

Modell's

Haemoglobinopathologist's

Almanac

Epidemiological Estimates for Haemoglobin Disorders: WHO Eastern Mediterranean Region by Country

Comprising the following charts and tables:

- Chart 1: Population
- Chart 2: Annual births
- Chart 3: Crude birth rate and infant mortality rate
- Chart 4: Per cent of pregnant women carrying alpha globin gene variants, by variant
- Chart 5: Per cent of pregnant women carrying beta globin gene variants, by variant
- Chart 6: Per cent of pregnant women carrying any haemoglobin gene variant
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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.

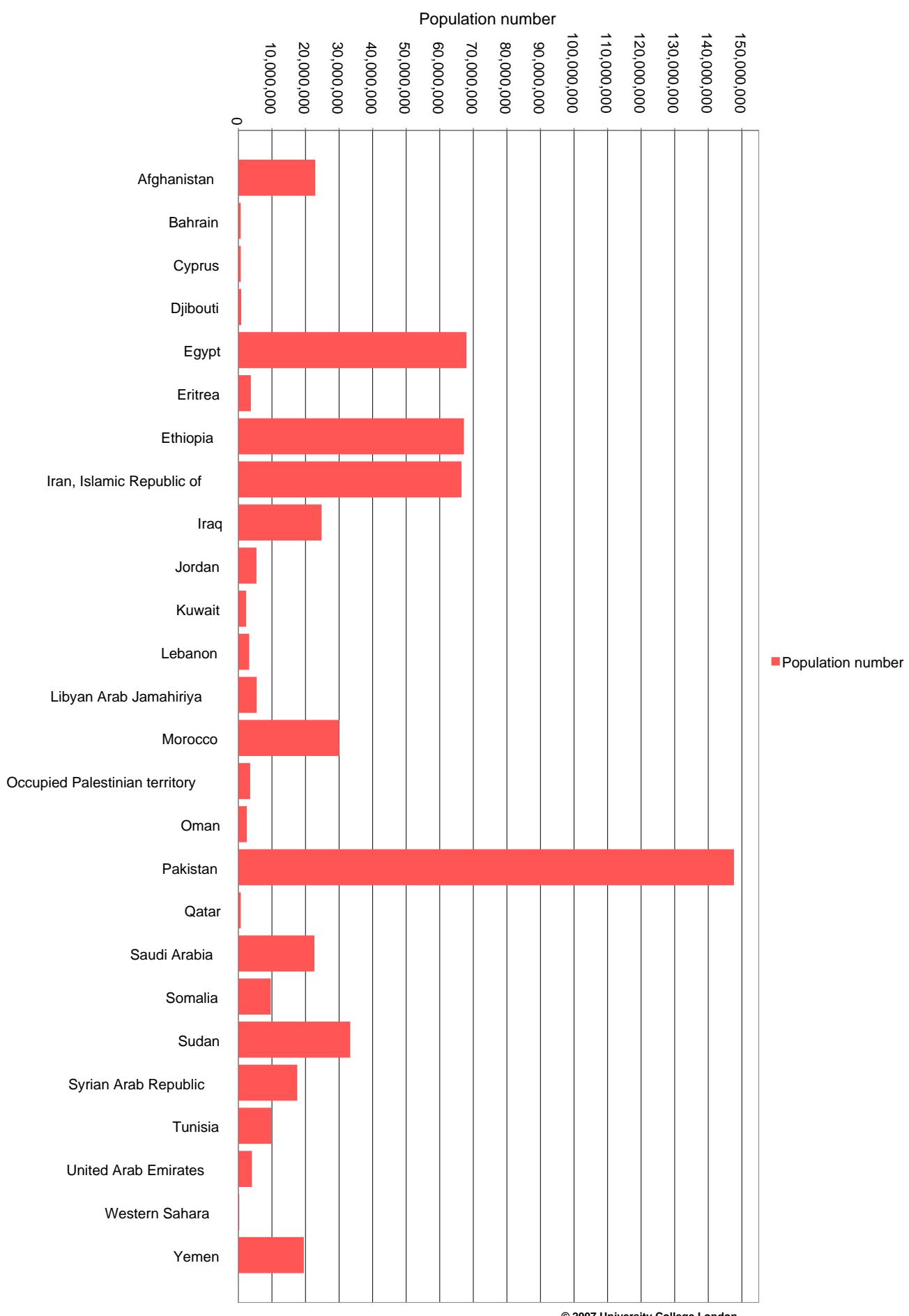
Definitions used

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:

