

Modell's

Haemoglobinopathologist's

Almanac

Epidemiological Estimates for Haemoglobin Disorders: WHO African Region by Country

Comprising the following charts and tables:

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- Chart 2: Annual births
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- Chart 9: Annual pregnancies where both parents carry a significant variant
- Chart 10: Annual conceptions with combinations of significant gene variants

Charts and tables compiled showing conservative estimates based on best available data presented on the World Wide Web in May 2007 by Professor Bernadette Modell (b.modell@pcps.ucl.ac.uk) and Matthew Darlison (m.darlison@ucl.ac.uk), UCL Centre for Health Informatics and Multiprofessional Education (CHIME) and World Health Organisation Collaborating Centre for the Community Control of Hereditary Disorders.

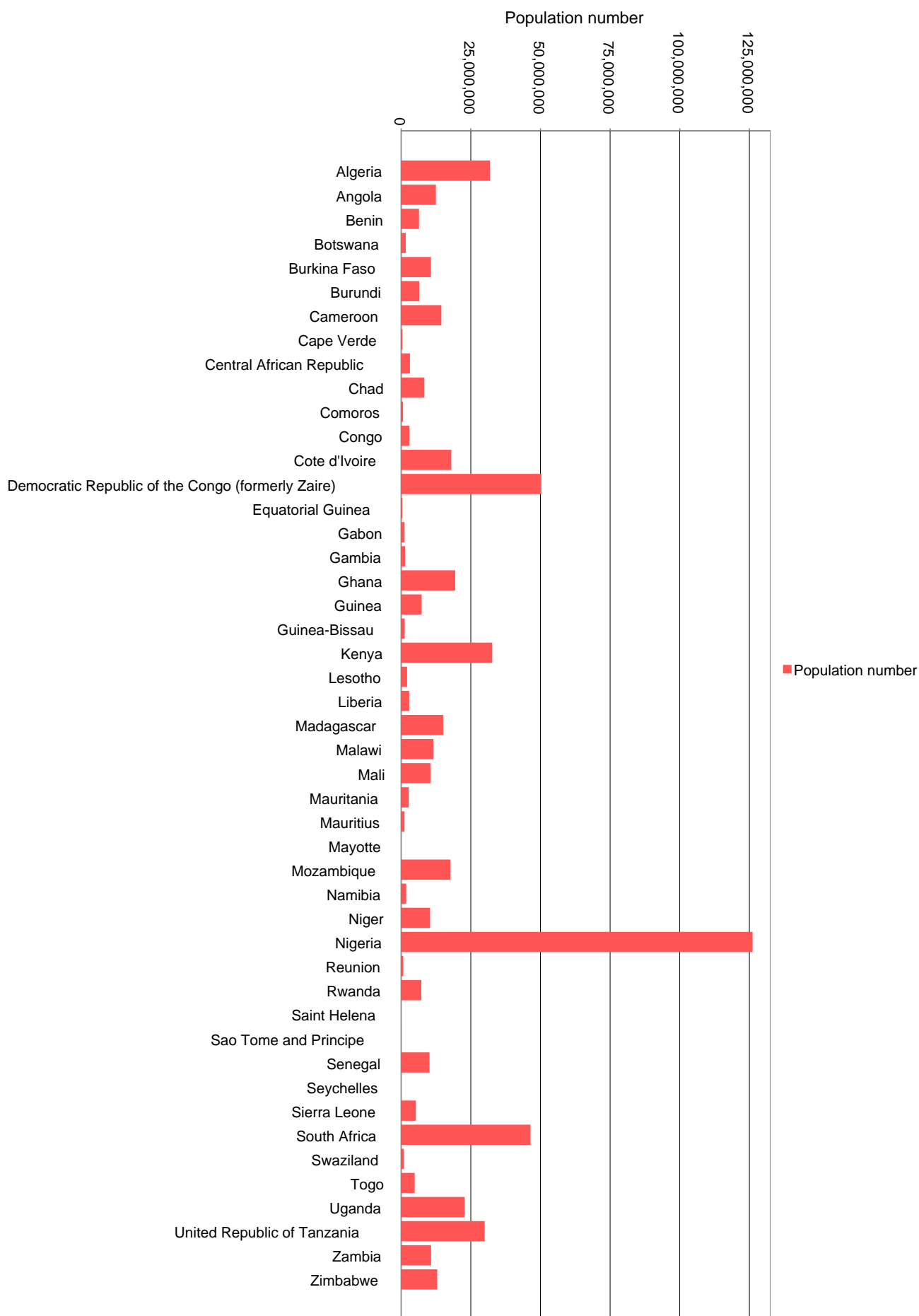
Definitions used

In terms of alpha globin genotypes, we define as pathological homozygous alpha zero thalassaemia (causes hydrops fetalis) and the combination of alpha zero and alpha plus thalassaemia (causes haemoglobin H disease). Homozygous alpha plus thalassaemia is not considered to cause pathology. In terms of beta globin genotypes, we define as pathological haemoglobin S/C, homozygous haemoglobin S (SS), haemoglobin S/beta thalassaemia, homozygous beta thalassaemia, haemoglobin E/beta thalassaemia and some rare combinations. We define as harmless homozygous haemoglobin C (CC), haemoglobin C/beta thalassaemia, homozygous haemoglobin E (EE), homozygous haemoglobin D (DD), haemoglobin D/beta thalassaemia, and some other rare combinations.

WHO Regions are constituted as follows:

