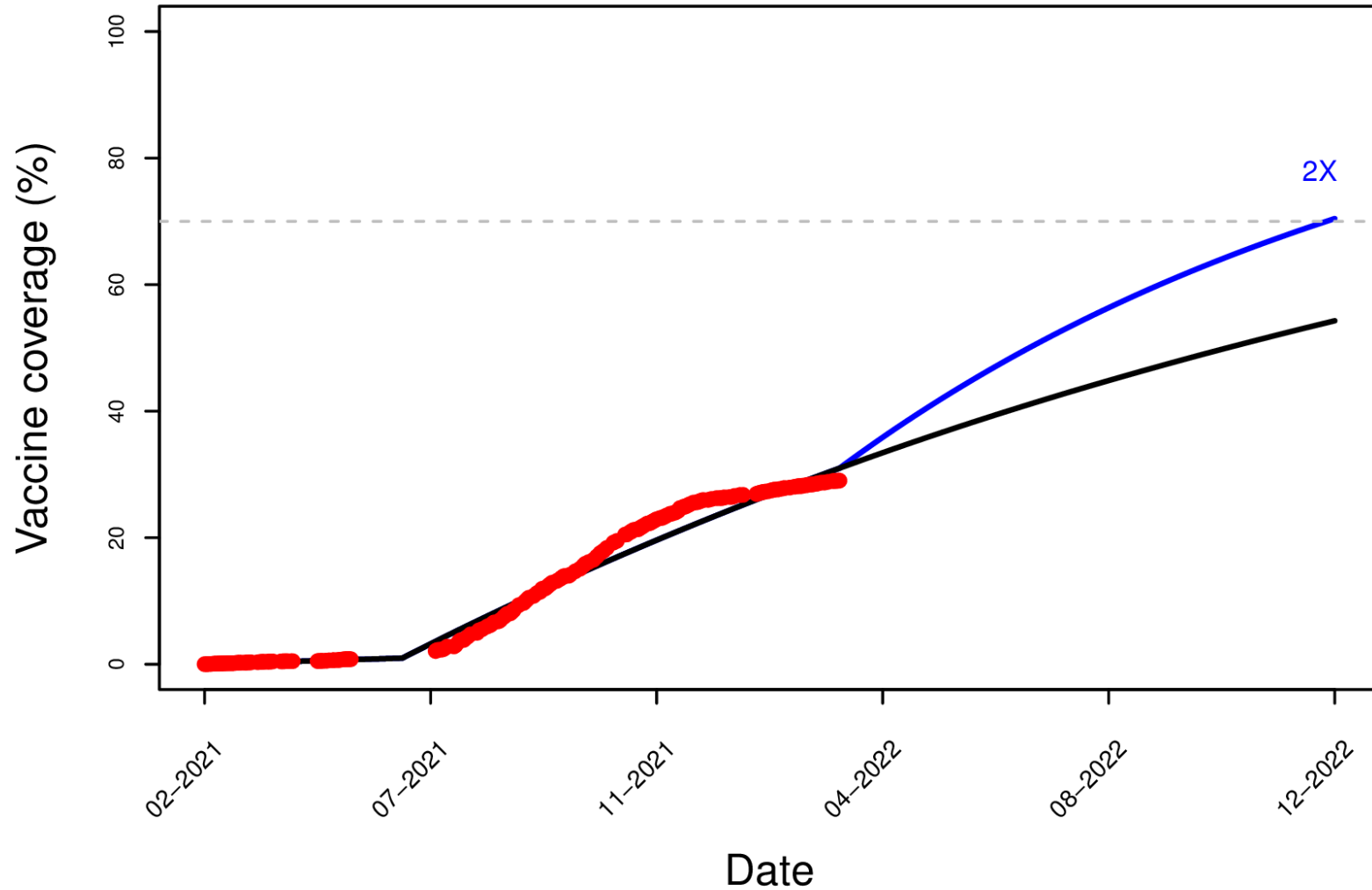
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Somalia



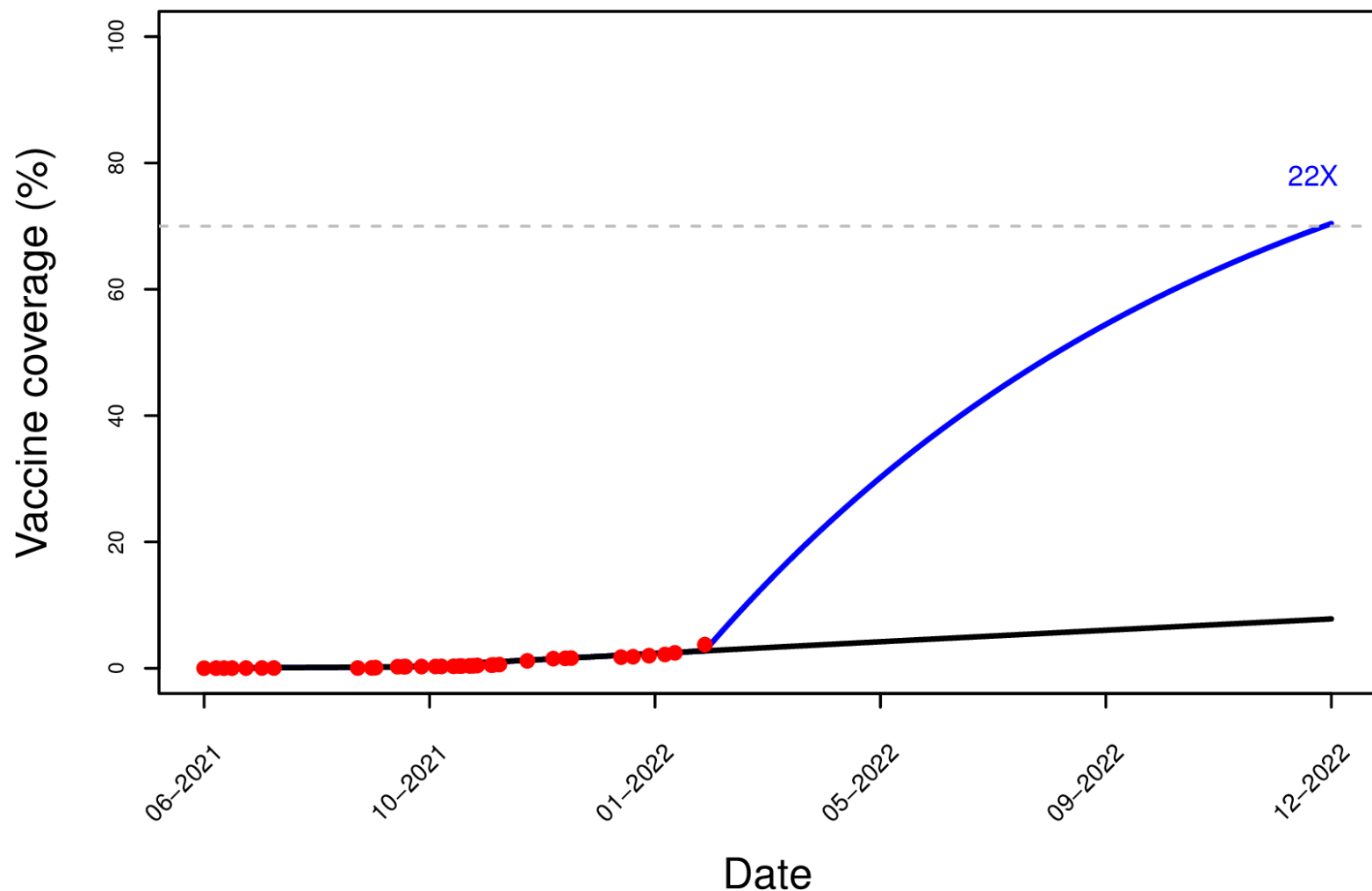
Supplementary Figure