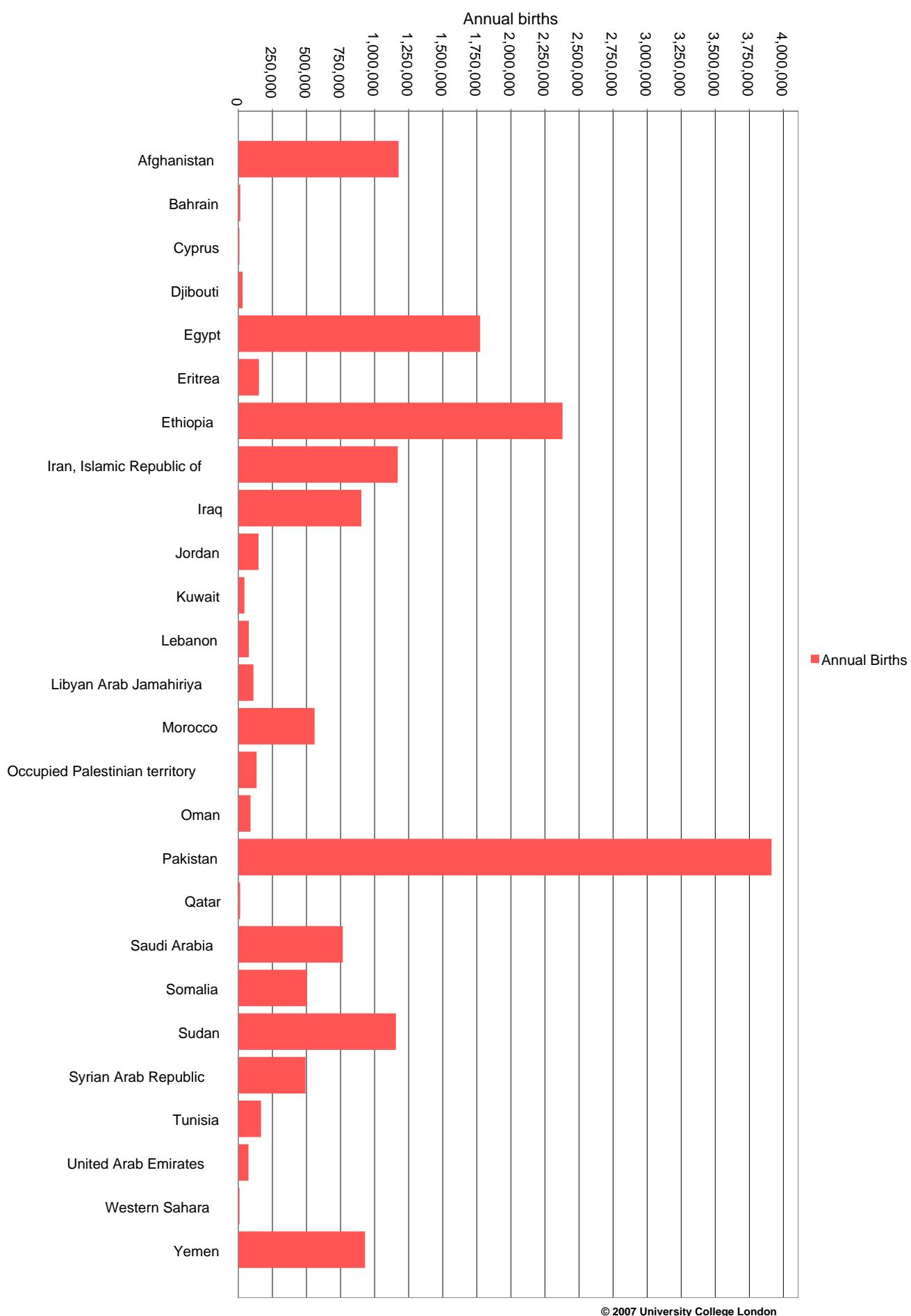
African Region (AFR)	American Region (AMR)	Eastern Mediterranean Region (EMR)	European Region (EUR)	South East Asian Region (SEAR)	Western Pacific Region (WPR)
Northern Africa: Algeria Western Africa: Benin, Burkina Faso, Côte d'Ivoire, Cape Verde, Gambia, Guinea-Bissau, Ghana, Guinea, Liberia, Mali, Mauritania, Niger, Nigeria, Sierra Leone, Saint Helena, Senegal, Togo Middle Africa: Angola, Central African Republic, Cameroon, Chad, Congo, Democratic Republic of the Congo (formerly Zaire), Equatorial Guinea, Gabon, São Tomé and Príncipe Eastern Africa: Burundi, Comoros, Kenya, Madagascar, Malawi, Mauritius, Mayotte, Mozambique, Réunion, Rwanda, Seychelles, United Republic of Tanzania, Uganda, Zambia, Zimbabwe Southern Africa: Botswana, Lesotho, Namibia, South Africa, Swaziland	Northern America: Bermuda, Canada, Greenland, Saint Pierre and Miquelon, United States Central America: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama 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 South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Falkland Islands, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela	Northern Africa: Libya, Arab Jamahiriya, Morocco, Sudan, Tunisia, Western Sahara Eastern Africa: Djibouti, Egypt, Eritrea, Ethiopia, Somalia Western Asia: Bahrain, Cyprus, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen South Central Asia: Afghanistan, Iran, Islamic Republic of, Pakistan, Occupied Palestinian territory	Northern Europe: Channel Islands, Denmark, Estonia, Faroe Islands, Finland, Isle of Man, Iceland, Ireland, Latvia, Lithuania, Norway, Sweden, United Kingdom Western Europe: Austria, Belgium, France, Germany, Liechtenstein, Luxembourg, Monaco, Netherlands, Switzerland Southern Europe: Albania, Andorra, Bosnia and Herzegovina, Croatia, Gibraltar, Greece, Italy, The former Yugoslav Republic of Macedonia, Malta, Portugal, San Marino, Slovenia, Spain, Yugoslavia Eastern Europe: Belarus, Bulgaria, Czech Republic, Hungary, Republic of Moldova, Poland, Romania, Russian Federation, Slovakia, Ukraine	South Central Asia: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan South East Asia: Armenia, Azerbaijan, Georgia, Israel, Turkey	Eastern Asia: China, China - Bangladesh, Bhutan, India, Maldives, Nepal, Sri Lanka South Eastern Asia: East Timor, Indonesia, Myanmar, Thailand South Eastern Asia: Brunei Darussalam, Cambodia, Heard Island and McDonald Islands, Lao Peoples' Democratic Republic, Malaysia, Philippines, Singapore, Vietnam 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 Australia and New Zealand: Australia, New Zealand