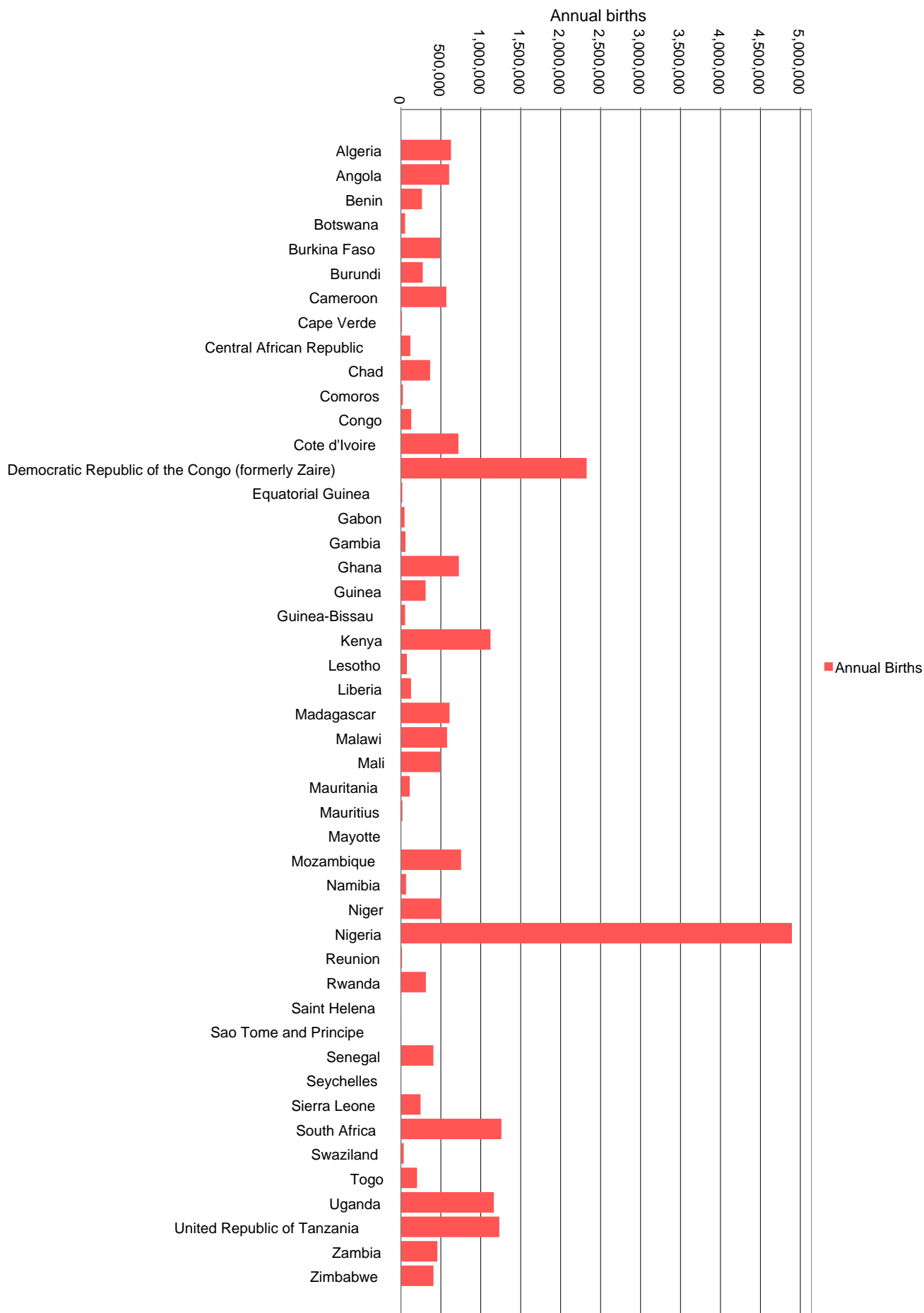
African Region (AFR)	American Region (AMR)	Eastern Mediterranean Region (EMR)	European Region (EUR)	South East Asian Region (SEAR)	Western Pacific Region (WPR)
<p>Northern Africa: Algeria</p> <p>Western Africa: Benin, Burkina Faso, Cote d'Ivoire, Cape Verde, Gambia, Guinea-Bissau, Ghana, Guinea, Liberia, Mali, Mauretania, Niger, Nigeria, Sierra Leone, Saint Helena, Senegal, Togo</p> <p>Middle Africa: Angola, Central African Republic, Cameroon, Chad, Congo, Democratic Republic of the Congo (formerly Zaire), Equatorial Guinea, Gabon, Sao Tome and Principe</p> <p>Eastern Africa: Burundi, Comoros, Kenya, Madagascar, Malawi, Mauritius, Mayotte, Mozambique, Reunion, Rwanda, Seychelles, United Republic of Tanzania, Uganda, Zambia, Zimbabwe</p> <p>Southern Africa: Botswana, Lesotho, Namibia, South Africa, Swaziland</p>	<p>Northern America: Bermuda, Canada, Greenland, Saint Pierre and Miquelon, United States</p> <p>Central America: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama</p> <p>Caribbean: Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, British Virgin Islands, Cayman Islands, Cuba, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Netherlands Antilles, Puerto Rico, Saint Kitt's and Nevis, Saint Vincent and the Grenadines, Saint Lucia, Trinidad and Tobago, Turks and Caicos Islands, US Virgin Islands</p> <p>South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Falkland Islands, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela</p>	<p>Northern Africa: Libyan Arab Jamahiriya, Morocco, Sudan, Tunisia, Western Sahara</p> <p>Eastern Africa: Djibouti, Egypt, Eritrea, Ethiopia, Somalia</p> <p>Western Asia: Bahrain, Cyprus, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen</p> <p>South Central Asia: Afghanistan, Iran, Islamic Republic of, Pakistan, Occupied Palestinian territory</p>	<p>Northern Europe: Channel Islands, Denmark, Estonia, Faroe Islands, Finland, Isle of Man, Iceland, Ireland, Latvia, Lithuania, Norway, Sweden, United Kingdom</p> <p>Western Europe: Austria, Belgium, France, Germany, Liechtenstein, Luxembourg, Monaco, Netherlands, Switzerland</p> <p>Southern Europe: Albania, Andorra, Bosnia and Herzegovina, Croatia, Gibraltar, Greece, Italy, The former Yugoslav Republic of Macedonia, Malta, Portugal, San Marino, Slovenia, Spain, Yugoslavia</p> <p>Eastern Europe: Belarus, Bulgaria, Czech Republic, Hungary, Republic of Moldova, Poland, Romania, Russian Federation, Slovakia, Ukraine</p> <p>South Central Asia: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan</p> <p>Western Asia: Armenia, Azerbaijan, Georgia, Israel, Turkey</p>	<p>South Central Asia: Bangladesh, Bhutan, India, Maldives, Nepal, Sri Lanka</p> <p>South Eastern Asia: East Timor, Indonesia, Myanmar, Thailand</p>	<p>Eastern Asia: China, China - Hong Kong, Japan, Korea, Democratic Peoples' Republic of Korea, Republic of, China - Macau, Mongolia, Taiwan, Province of China</p> <p>South Eastern Asia: Brunei Darussalam, Cambodia, Heard Island and McDonald Islands, Lao Peoples' Democratic Republic, Malaysia, Philippines, Singapore, Vietnam</p> <p>Melanesia, Micronesia, Polynesia: American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia, Federated States of New Caledonia, Northern Mariana Islands, Nauru, Niue, Palau, Pitcairn, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna Islands</p> <p>Australia and New Zealand: Australia, New Zealand</p>

Chart 1: Population



<i>Country</i>	<i>Population number</i>
Algeria	31,848,000
Angola	12,479,000
Benin	6,417,000
Botswana	1,653,000
Burkina Faso	10,683,000
Burundi	6,483,000
Cameroon	14,439,000
Cape Verde	461,000
Central African Republic	3,151,000
Chad	8,322,000
Comoros	676,000
Congo	2,974,000
Cote d'Ivoire	18,001,000
Democratic Republic of the Congo (formerly Zaire)	50,335,000
Equatorial Guinea	442,000
Gabon	1,237,000
Gambia	1,420,000
Ghana	19,412,000
Guinea	7,360,000
Guinea-Bissau	1,267,000
Kenya	32,692,000
Lesotho	2,144,000
Liberia	2,879,000
Madagascar	15,085,000
Malawi	11,549,000
Mali	10,525,000
Mauritania	2,724,000
Mauritius	1,223,000
Mayotte	85,800
Mozambique	17,656,000
Namibia	1,817,000
Niger	10,400,000
Nigeria	126,153,000
Reunion	764,000
Rwanda	7,235,000
Saint Helena	5,000
Sao Tome and Principe	140,000
Senegal	10,165,000
Seychelles	83,000
Sierra Leone	5,280,000
South Africa	46,430,000
Swaziland	938,000
Togo	4,854,000
Uganda	22,788,000
United Republic of Tanzania	29,984,000
Zambia	10,744,000
Zimbabwe	12,960,000
WHO African Region population total	586,362,800

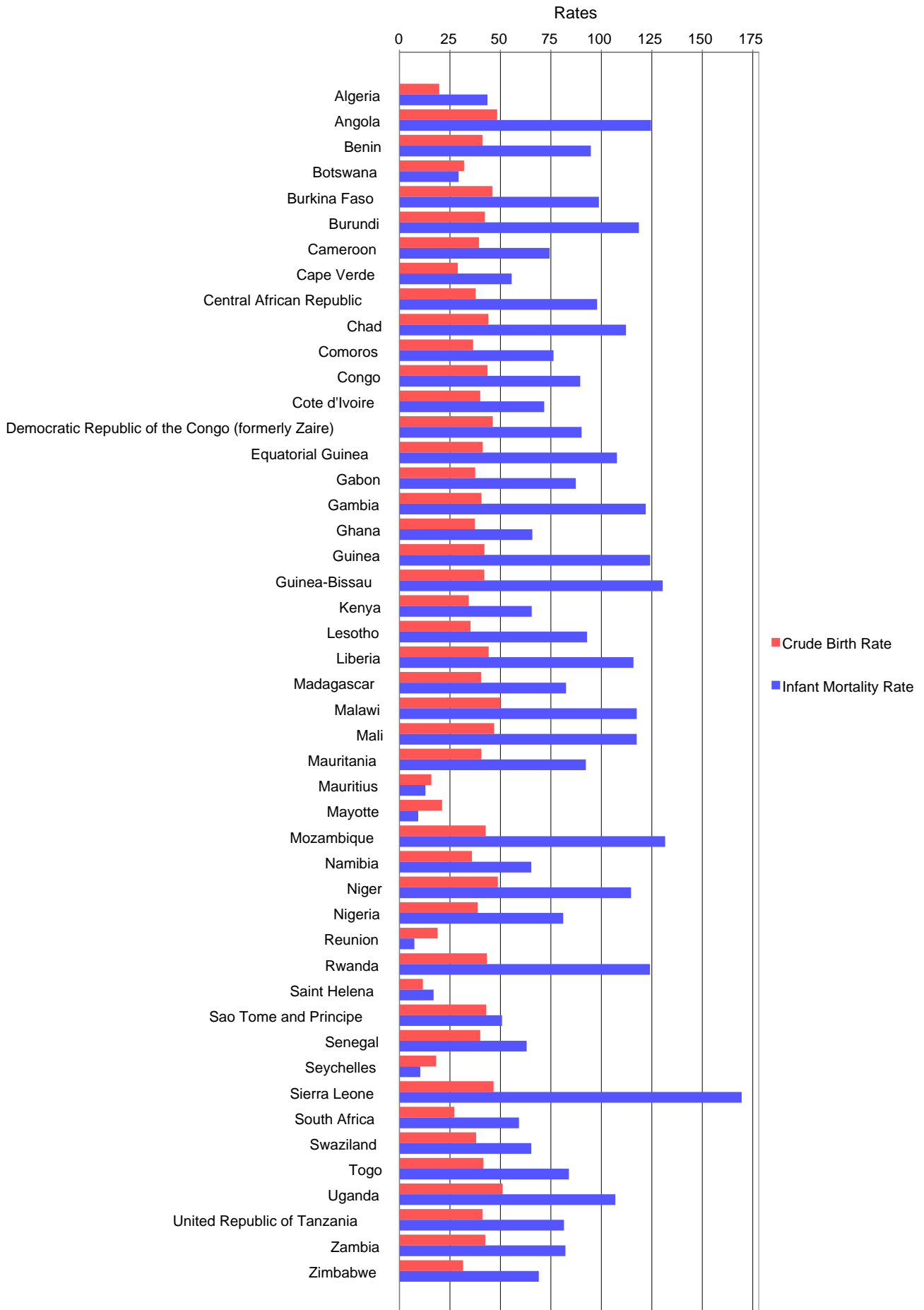
Chart 2: Annual births



Indicates requirement for carrier screening during pregnancy. The annual number of people marrying (not shown) is the indicator for pre-marital or pre-pregnancy screening.