S35: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

South Africa

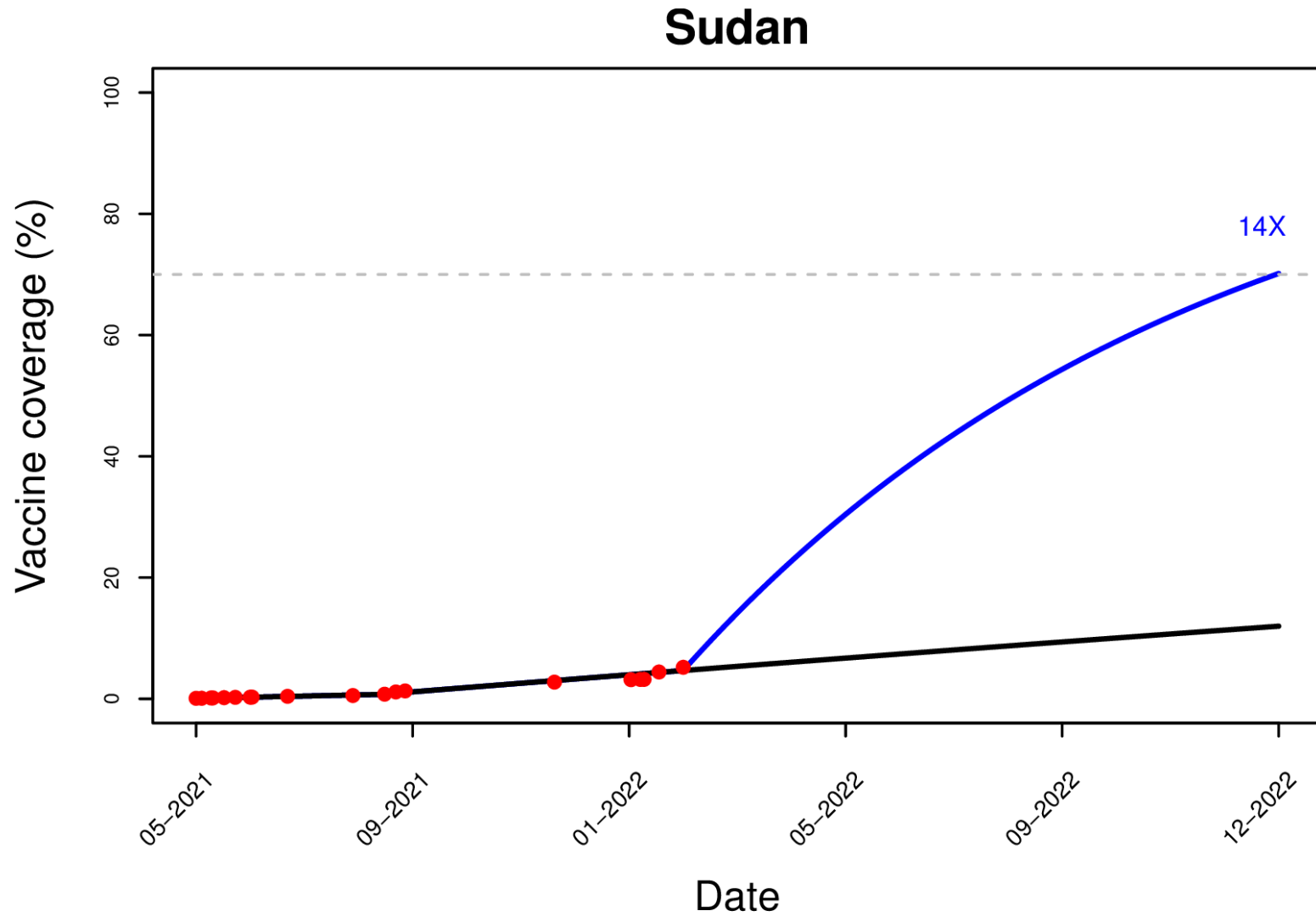


Supplementary Figure S36: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

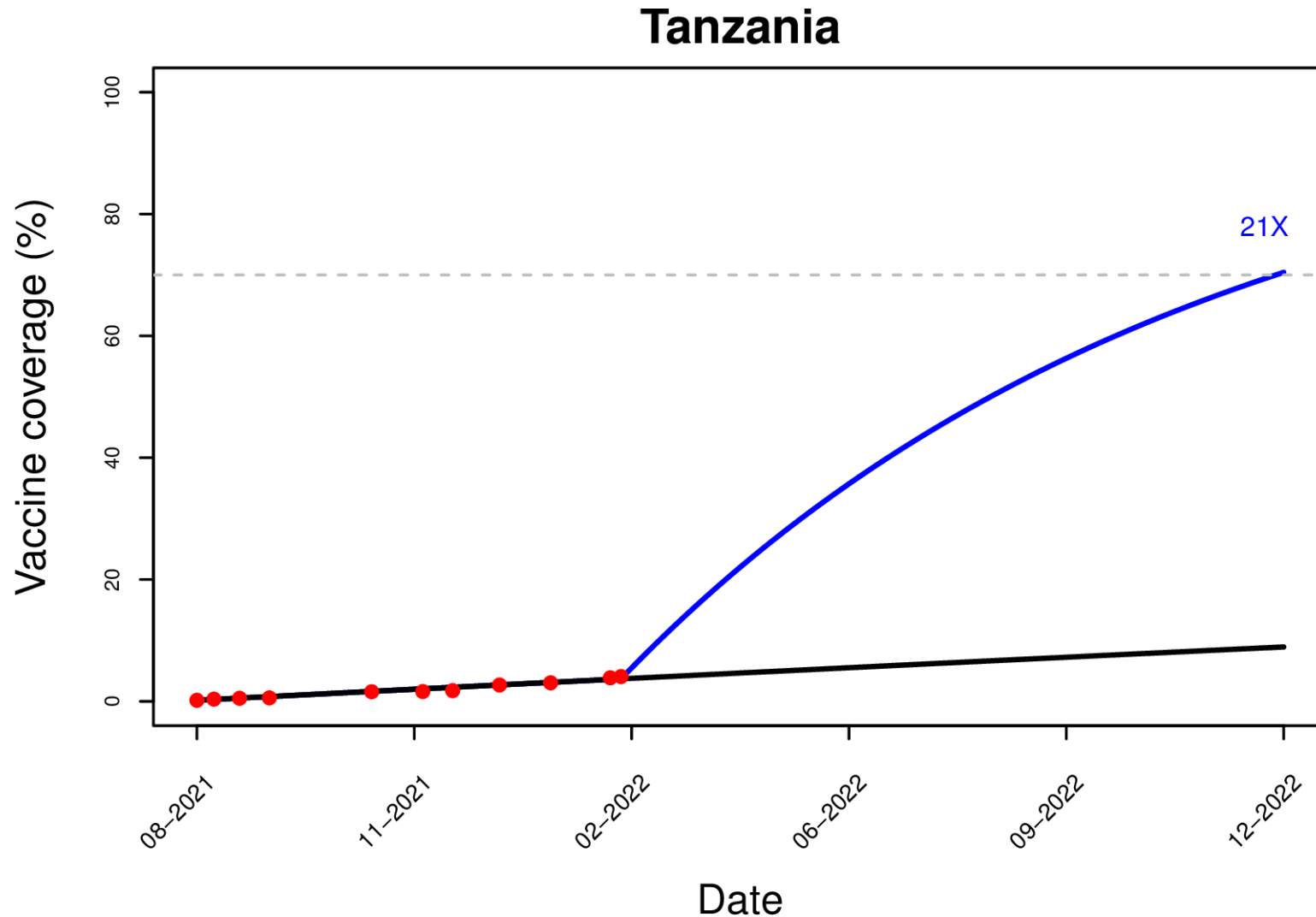