Chart 1: Population



<i>Country</i>	<i>Population number</i>
Afghanistan	22,930,000
Bahrain	689,000
Cyprus	721,000
Djibouti	840,000
Egypt	67,976,000
Eritrea	3,719,000
Ethiopia	67,220,000
Iran, Islamic Republic of	66,480,000
Iraq	24,813,000
Jordan	5,404,000
Kuwait	2,325,000
Lebanon	3,236,000
Libyan Arab Jamahiriya	5,484,000
Morocco	30,088,000
Occupied Palestinian territory	3,515,000
Oman	2,538,000
Pakistan	147,662,000
Qatar	719,000
Saudi Arabia	22,673,538
Somalia	9,672,000
Sudan	33,334,000
Syrian Arab Republic	17,550,000
Tunisia	9,840,000
United Arab Emirates	4,041,000
Western Sahara	284,000
Yemen	19,495,000
WHO Eastern Mediterranean Region population total	573,248,538

Chart 2: Annual births

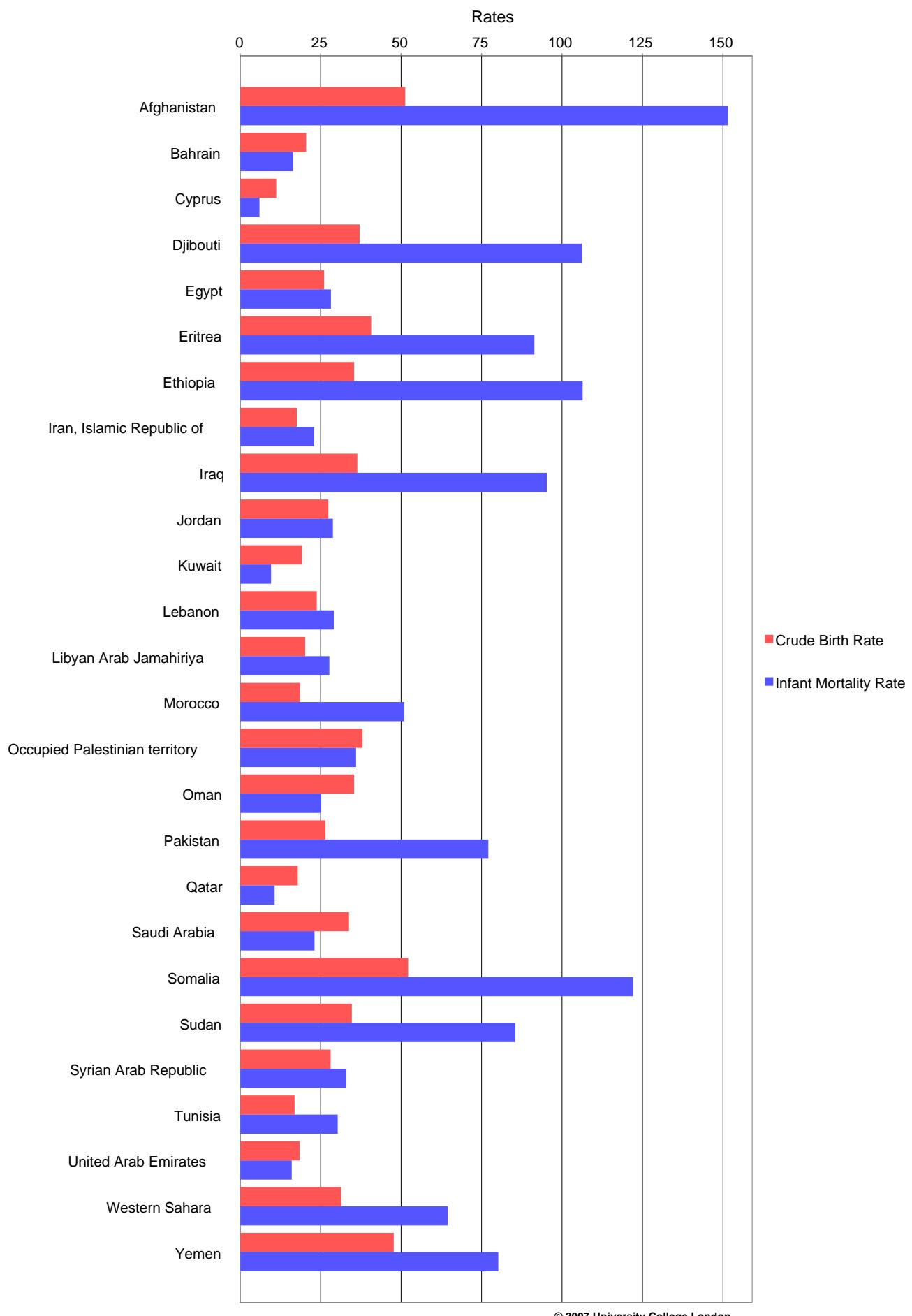


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Indicates requirement for carrier screening during pregnancy. The annual number of people marrying (not shown) is the indicator for pre-marital or pre-pregnancy screening.