<i>Country</i>	<i>Annual Births</i>
Algeria	627,405
Angola	603,983
Benin	263,738
Botswana	52,896
Burkina Faso	491,418
Burundi	274,230
Cameroon	568,896
Cape Verde	13,322
Central African Republic	118,792
Chad	366,167
Comoros	24,674
Congo	129,666
Cote d'Ivoire	720,040
Democratic Republic of the Congo (formerly Zaire)	2,325,477
Equatorial Guinea	18,210
Gabon	46,387
Gambia	57,652
Ghana	726,008
Guinea	309,856
Guinea-Bissau	53,214
Kenya	1,121,335
Lesotho	75,468
Liberia	127,251
Madagascar	609,434
Malawi	578,604
Mali	493,622
Mauritania	110,322
Mauritius	19,323
Mayotte	1,810
Mozambique	753,911
Namibia	65,230
Niger	506,480
Nigeria	4,894,736
Reunion	14,439
Rwanda	313,275
Saint Helena	57
Sao Tome and Principe	6,020
Senegal	406,600
Seychelles	1,502
Sierra Leone	246,048
South Africa	1,258,253
Swaziland	35,644
Togo	201,926
Uganda	1,164,466
United Republic of Tanzania	1,232,342
Zambia	456,620
Zimbabwe	408,240
WHO African Region total births	22,894,989

Chart 3: Crude birth rate and infant mortality rate

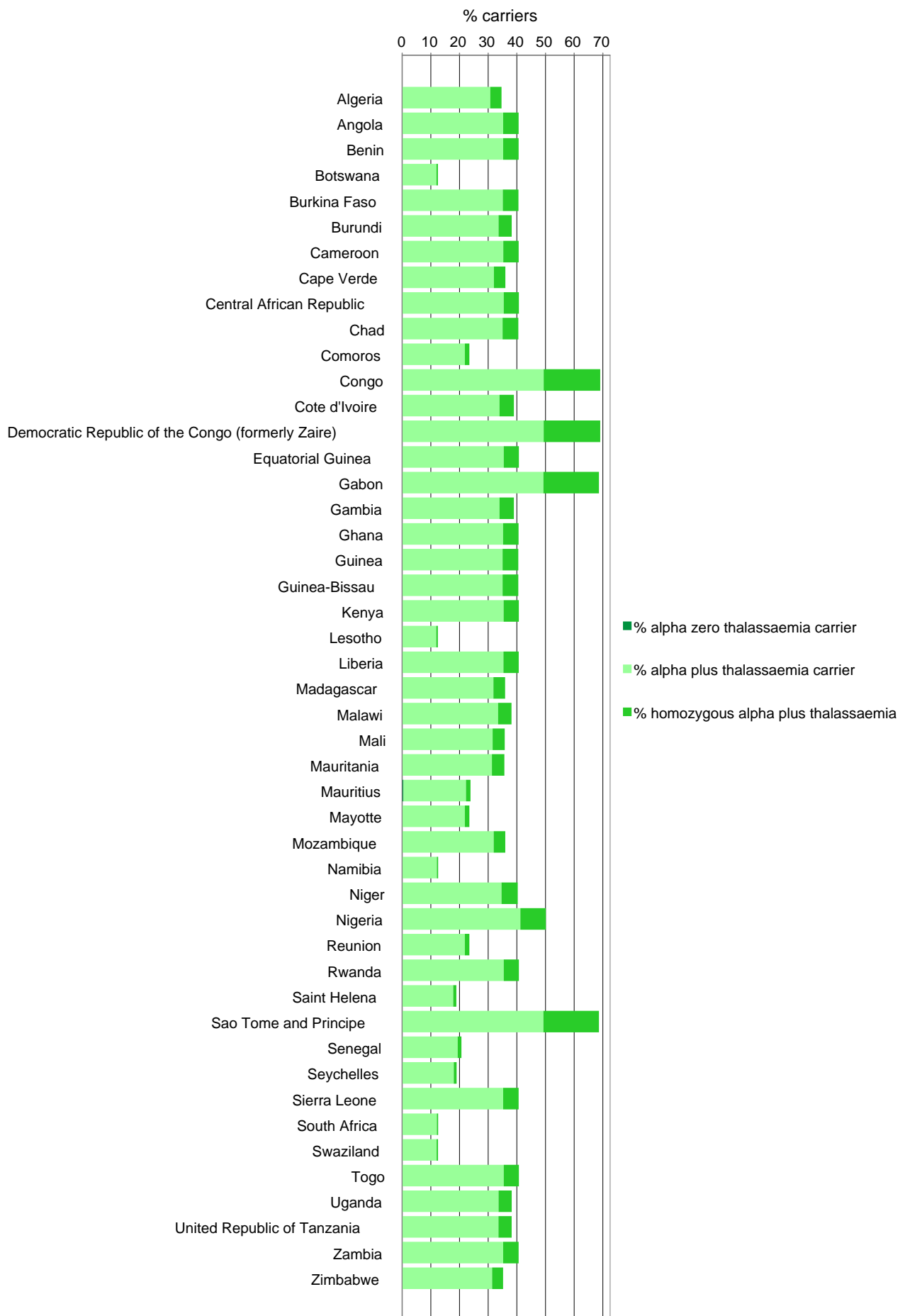


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Crude birth rate (CBR) = live births per 1000 population per year; infant mortality rate (IMR) = deaths under 1 year, per 1,000 live births.

<i>Country</i>	<i>Crude Birth Rate</i>	<i>Infant Mortality Rate</i>
Algeria	19.7	43.6
Angola	48.4	124.6
Benin	41.1	94.8
Botswana	32	29.3
Burkina Faso	46	98.8
Burundi	42.3	118.6
Cameroon	39.4	74.4
Cape Verde	28.9	55.6
Central African Republic	37.7	97.9
Chad	44	112.2
Comoros	36.5	76.3
Congo	43.6	89.5
Cote d'Ivoire	40	71.7
Democratic Republic of the Congo (formerly Zaire)	46.2	90.2
Equatorial Guinea	41.2	107.7
Gabon	37.5	87.3
Gambia	40.6	122
Ghana	37.4	65.8
Guinea	42.1	124.2
Guinea-Bissau	42	130.4
Kenya	34.3	65.5
Lesotho	35.2	92.9
Liberia	44.2	115.9
Madagascar	40.4	82.5
Malawi	50.1	117.5
Mali	46.9	117.5
Mauritania	40.5	92.3
Mauritius	15.8	12.9
Mayotte	21.1	9.3
Mozambique	42.7	131.6
Namibia	35.9	65.3
Niger	48.7	114.7
Nigeria	38.8	81.1
Reunion	18.9	7.4
Rwanda	43.3	124.1
Saint Helena	11.6	16.9
Sao Tome and Principe	43	50.8
Senegal	40	63
Seychelles	18.1	10.3
Sierra Leone	46.6	169.5
South Africa	27.1	59.2
Swaziland	38	65.3
Togo	41.6	83.9
Uganda	51.1	106.9
United Republic of Tanzania	41.1	81.5
Zambia	42.5	82.2
Zimbabwe	31.5	69
WHO African Region aggregate rates	39	88

Chart 4: Per cent of pregnant women carrying alpha globin gene variants, by variant