South Sudan



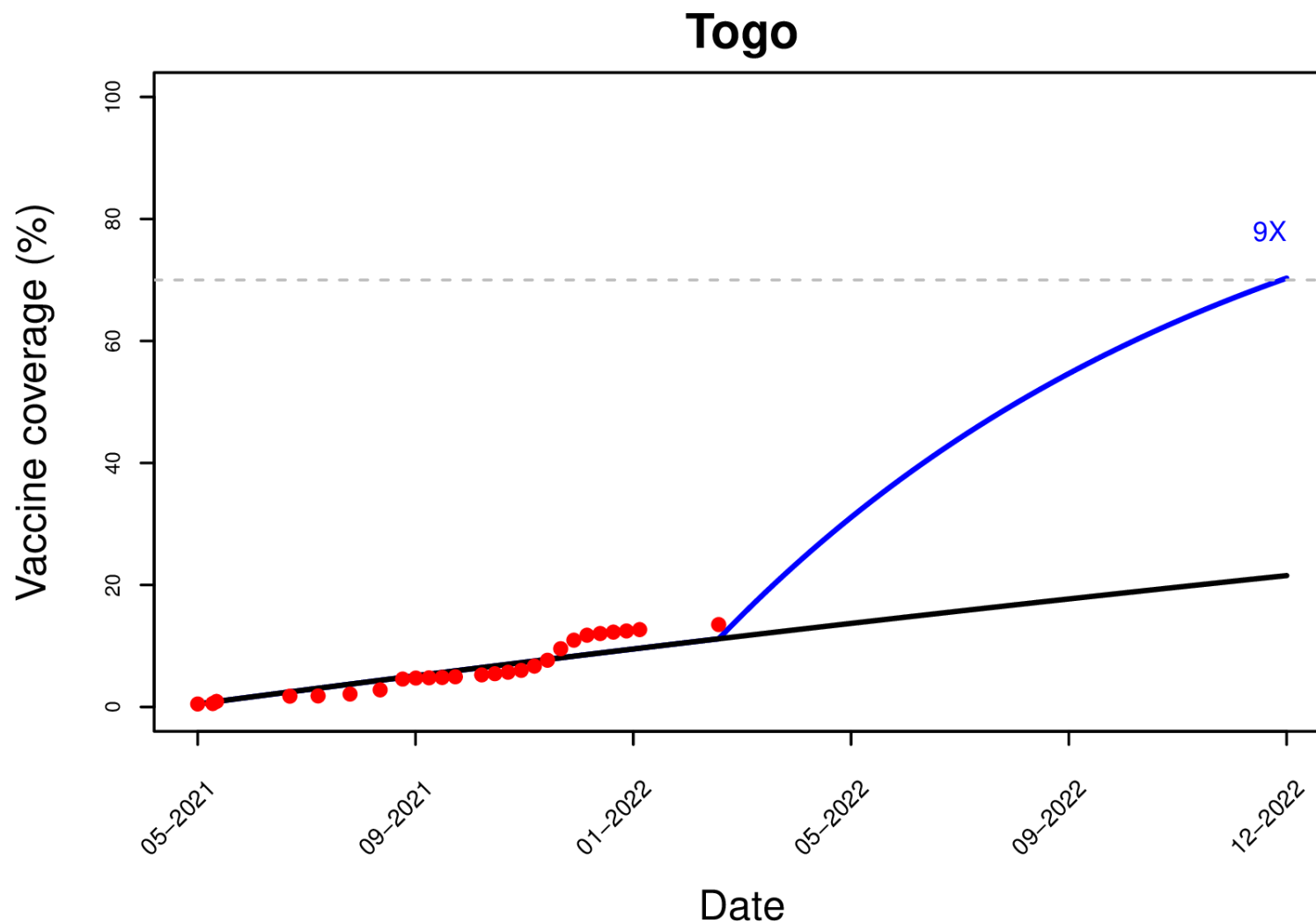
Supplementary Figure S37: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



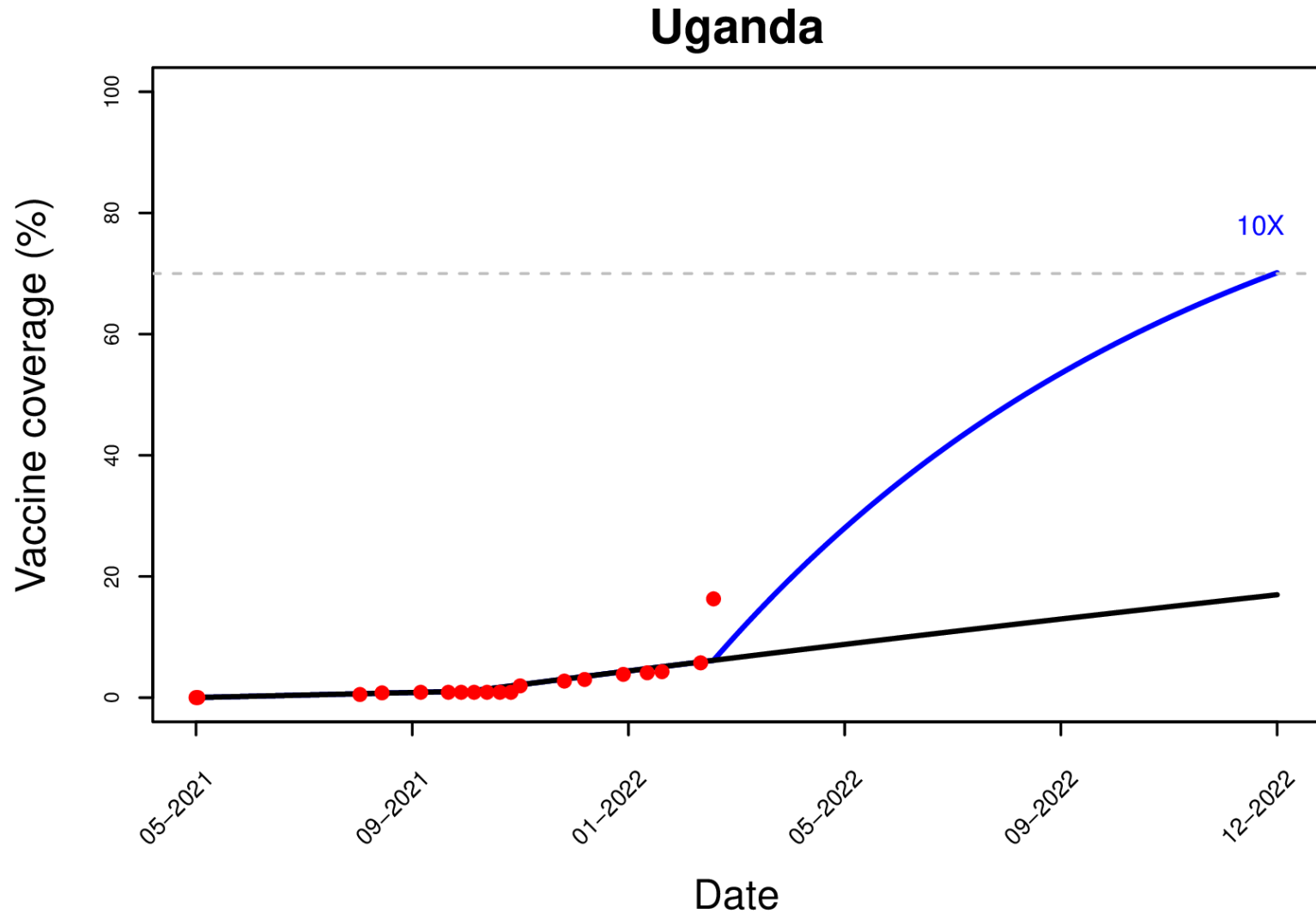