<i>Country</i>	<i>Annual Births</i>
Afghanistan	1,176,309
Bahrain	14,124
Cyprus	8,075
Djibouti	31,164
Egypt	1,774,173
Eritrea	151,363
Ethiopia	2,379,587
Iran, Islamic Republic of	1,170,048
Iraq	903,193
Jordan	148,069
Kuwait	44,640
Lebanon	77,016
Libyan Arab Jamahiriya	110,776
Morocco	559,636
Occupied Palestinian territory	133,570
Oman	89,845
Pakistan	3,913,043
Qatar	12,870
Saudi Arabia	766,365
Somalia	504,878
Sudan	1,156,689
Syrian Arab Republic	493,155
Tunisia	166,296
United Arab Emirates	74,758
Western Sahara	8,917
Yemen	929,911
WHO Eastern Mediterranean Region total births	16,798,470

Chart 3: Crude birth rate and infant mortality rate

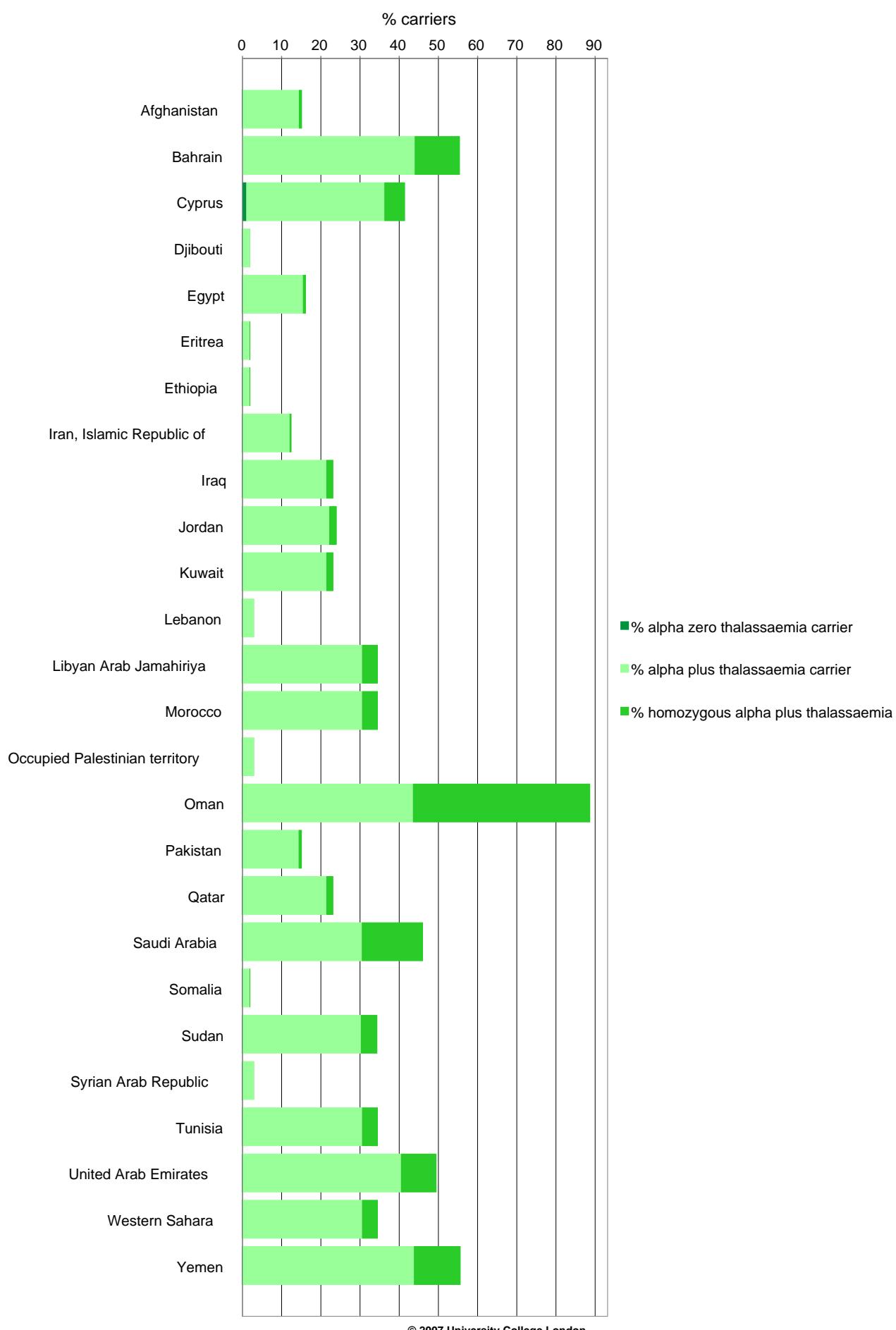


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Crude birth rate (CBR) = live births per 1000 population per year; infant mortality rate (IMR) = deaths under 1 year, per 1,000 live births.

<i>Country</i>	<i>Crude Birth Rate</i>	<i>Infant Mortality Rate</i>
Afghanistan	51.3	151.5
Bahrain	20.5	16.5
Cyprus	11.2	6
Djibouti	37.1	106.2
Egypt	26.1	28.2
Eritrea	40.7	91.4
Ethiopia	35.4	106.4
Iran, Islamic Republic of	17.6	23
Iraq	36.4	95.3
Jordan	27.4	28.8
Kuwait	19.2	9.6
Lebanon	23.8	29.2
Libyan Arab Jamahiriya	20.2	27.7
Morocco	18.6	51
Occupied Palestinian territory	38	36
Oman	35.4	25.2
Pakistan	26.5	77.1
Qatar	17.9	10.7
Saudi Arabia	33.8	23.1
Somalia	52.2	122.1
Sudan	34.7	85.5
Syrian Arab Republic	28.1	33
Tunisia	16.9	30.3
United Arab Emirates	18.5	16
Western Sahara	31.4	64.5
Yemen	47.7	80.2
WHO Eastern Mediterranean Region aggregate rates	29	73