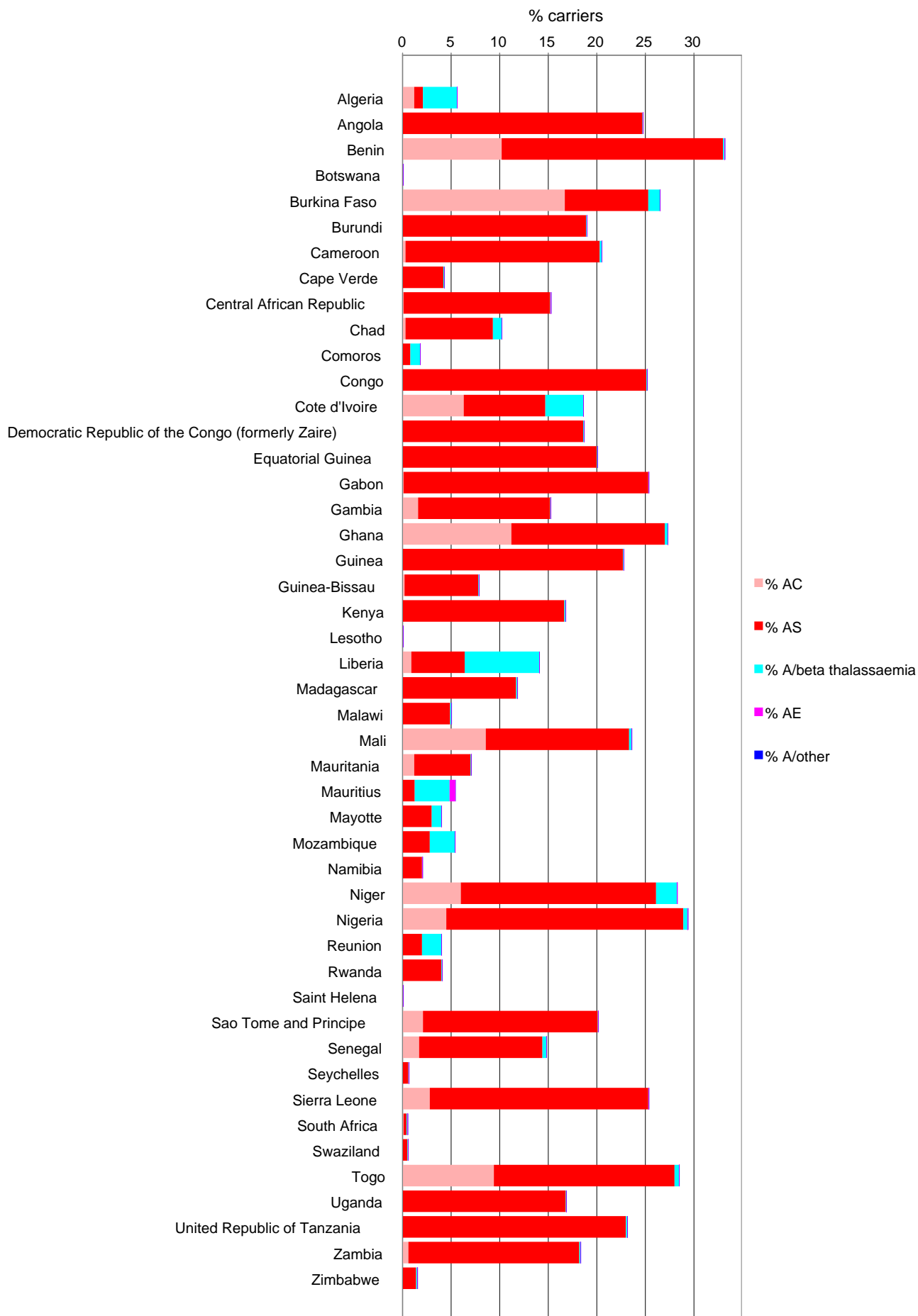


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Data is for deletional alpha globin gene variants. Homozygous alpha plus thalassaemia is included as it is common and harmless.

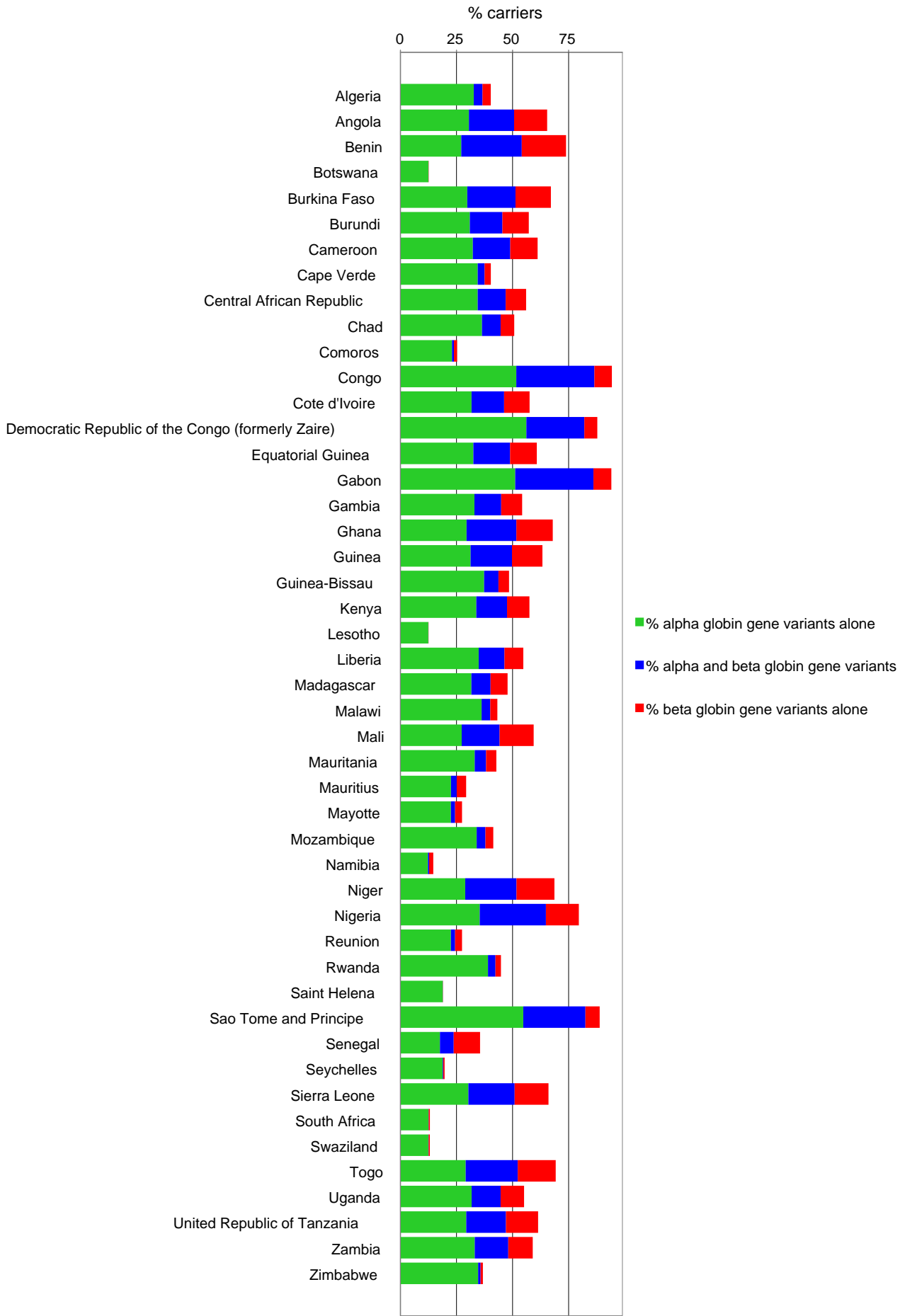
Country	% alpha zero thalassaemia carrier	% alpha plus thalassaemia carrier	% homozygous alpha plus thalassaemia
Algeria	0	30.727	3.937
Angola	0	35.231	5.384
Benin	0	35.231	5.384
Botswana	0	11.961	0.52
Burkina Faso	0	35.118	5.441
Burundi	0	33.641	4.58
Cameroon	0	35.269	5.365
Cape Verde	0	32	4
Central African Republic	0	35.42	5.29
Chad	0	35.043	5.479
Comoros	0	21.875	1.562
Congo	0	49.373	19.714
Cote d'Ivoire	0	33.953	5.024
Democratic Republic of the Congo (formerly Zaire)	0	49.373	19.714
Equatorial Guinea	0	35.42	5.29
Gabon	0	49.28	19.36
Gambia	0	33.953	5.024
Ghana	0	35.194	5.403
Guinea	0	35.041	5.479
Guinea-Bissau	0	35.041	5.479
Kenya	0	35.382	5.309
Lesotho	0	11.896	0.552
Liberia	0	35.326	5.337
Madagascar	0	31.83	4.085
Malawi	0	33.462	4.669
Mali	0	31.55	4.225
Mauritania	0	31.318	4.341
Mauritius	0.45	21.819	1.562
Mayotte	0	21.875	1.562
Mozambique	0	31.932	4.034
Namibia	0	12.09	0.455
Niger	0	34.666	5.667
Nigeria	0	41.241	8.88
Reunion	0	21.875	1.562
Rwanda	0	35.42	5.29
Saint Helena	0	17.82	1.09
Sao Tome and Principe	0	49.28	19.36
Senegal	0	19.37	1.315
Seychelles	0	18	1
Sierra Leone	0	35.231	5.384
South Africa	0	12.097	0.452
Swaziland	0	12.025	0.488
Togo	0	35.42	5.29
Uganda	0	33.641	4.58
United Republic of Tanzania	0	33.604	4.598
Zambia	0	35.231	5.384
Zimbabwe	0	31.395	3.802
WHO African Region aggregate carrier rates	0	35.468	7.001

Chart 5: Per cent of pregnant women carrying beta globin gene variants, by variant