Supplementary Figure S38: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



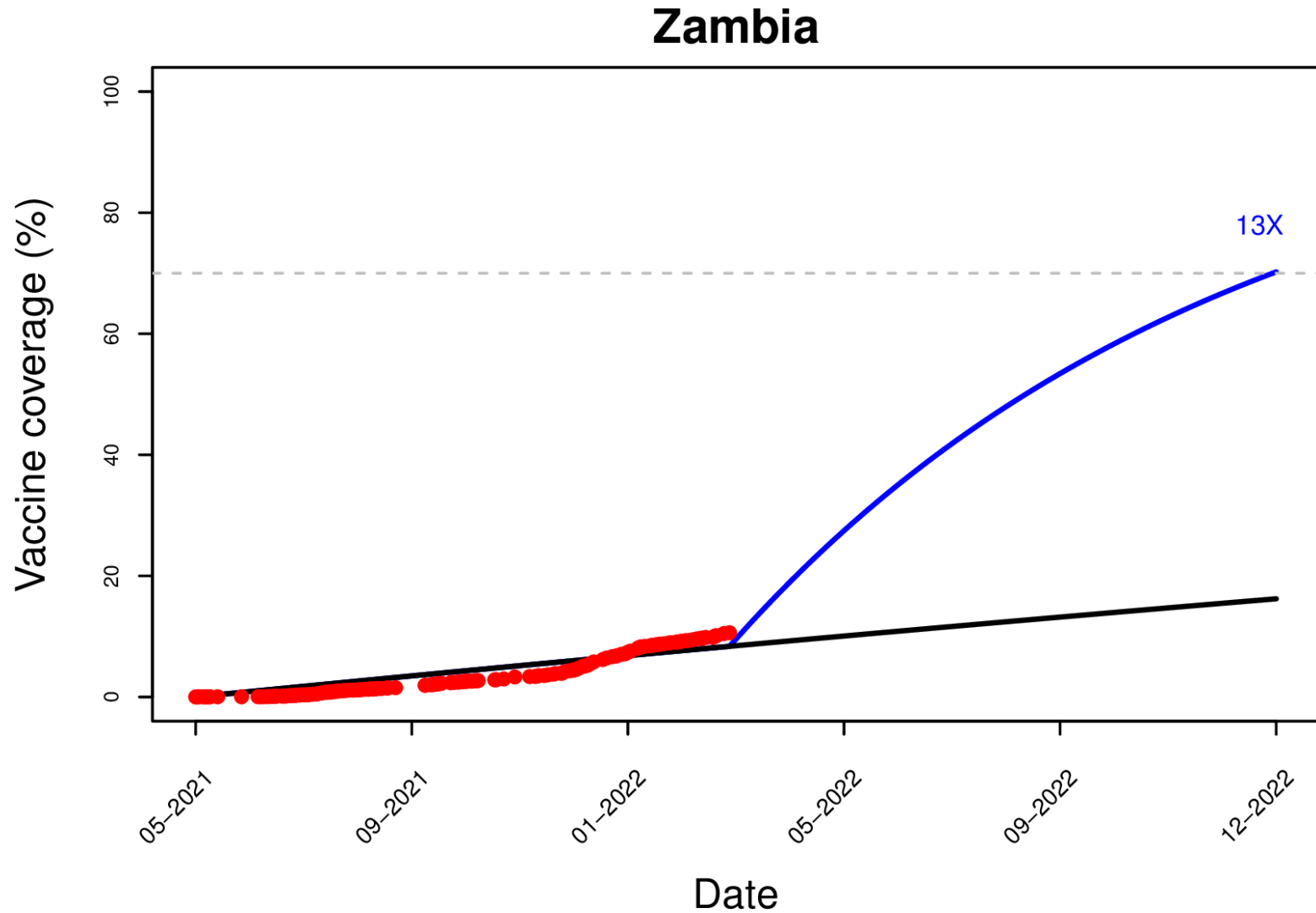
Supplementary Figure S39: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