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

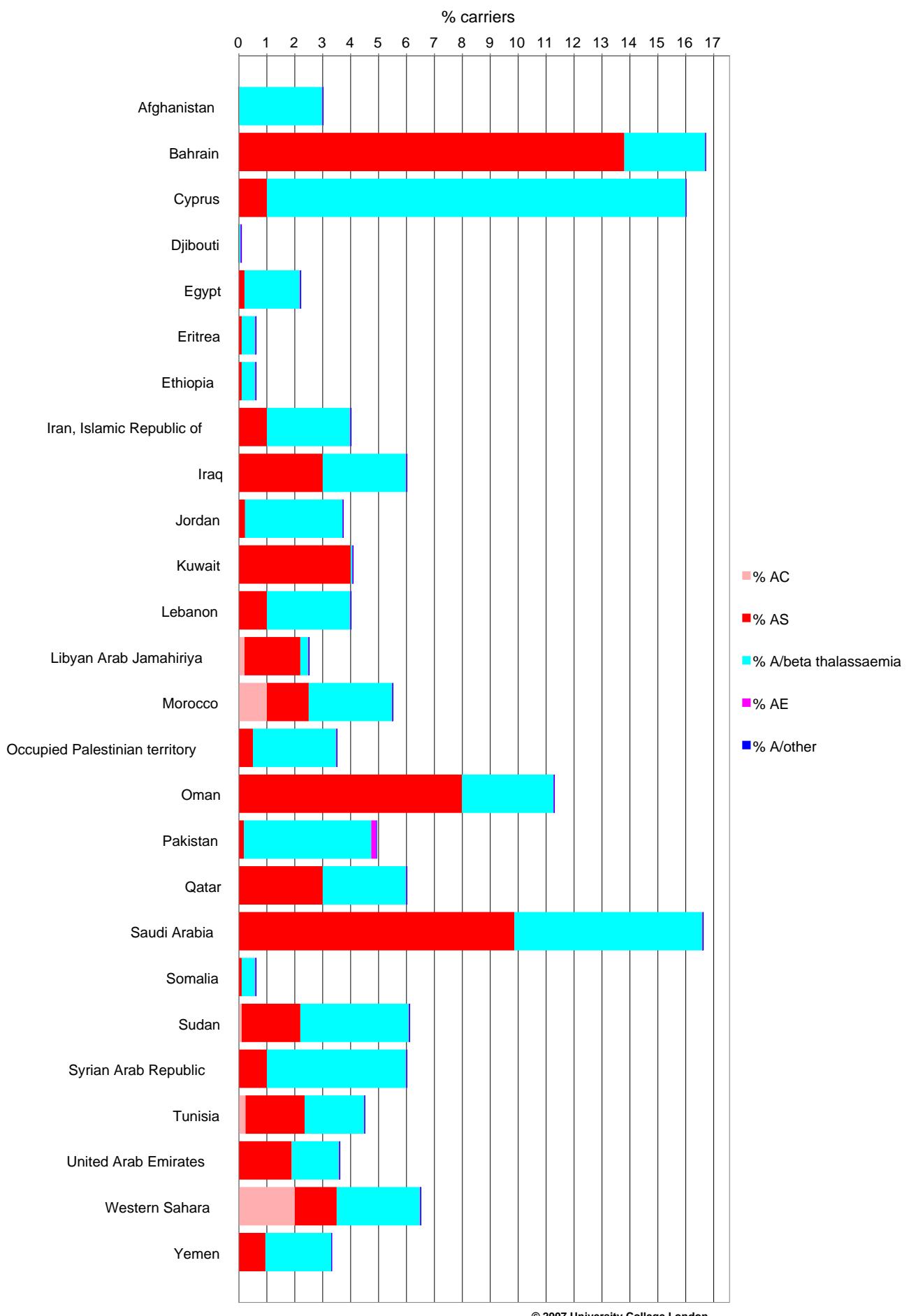


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Data is for deletional alpha globin gene variants. Homozygous alpha plus thalassaemia is included as it is common and harmless.