Country	% AC	% AS	% A/beta thalassaemia	% AE	% A/other
Algeria	1.2	0.9	3.5	0	0.03
Angola	0	24.7	0.075	0	0.03
Benin	10.2	22.8	0.2	0	0.03
Botswana	0	0	0.075	0	0.03
Burkina Faso	16.7	8.6	1.2	0	0.03
Burundi	0	18.9	0.075	0	0.03
Cameroon	0.3	20	0.2	0	0.03
Cape Verde	0	4.2	0.075	0	0.03
Central African Republic	0.1	15.1	0.1	0	0.03
Chad	0.3	9	0.9	0	0.03
Comoros	0	0.8	1	0	0.03
Congo	0	25.1	0.075	0	0.03
Cote d'Ivoire	6.3	8.4	3.9	0	0.03
Democratic Republic of the Congo (formerly Zaire)	0	18.6	0.075	0	0.03
Equatorial Guinea	0	20	0.075	0	0.03
Gabon	0.1	25.2	0.075	0	0.03
Gambia	1.6	13.6	0.075	0	0.03
Ghana	11.2	15.8	0.3	0	0.03
Guinea	0	22.7	0.075	0	0.03
Guinea-Bissau	0.2	7.6	0.075	0	0.03
Kenya	0	16.66	0.15	0	0.03
Lesotho	0	0	0.075	0	0.03
Liberia	0.9	5.5	7.7	0	0.03
Madagascar	0	11.695	0.15	0	0.03
Malawi	0	4.9	0.15	0	0.03
Mali	8.566	14.758	0.289	0	0.03
Mauritania	1.2	5.8	0.075	0	0.03
Mauritius	0	1.249	3.589	0.609	0.03
Mayotte	0	3	1	0	0.03
Mozambique	0	2.8	2.6	0	0.03
Namibia	0	2	0.075	0	0.03
Niger	6	20.1	2.2	0	0.03
Nigeria	4.5	24.4	0.5	0	0.03
Reunion	0	2	2	0	0.03
Rwanda	0	4	0.075	0	0.03
Saint Helena	0	0	0.075	0	0.03
Sao Tome and Principe	2.1	18	0.075	0	0.03
Senegal	1.7	12.7	0.4	0	0.03
Seychelles	0	0.6	0.075	0	0.03
Sierra Leone	2.8	22.5	0.075	0	0.03
South Africa	0.1	0.3	0.15	0	0.03
Swaziland	0	0.5	0.075	0	0.03
Togo	9.4	18.6	0.5	0	0.03
Uganda	0	16.8	0.075	0	0.03
United Republic of Tanzania	0	23	0.15	0	0.03
Zambia	0.6	17.6	0.15	0	0.03
Zimbabwe	0	1.4	0.15	0	0.03
WHO African Region aggregate carrier rates	2.531	15.861	0.64	0.001	0.03

Chart 6: Per cent of pregnant women carrying any haemoglobin gene variant

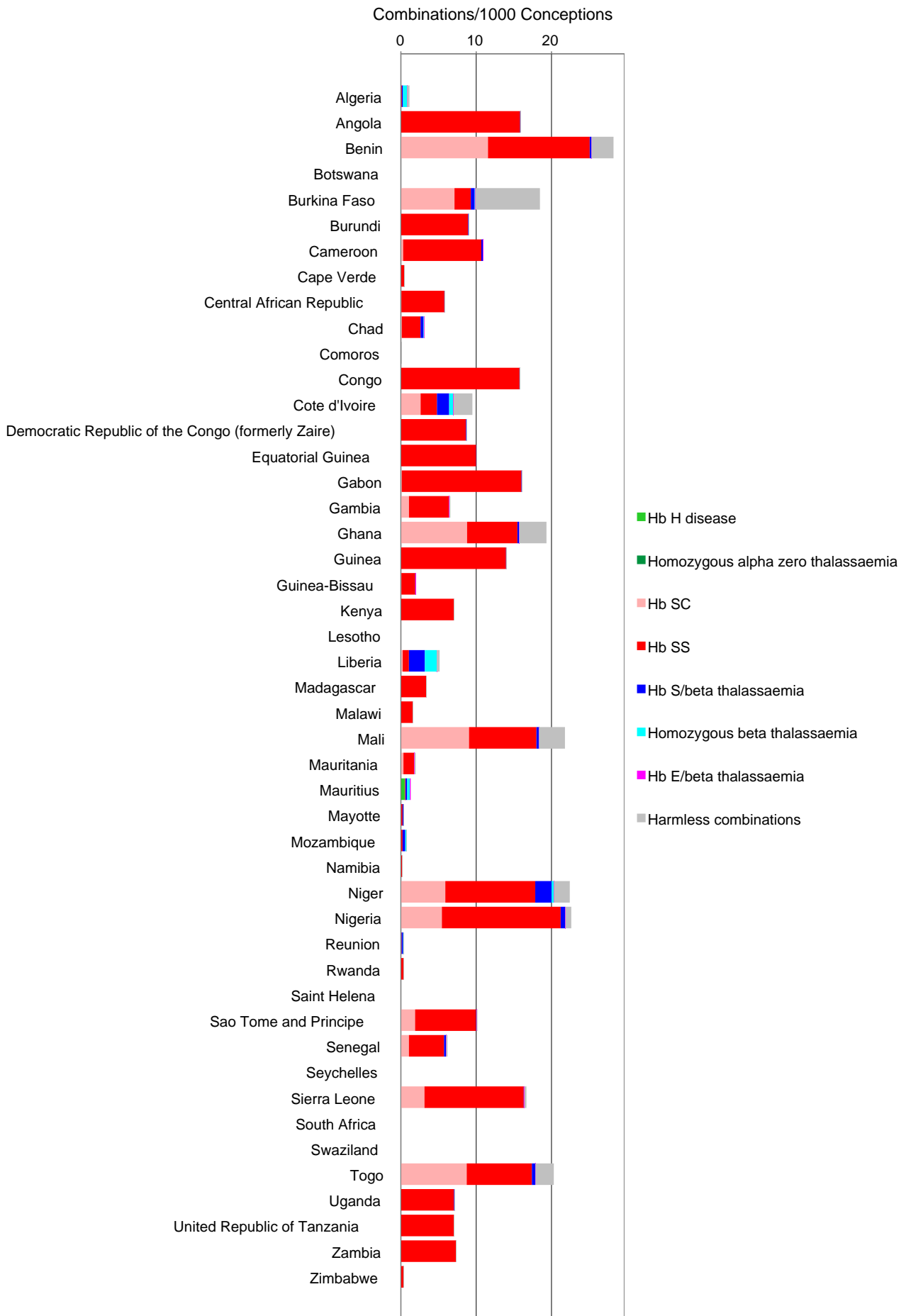


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Alpha and beta globin gene variants are inherited independently and do not interact to cause disease: many people carry both alpha and beta variants.