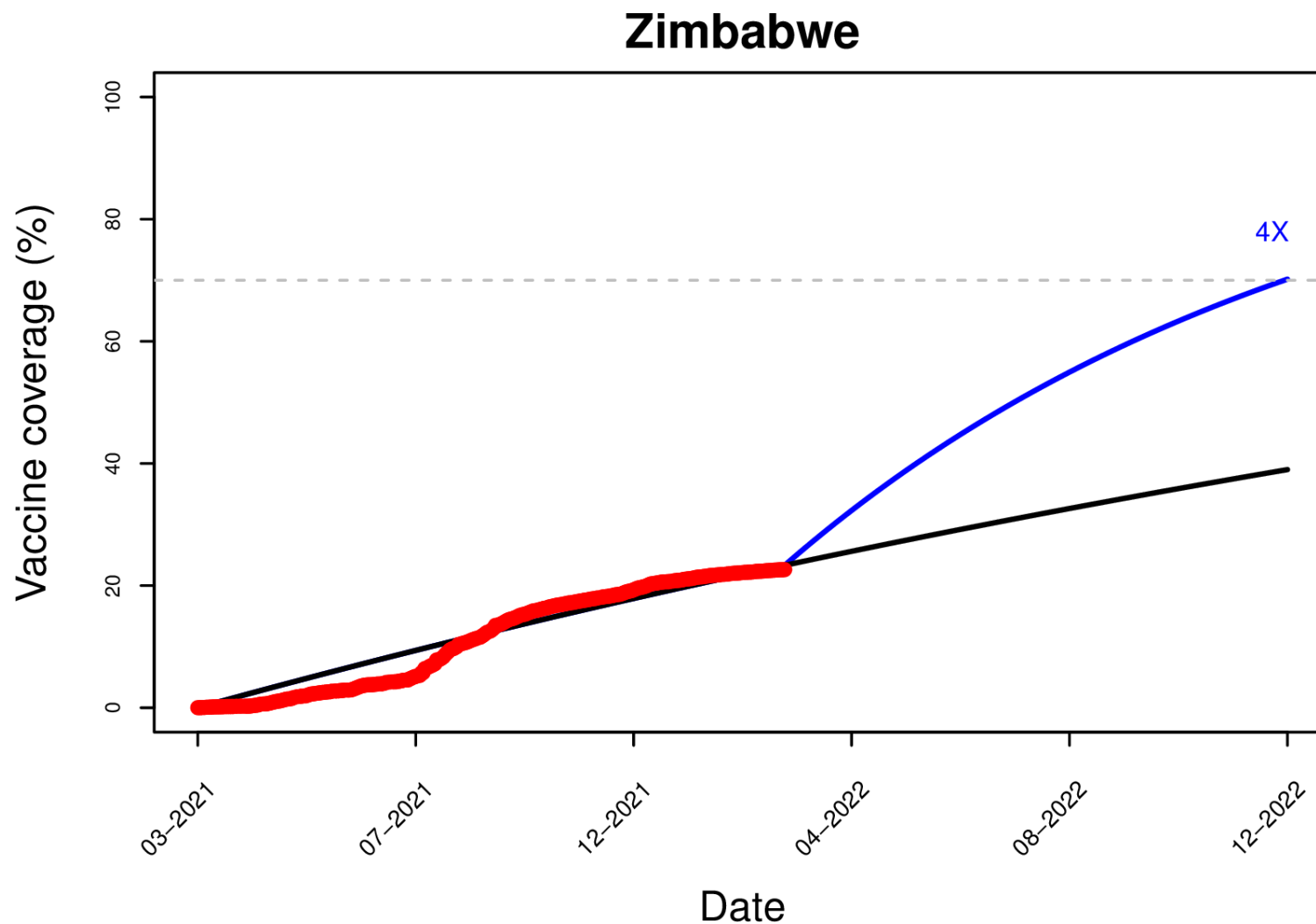
Supplementary Figure S40: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



Supplementary Figure S41: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



Supplementary Figure S42: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target



Supplementary Figure S43: Graphs showing model vaccination coverage trends from the model (black line) and vaccination coverage data (red dots). The blue lines show vaccine coverage trends when vaccination rates are increased (from current rates) to reach 70% by end of December 2022. Grey dashed lines indicate the 70% coverage target. The numbers show how much vaccination coverage rate should be increased by to reach that target

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