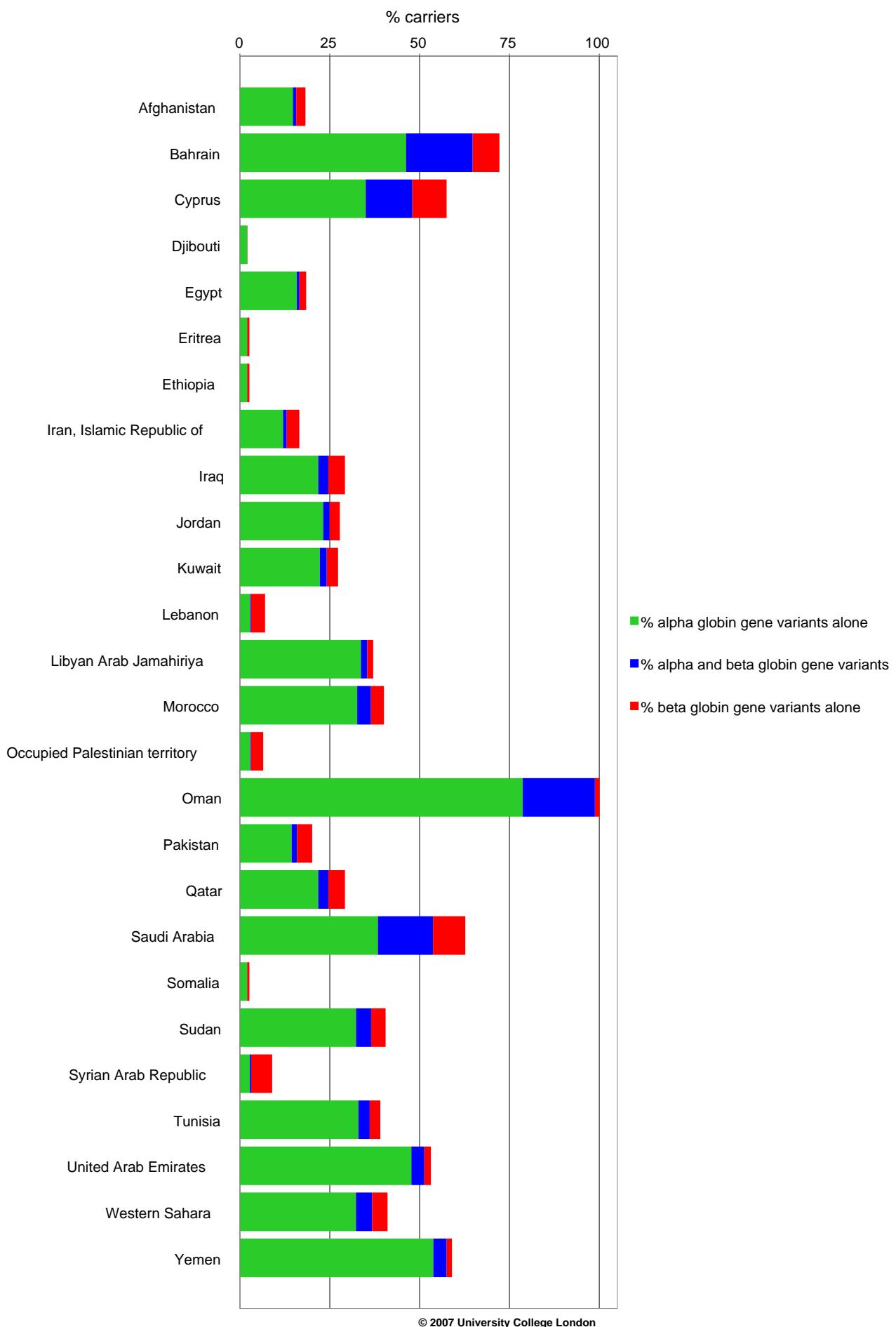
Country	% alpha zero thalassaemia carrier	% alpha plus thalassaemia carrier	% homozygous alpha plus thalassaemia
Afghanistan	0	14.389	0.806
Bahrain	0.07	43.855	11.561
Cyprus	1	35.19	5.29
Djibouti	0	1.935	0.032
Egypt	0	15.398	0.801
Eritrea	0	1.979	0.011
Ethiopia	0	1.979	0.011
Iran, Islamic Republic of	0	12.013	0.494
Iraq	0	21.383	1.809
Jordan	0	22.111	1.944
Kuwait	0	21.396	1.802
Lebanon	0	2.921	0.04
Libyan Arab Jamahiriya	0	30.487	4.057
Morocco	0	30.487	4.057
Occupied Palestinian territory	0	2.889	0.056
Oman	0	43.474	45.263
Pakistan	0	14.308	0.846
Qatar	0	21.383	1.809
Saudi Arabia	0	30.443	15.618
Somalia	0	1.979	0.011
Sudan	0	30.209	4.195
Syrian Arab Republic	0	2.889	0.056
Tunisia	0	30.487	4.057
United Arab Emirates	0	40.415	9.092
Western Sahara	0	30.487	4.057
Yemen	0	43.744	11.928
WHO Eastern Mediterranean Region aggregate carrier rates	0.001	16.595	2.658

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



Country	% AC	% AS	% A/beta thalassaemia	% AE	% A/other
Afghanistan	0	0	3	0	0.03
Bahrain	0	13.8	2.9	0	0.03
Cyprus	0	1	15	0	0.03
Djibouti	0	0	0.075	0	0.03
Egypt	0	0.2	2	0	0.03
Eritrea	0	0.1	0.5	0	0.03
Ethiopia	0	0.1	0.5	0	0.03
Iran, Islamic Republic of	0	1	3	0	0.03
Iraq	0	3	3	0	0.03
Jordan	0	0.22	3.5	0	0.03
Kuwait	0	4	0.075	0	0.03
Lebanon	0	1	3	0	0.03
Libyan Arab Jamahiriya	0.2	2	0.3	0	0.03
Morocco	1	1.5	3	0	0.03
Occupied Palestinian territory	0	0.5	3	0	0.03
Oman	0	7.983	3.298	0	0.03
Pakistan	0	0.18	4.558	0.18	0.03
Qatar	0	3	3	0	0.03
Saudi Arabia	0	9.866	6.745	0	0.03
Somalia	0	0.1	0.5	0	0.03
Sudan	0.1	2.1	3.9	0	0.03
Syrian Arab Republic	0	1	5	0	0.03
Tunisia	0.235	2.118	2.142	0	0.03
United Arab Emirates	0	1.89	1.71	0	0.03
Western Sahara	2	1.5	3	0	0.03
Yemen	0	0.95	2.36	0	0.03
WHO Eastern Mediterranean Region aggregate carrier rates	0.045	1.16	3.028	0.042	0.03