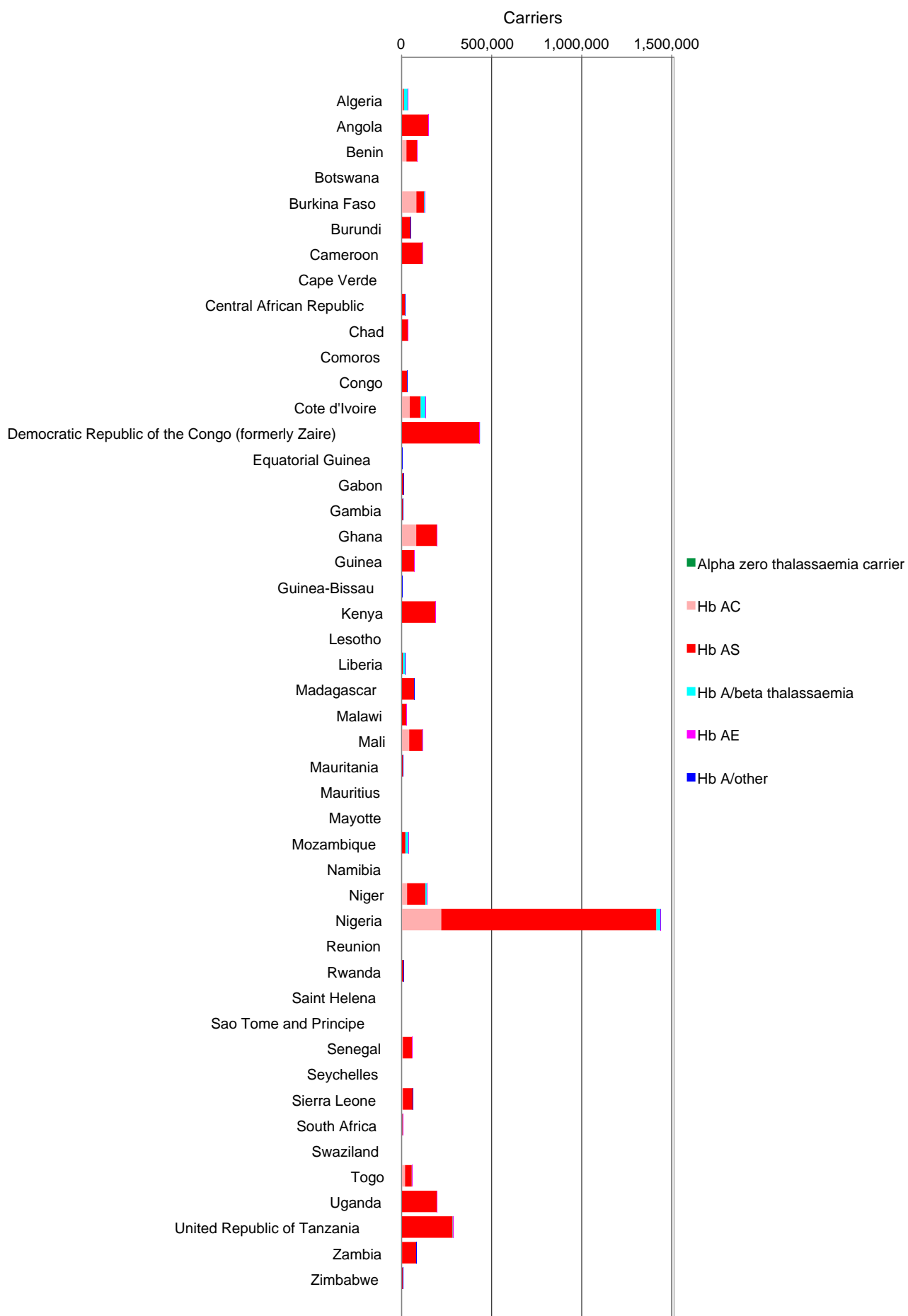
<i>Country</i>	<i>% carriers of alpha globin gene variants alone</i>	<i>% carriers of both alpha and beta globin gene variants</i>	<i>% carriers of beta globin gene variants alone</i>	<i>Total % carriers</i>
Algeria	32.712	3.903	3.678	40.293
Angola	30.541	20.149	14.73	65.421
Benin	27.119	26.993	19.733	73.846
Botswana	12.467	0.026	0.092	12.585
Burkina Faso	29.799	21.521	15.77	67.089
Burundi	30.957	14.528	11.741	57.225
Cameroon	32.292	16.685	12.188	61.165
Cape Verde	34.45	3.1	2.755	40.305
Central African Republic	34.469	12.482	9.089	56.04
Chad	36.376	8.291	6.085	50.751
Comoros	23.009	0.858	1.401	25.268
Congo	51.673	34.826	7.792	94.291
Cote d'Ivoire	31.715	14.523	11.369	57.606
Democratic Republic of the Congo (formerly Zaire)	56.164	25.845	5.782	87.791
Equatorial Guinea	32.525	16.369	11.92	60.815
Gabon	51.202	34.876	7.967	94.045
Gambia	33.011	11.931	9.34	54.281
Ghana	29.502	22.19	16.235	67.927
Guinea	31.28	18.481	13.564	63.326
Guinea-Bissau	37.317	6.406	4.702	48.426
Kenya	33.839	13.705	9.988	57.531
Lesotho	12.435	0.026	0.092	12.553
Liberia	34.917	11.491	8.384	54.793
Madagascar	31.65	8.53	7.61	47.79
Malawi	36.194	3.874	3.143	43.211
Mali	27.317	16.916	15.184	59.418
Mauritania	33.126	5.067	4.571	42.764
Mauritius	22.551	2.561	4.196	29.308
Mayotte	22.493	1.889	3.085	27.468
Mozambique	34.013	3.906	3.477	41.396
Namibia	12.281	0.528	1.841	14.65
Niger	28.907	22.853	16.904	68.663
Nigeria	35.37	29.501	14.68	79.55
Reunion	22.493	1.889	3.085	27.468
Rwanda	39.039	3.342	2.434	44.815
Saint Helena	18.89	0.04	0.085	19.015
Sao Tome and Principe	54.771	27.737	6.336	88.845
Senegal	17.618	6.135	11.762	35.515
Seychelles	18.866	0.268	0.571	19.705
Sierra Leone	30.297	20.637	15.087	66.021
South Africa	12.476	0.146	0.507	13.128
Swaziland	12.437	0.151	0.529	13.117
Togo	29.095	23.229	16.915	69.24
Uganda	31.759	12.922	10.444	55.125
United Republic of Tanzania	29.347	17.71	14.325	61.382
Zambia	33.151	14.93	10.915	58.996
Zimbabwe	34.641	1.112	1.024	36.777
WHO African Region aggregate carrier rates	33.728	17.482	10.321	61.531

Chart 7: Conceptions/1000 with combinations of significant variants



Country	Hb H disease	Homozygous alpha zero thalassaemia	Hb SC	Hb SS	Hb S/beta thalassaemia	Homozygous beta thalassaemia	Hb E/beta thalassaemia	Harmless combinations	Total affected conceptions	Total conceptions
Algeria	0	0	0.053	0.08	0.155	0.538	0	0.322	0.826	1.148
Angola	0	0	0	15.828	0.092	0.002	0	0	15.922	15.922
Benin	0	0	11.566	13.502	0.227	0.005	0	2.929	25.3	28.229
Botswana	0	0	0	0	0	0.006	0	0	0.006	0.006
Burkina Faso	0	0	7.12	2.167	0.512	0.08	0	8.583	9.879	18.461
Burundi	0	0	0	8.93	0.071	0	0	0	9.001	9.001
Cameroon	0	0	0.299	10.382	0.199	0.005	0	0.011	10.885	10.896
Cape Verde	0	0	0	0.441	0.016	0	0	0	0.457	0.457
Central African Republic	0	0	0.076	5.7	0.076	0	0	0.001	5.852	5.852
Chad	0	0	0.134	2.48	0.401	0.066	0	0.031	3.08	3.11
Comoros	0	0	0	0.016	0.04	0.025	0	0	0.081	0.081
Congo	0	0	0	15.75	0.094	0	0	0	15.845	15.845
Cote d'Ivoire	0	0	2.618	2.172	1.62	0.569	0	2.513	6.979	9.492
Democratic Republic of the Congo (formerly Zaire)	0	0	0	8.649	0.07	0	0	0	8.719	8.719
Equatorial Guinea	0	0	0	10	0.075	0	0	0	10.075	10.075
Gabon	0	0	0.126	15.876	0.094	0	0	0.001	16.097	16.097
Gambia	0	0	1.076	5.296	0.05	0.004	0	0.149	6.427	6.576
Ghana	0	0	8.791	6.677	0.235	0.011	0	3.612	15.714	19.326
Guinea	0	0	0	13.958	0.084	0.004	0	0	14.046	14.046
Guinea-Bissau	0	0	0.075	1.835	0.028	0.004	0	0.012	1.942	1.954
Kenya	0	0	0	7.02	0.002	0.006	0	0	7.029	7.029
Lesotho	0	0	0	0	0	0.008	0	0	0.008	0.008
Liberia	0	0	0.247	0.824	2.112	1.578	0	0.377	4.761	5.137
Madagascar	0	0	0	3.419	0	0	0	0	3.419	3.419
Malawi	0	0	0	1.584	0.002	0.006	0	0	1.593	1.593
Mali	0	0	9.046	8.955	0.305	0.024	0	3.45	18.329	21.78
Mauritania	0	0	0.341	1.437	0.021	0.008	0	0.164	1.806	1.97
Mauritius	0.562	0.005	0	0.047	0.227	0.342	0.123	0.012	1.306	1.318
Mayotte	0	0	0	0.225	0.15	0.025	0	0	0.4	0.4
Mozambique	0	0	0	0.225	0.363	0.196	0	0	0.784	0.784
Namibia	0	0	0	0.153	0.007	0.002	0	0	0.162	0.162
Niger	0	0	5.902	11.938	2.164	0.322	0	2.094	20.325	22.42
Nigeria	0	0	5.443	15.77	0.605	0.024	0	0.781	21.843	22.624
Reunion	0	0	0	0.1	0.2	0.1	0	0	0.4	0.4
Rwanda	0	0	0	0.4	0.015	0	0	0	0.415	0.415
Saint Helena	0	0	0	0	0	0.004	0	0	0.004	0.004
Sao Tome and Principe	0	0	1.89	8.1	0.068	0	0	0.118	10.058	10.176
Senegal	0	0	1.068	4.661	0.251	0.024	0	0.19	6.004	6.194
Seychelles	0	0	0	0.009	0.002	0	0	0	0.011	0.011
Sierra Leone	0	0	3.133	13.179	0.084	0.002	0	0.272	16.398	16.67
South Africa	0	0	0	0	0	0.002	0	0	0.002	0.002
Swaziland	0	0	0	0.033	0.002	0.004	0	0	0.039	0.039
Togo	0	0	8.742	8.649	0.465	0.006	0	2.444	17.862	20.306
Uganda	0	0	0	7.056	0.063	0	0	0	7.119	7.119
United Republic of Tanzania	0	0	0	7.023	0.002	0.006	0	0	7.032	7.032
Zambia	0	0	0	7.328	0.002	0.006	0	0	7.337	7.337
Zimbabwe	0	0	0	0.396	0.002	0.006	0	0	0.405	0.405
WHO African Region aggregate rates	0	0	2.283	8.066	0.322	0.066	0	0.74	10.737	11.477