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

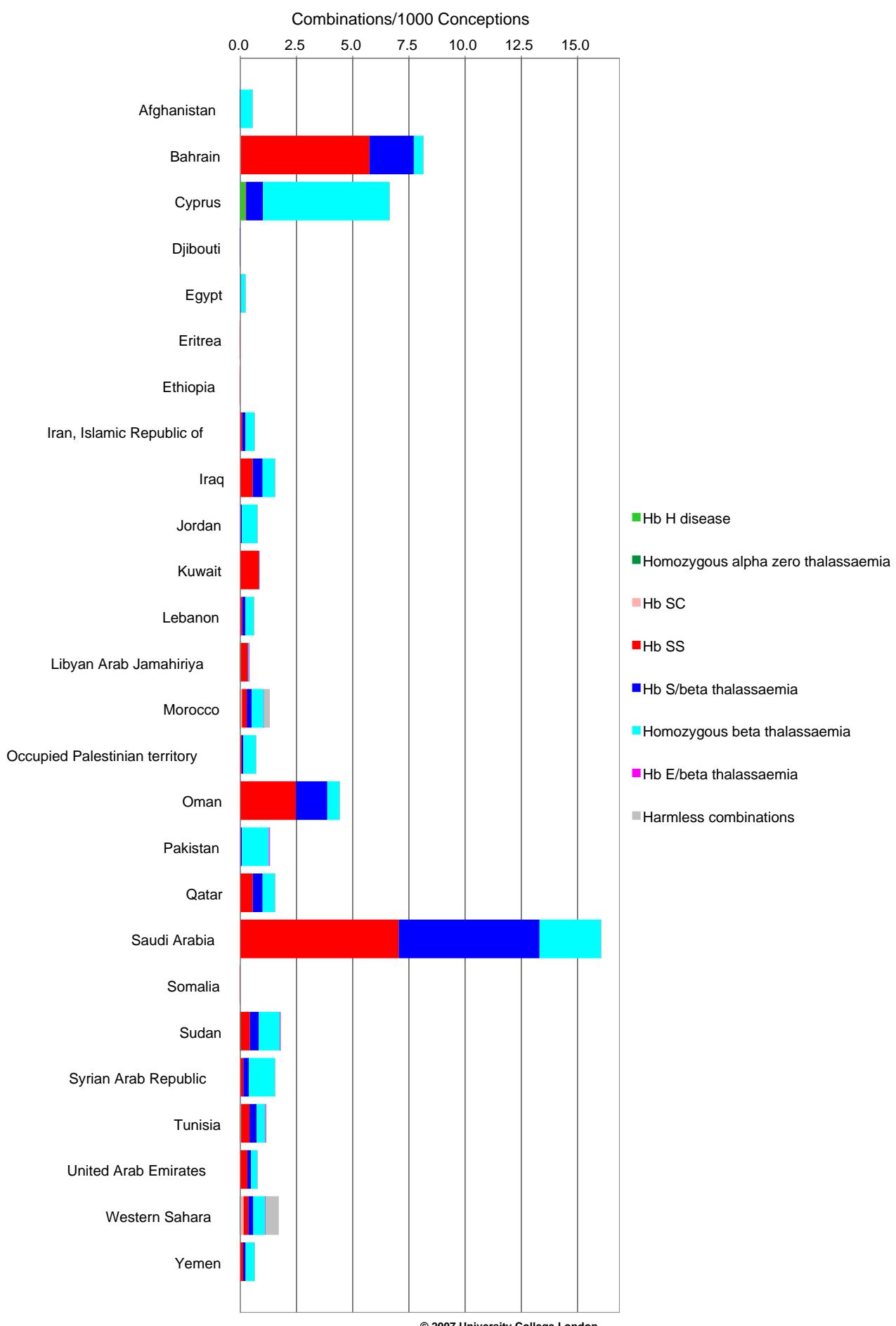


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Alpha and beta globin gene variants are inherited independently and do not interact to cause disease: many people carry both alpha and beta variants.

Country	% carriers of alpha globin gene variants alone	% carriers of both alpha and beta globin gene variants	% carriers of beta globin gene variants alone	Total % carriers
Afghanistan	14.734	0.921	2.57	18.224
Bahrain	46.215	18.542	7.459	72.216
Cyprus	34.991	12.978	9.541	57.51
Djibouti	1.966	0.004	0.103	2.073
Egypt	15.838	0.722	1.869	18.429
Eritrea	1.977	0.025	0.617	2.619
Ethiopia	1.977	0.025	0.617	2.619
Iran, Islamic Republic of	12.002	1.008	3.526	16.536
Iraq	21.793	2.797	4.632	29.221
Jordan	23.153	1.804	2.848	27.806
Kuwait	22.246	1.905	3.153	27.303
Lebanon	2.841	0.239	3.911	6.99
Libyan Arab Jamahiriya	33.669	1.748	1.656	37.073
Morocco	32.633	3.82	3.62	40.073
Occupied Palestinian territory	2.84	0.208	3.426	6.474
Oman	78.7	20.074	1.274	100.048
Pakistan	14.404	1.5	4.199	20.102
Qatar	21.793	2.797	4.632	29.221
Saudi Arabia	38.396	15.33	8.976	62.702
Somalia	1.977	0.025	0.617	2.619
Sudan	32.296	4.218	4.021	40.535
Syrian Arab Republic	2.767	0.355	5.852	8.974
Tunisia	32.98	3.126	2.962	39.069
United Arab Emirates	47.71	3.594	1.833	53.138
Western Sahara	32.288	4.511	4.274	41.073
Yemen	53.813	3.719	1.481	59.012
WHO Eastern Mediterranean Region aggregate carrier rates	18.121	2.265	3.173	23.559