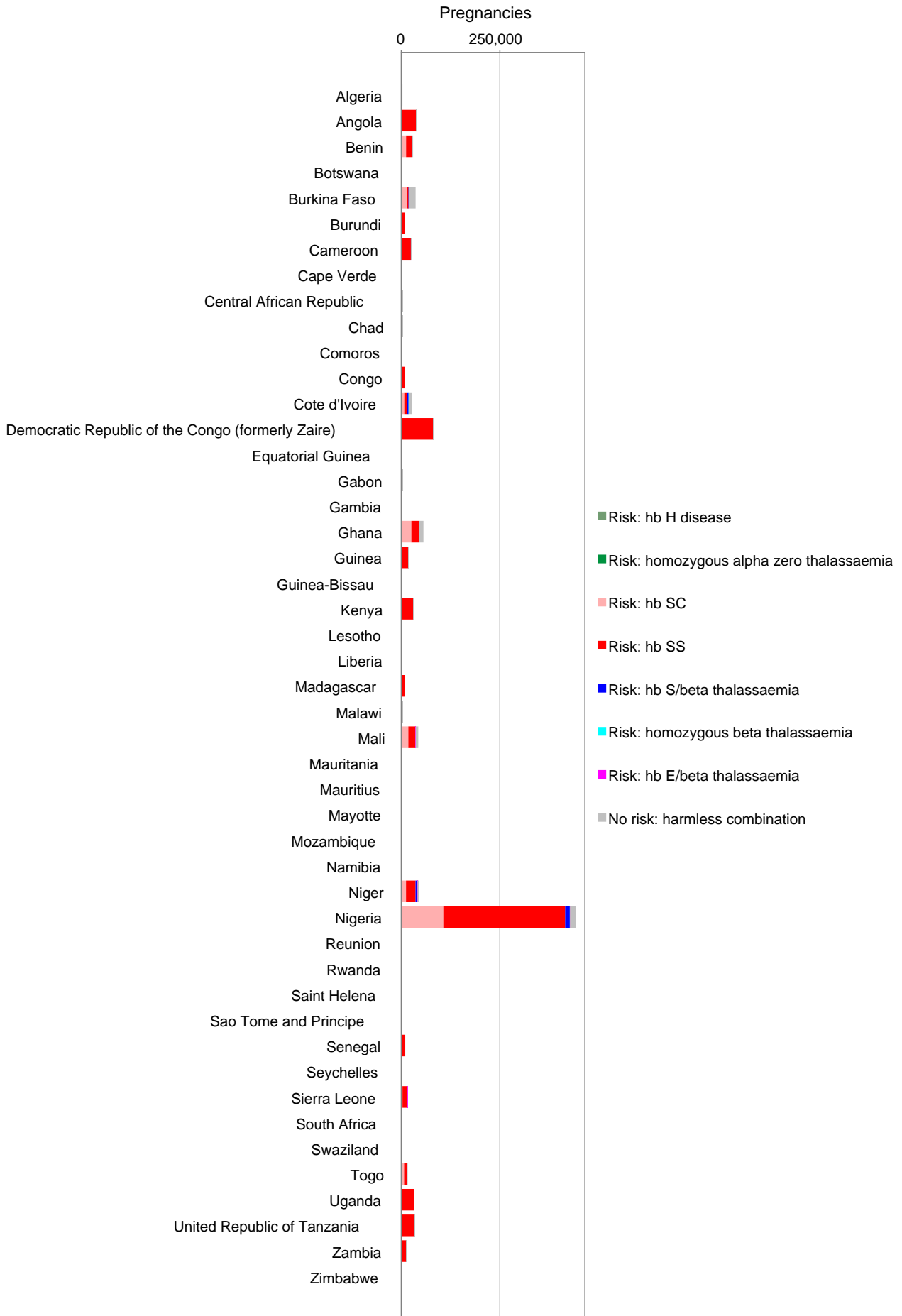
Chart 8: Annual pregnant carriers of significant variants



Indicates requirement for information for carriers, and the offer of partner testing. Also indicates annual carriers detectable by neonatal screening.

Country	Alpha zero thalassaemia carrier	Hb AC	Hb AS	Beta thalassaemia carrier	Hb AE	Hb A/other	Total carriers
Algeria	0	7,528	5,646	21,959	0	188	35,321
Angola	0	0	149,183	452	0	181	149,816
Benin	0	26,901	60,132	527	0	79	87,639
Botswana	0	0	0	39	0	15	54
Burkina Faso	0	82,066	42,261	5,897	0	147	130,371
Burundi	0	0	51,829	205	0	82	52,116
Cameroon	0	1,706	113,779	1,137	0	170	116,792
Cape Verde	0	0	559	9	0	3	571
Central African Republic	0	118	17,937	118	0	35	18,208
Chad	0	1,098	32,955	3,295	0	109	37,457
Comoros	0	0	197	246	0	7	450
Congo	0	0	32,546	97	0	38	32,681
Cote d'Ivoire	0	45,362	60,483	28,081	0	216	134,142
Democratic Republic of the Congo (formerly Zaire)	0	0	432,538	1,744	0	697	434,979
Equatorial Guinea	0	0	3,642	13	0	5	3,660
Gabon	0	46	11,689	34	0	13	11,782
Gambia	0	922	7,840	43	0	17	8,822
Ghana	0	81,312	114,709	2,178	0	217	198,416
Guinea	0	0	70,337	232	0	92	70,661
Guinea-Bissau	0	106	4,044	39	0	15	4,204
Kenya	0	0	186,814	1,682	0	336	188,832
Lesotho	0	0	0	56	0	22	78
Liberia	0	1,145	6,998	9,798	0	38	17,979
Madagascar	0	0	71,273	914	0	182	72,369
Malawi	0	0	28,351	867	0	173	29,391
Mali	0	42,283	72,848	1,425	0	148	116,704
Mauritania	0	1,323	6,398	82	0	33	7,836
Mauritius	86	0	241	693	117	5	1,142
Mayotte	0	0	54	18	0	0	72
Mozambique	0	0	21,109	19,601	0	226	40,936
Namibia	0	0	1,304	48	0	19	1,371
Niger	0	30,388	101,802	11,142	0	151	143,483
Nigeria	0	220,263	1,194,315	24,473	0	1,468	1,440,519
Reunion	0	0	288	288	0	4	580
Rwanda	0	0	12,531	234	0	93	12,858
Saint Helena	0	0	0	0	0	0	0
Sao Tome and Principe	0	126	1,083	4	0	1	1,214
Senegal	0	6,912	51,638	1,626	0	121	60,297
Seychelles	0	0	9	1	0	0	10
Sierra Leone	0	6,889	55,360	184	0	73	62,506
South Africa	0	1,258	3,774	1,887	0	377	7,296
Swaziland	0	0	178	26	0	10	214
Togo	0	18,981	37,558	1,009	0	60	57,608
Uganda	0	0	195,630	873	0	349	196,852
United Republic of Tanzania	0	0	283,438	1,848	0	369	285,655
Zambia	0	2,739	80,365	684	0	136	83,924
Zimbabwe	0	0	5,715	612	0	122	6,449
WHO African Region total pregnant carriers	86	579,472	3,631,380	146,420	117	6,842	4,364,317

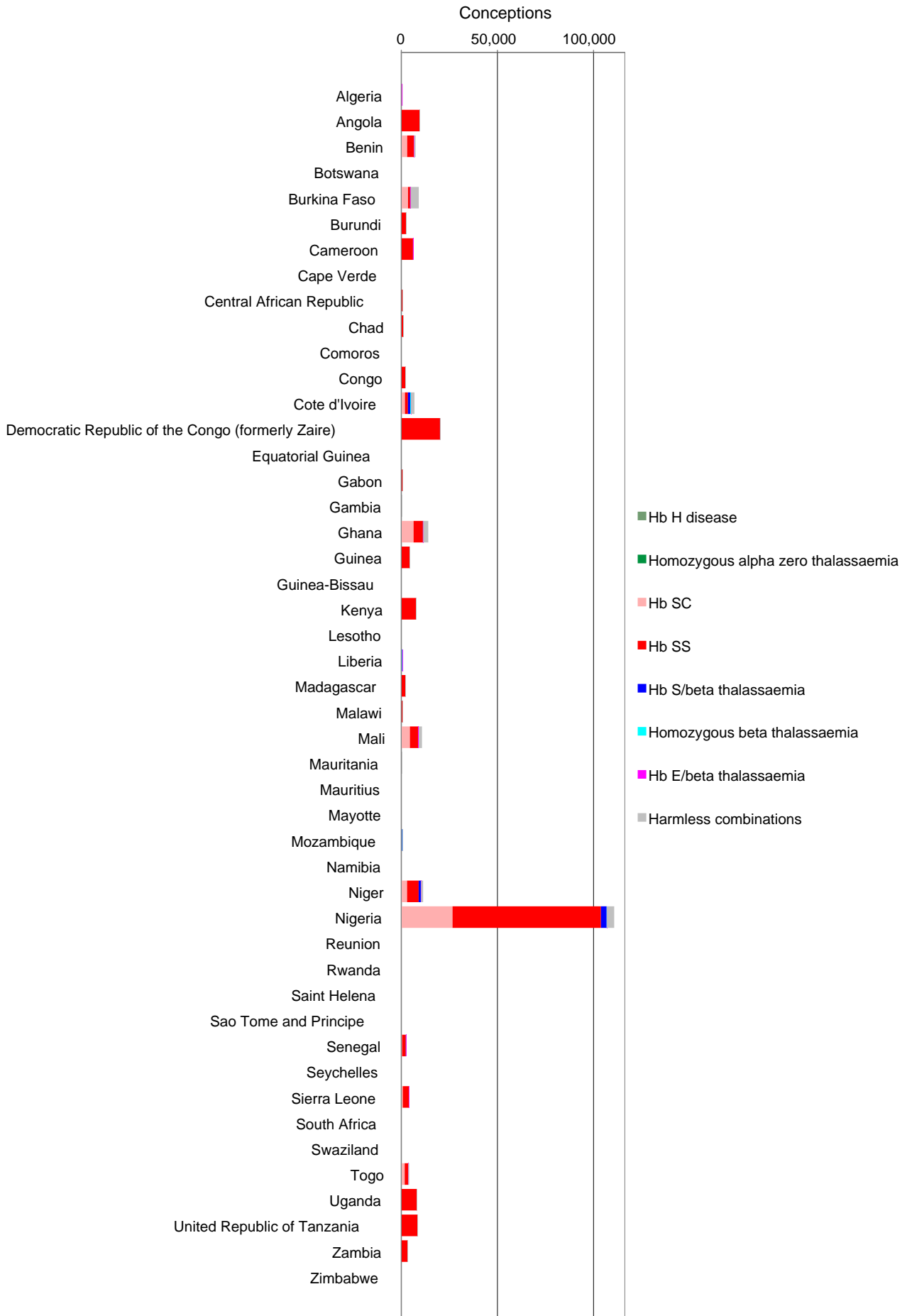
Chart 9: Annual pregnancies where both parents carry a significant variant



Indicates requirement for expert risk assessment, genetic counselling and the offer of prenatal diagnosis.

Country	Risk: hb H disease	Risk: homozygous alpha zero thalassaemia	Risk: hb SC	Risk: hb SS	Risk: hb S/beta thalassaemia	Risk: homozygous beta thalassaemia	Risk: hb E/beta thalassaemia	No risk: harmless combination	Total at-risk pregnancies	Total pregnancies requiring risk assessment
Algeria	0	0	132	200	388	1,348	0	808	2,068	2,876
Angola	0	0	0	38,240	220	4	0	0	38,464	38,464
Benin	0	0	12,200	14,244	236	4	0	3,088	26,684	29,772
Botswana	0	0	0	0	0	0	0	0	0	0
Burkina Faso	0	0	13,992	4,256	1,004	156	0	16,868	19,408	36,276
Burundi	0	0	0	9,792	76	0	0	0	9,868	9,868
Cameroon	0	0	676	23,624	452	8	0	24	24,760	24,784
Cape Verde	0	0	0	20	0	0	0	0	20	20
Central African Republic	0	0	32	2,708	32	0	0	0	2,772	2,772
Chad	0	0	192	3,632	584	96	0	44	4,504	4,548
Comoros	0	0	0	0	0	0	0	0	0	0
Congo	0	0	0	8,168	48	0	0	0	8,216	8,216
Cote d'Ivoire	0	0	7,536	6,252	4,664	1,640	0	7,236	20,092	27,328
Democratic Republic of the Congo (formerly Zaire)	0	0	0	80,452	648	0	0	0	81,100	81,100
Equatorial Guinea	0	0	0	728	4	0	0	0	732	732
Gabon	0	0	20	2,944	16	0	0	0	2,980	2,980
Gambia	0	0	248	1,220	8	0	0	32	1,476	1,508
Ghana	0	0	25,528	19,388	680	28	0	10,488	45,624	56,112
Guinea	0	0	0	17,300	104	4	0	0	17,408	17,408
Guinea-Bissau	0	0	16	388	4	0	0	0	408	408
Kenya	0	0	0	31,484	8	28	0	0	31,520	31,520
Lesotho	0	0	0	0	0	0	0	0	0	0
Liberia	0	0	124	416	1,072	800	0	188	2,412	2,600
Madagascar	0	0	0	8,332	0	0	0	0	8,332	8,332
Malawi	0	0	0	3,664	4	12	0	0	3,680	3,680
Mali	0	0	17,860	17,680	600	44	0	6,812	36,184	42,996
Mauritania	0	0	148	632	8	0	0	72	788	860
Mauritius	40	0	0	0	16	24	8	0	88	88
Mayotte	0	0	0	0	0	0	0	0	0	0
Mozambique	0	0	0	676	1,092	588	0	0	2,356	2,356
Namibia	0	0	0	36	0	0	0	0	36	36
Niger	0	0	11,956	24,184	4,380	652	0	4,240	41,172	45,412
Nigeria	0	0	106,572	308,768	11,840	476	0	15,296	427,656	442,952
Reunion	0	0	0	4	8	4	0	0	16	16
Rwanda	0	0	0	500	16	0	0	0	516	516
Saint Helena	0	0	0	0	0	0	0	0	0	0
Sao Tome and Principe	0	0	44	192	0	0	0	0	236	236
Senegal	0	0	1,736	7,580	408	36	0	308	9,760	10,068
Seychelles	0	0	0	0	0	0	0	0	0	0
Sierra Leone	0	0	3,080	12,968	80	0	0	264	16,128	16,392
South Africa	0	0	0	0	0	4	0	0	4	4
Swaziland	0	0	0	4	0	0	0	0	4	4
Togo	0	0	7,060	6,984	372	4	0	1,972	14,420	16,392
Uganda	0	0	0	32,864	292	0	0	0	33,156	33,156
United Republic of Tanzania	0	0	0	34,616	12	28	0	0	34,656	34,656
Zambia	0	0	0	13,384	4	8	0	0	13,396	13,396
Zimbabwe	0	0	0	644	4	8	0	0	656	656
WHO African Region total pregnancies	40	0	209,152	739,168	29,384	6,004	8	67,740	983,756	1,051,496

Chart 10: Annual conceptions with combinations of significant gene variants



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Indicates (potential) annual affected births, and annual increase in requirements for patient care. Baseline for assessing effects of prevention.

Country	Hb H disease	Homozygous alpha zero thalassaemia	Hb SC	Hb SS	Hb S/beta thalassaemia	Homozygous beta thalassaemia	Hb E/beta thalassaemia	Harmless combinations	Total affected conceptions	Total conceptions with combinations
Algeria	0	0	33	50	97	337	0	202	517	719
Angola	0	0	0	9,560	55	1	0	0	9,616	9,616
Benin	0	0	3,050	3,561	59	1	0	772	6,671	7,443
Botswana	0	0	0	0	0	0	0	0	0	0
Burkina Faso	0	0	3,498	1,064	251	39	0	4,217	4,852	9,069
Burundi	0	0	0	2,448	19	0	0	0	2,467	2,467
Cameroon	0	0	169	5,906	113	2	0	6	6,190	6,196
Cape Verde	0	0	0	5	0	0	0	0	5	5
Central African Republic	0	0	8	677	8	0	0	0	693	693
Chad	0	0	48	908	146	24	0	11	1,126	1,137
Comoros	0	0	0	0	0	0	0	0	0	0
Congo	0	0	0	2,042	12	0	0	0	2,054	2,054
Cote d'Ivoire	0	0	1,884	1,563	1,166	410	0	1,809	5,023	6,832
Democratic Republic of the Congo (formerly Zaire)	0	0	0	20,113	162	0	0	0	20,275	20,275
Equatorial Guinea	0	0	0	182	1	0	0	0	183	183
Gabon	0	0	5	736	4	0	0	0	745	745
Gambia	0	0	62	305	2	0	0	8	369	377
Ghana	0	0	6,382	4,847	170	7	0	2,622	11,406	14,028
Guinea	0	0	0	4,325	26	1	0	0	4,352	4,352
Guinea-Bissau	0	0	4	97	1	0	0	0	102	102
Kenya	0	0	0	7,871	2	7	0	0	7,880	7,880
Lesotho	0	0	0	0	0	0	0	0	0	0
Liberia	0	0	31	104	268	200	0	47	603	650
Madagascar	0	0	0	2,083	0	0	0	0	2,083	2,083
Malawi	0	0	0	916	1	3	0	0	920	920
Mali	0	0	4,465	4,420	150	11	0	1,703	9,046	10,749
Mauritania	0	0	37	158	2	0	0	18	197	215
Mauritius	10	0	0	0	4	6	2	0	22	22
Mayotte	0	0	0	0	0	0	0	0	0	0
Mozambique	0	0	0	169	273	147	0	0	589	589
Namibia	0	0	0	9	0	0	0	0	9	9
Niger	0	0	2,989	6,046	1,095	163	0	1,060	10,293	11,353
Nigeria	0	0	26,643	77,192	2,960	119	0	3,824	106,914	110,738
Reunion	0	0	0	1	2	1	0	0	4	4
Rwanda	0	0	0	125	4	0	0	0	129	129
Saint Helena	0	0	0	0	0	0	0	0	0	0
Sao Tome and Principe	0	0	11	48	0	0	0	0	59	59
Senegal	0	0	434	1,895	102	9	0	77	2,440	2,517
Seychelles	0	0	0	0	0	0	0	0	0	0
Sierra Leone	0	0	770	3,242	20	0	0	66	4,032	4,098
South Africa	0	0	0	0	0	1	0	0	1	1
Swaziland	0	0	0	1	0	0	0	0	1	1
Togo	0	0	1,765	1,746	93	1	0	493	3,605	4,098
Uganda	0	0	0	8,216	73	0	0	0	8,289	8,289
United Republic of Tanzania	0	0	0	8,654	3	7	0	0	8,664	8,664
Zambia	0	0	0	3,346	1	2	0	0	3,349	3,349
Zimbabwe	0	0	0	161	1	2	0	0	164	164
WHO African Region total pregnancies	10	0	52,288	184,792	7,346	1,501	2	16,935	245,939	262,874