Chart 7: Conceptions/1000 with combinations of significant variants

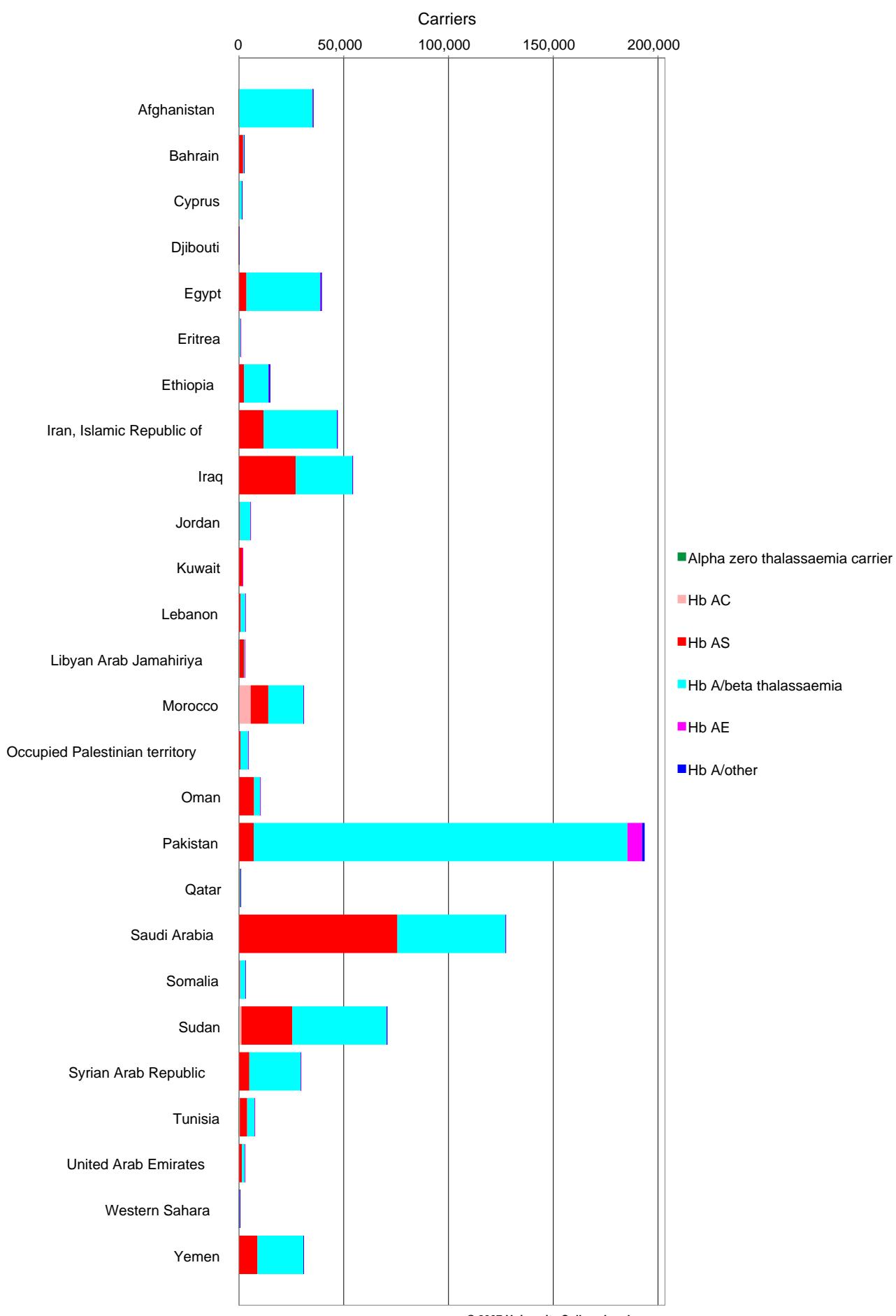


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Pathological combinations are shown individually. Harmless combinations are grouped together. For details see definitions.

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
Afghanistan	0	0	0	0	0	0.557	0	0	0.557	0.557
Bahrain	0.023	0	0	5.722	1.971	0.412	0	0	8.128	8.128
Cyprus	0.23	0.002	0	0.025	0.75	5.625	0	0	6.632	6.633
Djibouti	0	0	0	0	0	0.009	0	0	0.009	0.009
Egypt	0	0	0	0.011	0.02	0.2	0	0	0.231	0.231
Eritrea	0	0	0	0.001	0.002	0.008	0	0	0.011	0.011
Ethiopia	0	0	0	0.001	0.002	0.008	0	0	0.011	0.011
Iran, Islamic Republic of	0	0	0	0.082	0.148	0.397	0	0	0.628	0.628
Iraq	0	0	0	0.552	0.44	0.552	0	0	1.545	1.545
Jordan	0	0	0	0.025	0.038	0.693	0	0	0.756	0.756
Kuwait	0	0	0	0.829	0.015	0.008	0	0	0.852	0.852
Lebanon	0	0	0	0.082	0.148	0.395	0	0	0.626	0.626
Libyan Arab Jamahiriya	0	0	0.02	0.31	0.029	0.034	0	0.025	0.393	0.418
Morocco	0	0	0.073	0.212	0.22	0.536	0	0.275	1.041	1.316
Occupied Palestinian territory	0	0	0	0.062	0.073	0.557	0	0	0.691	0.691
Oman	0	0	0	2.473	1.397	0.56	0	0	4.43	4.43
Pakistan	0	0	0	0.026	0.04	1.201	0.04	0.026	1.308	1.334
Qatar	0	0	0	0.552	0.44	0.552	0	0	1.545	1.545
Saudi Arabia	0	0	0	7.043	6.265	2.749	0	0	16.057	16.057
Somalia	0	0	0	0.001	0.002	0.008	0	0	0.011	0.011
Sudan	0	0	0.01	0.418	0.397	0.951	0	0.034	1.776	1.81
Syrian Arab Republic	0	0	0	0.134	0.244	1.171	0	0	1.549	1.549
Tunisia	0	0	0.035	0.376	0.309	0.396	0	0.061	1.116	1.177
United Arab Emirates	0	0	0	0.317	0.158	0.279	0	0	0.753	0.753
Western Sahara	0	0	0.147	0.211	0.22	0.534	0	0.6	1.112	1.712
Yemen	0	0	0	0.128	0.11	0.4	0	0	0.638	0.638
WHO Eastern Mediterranean Region aggregate rates	0	0	0.004	0.439	0.395	0.688	0.009	0.019	1.536	1.554

Chart 8: Annual pregnant carriers of significant variants

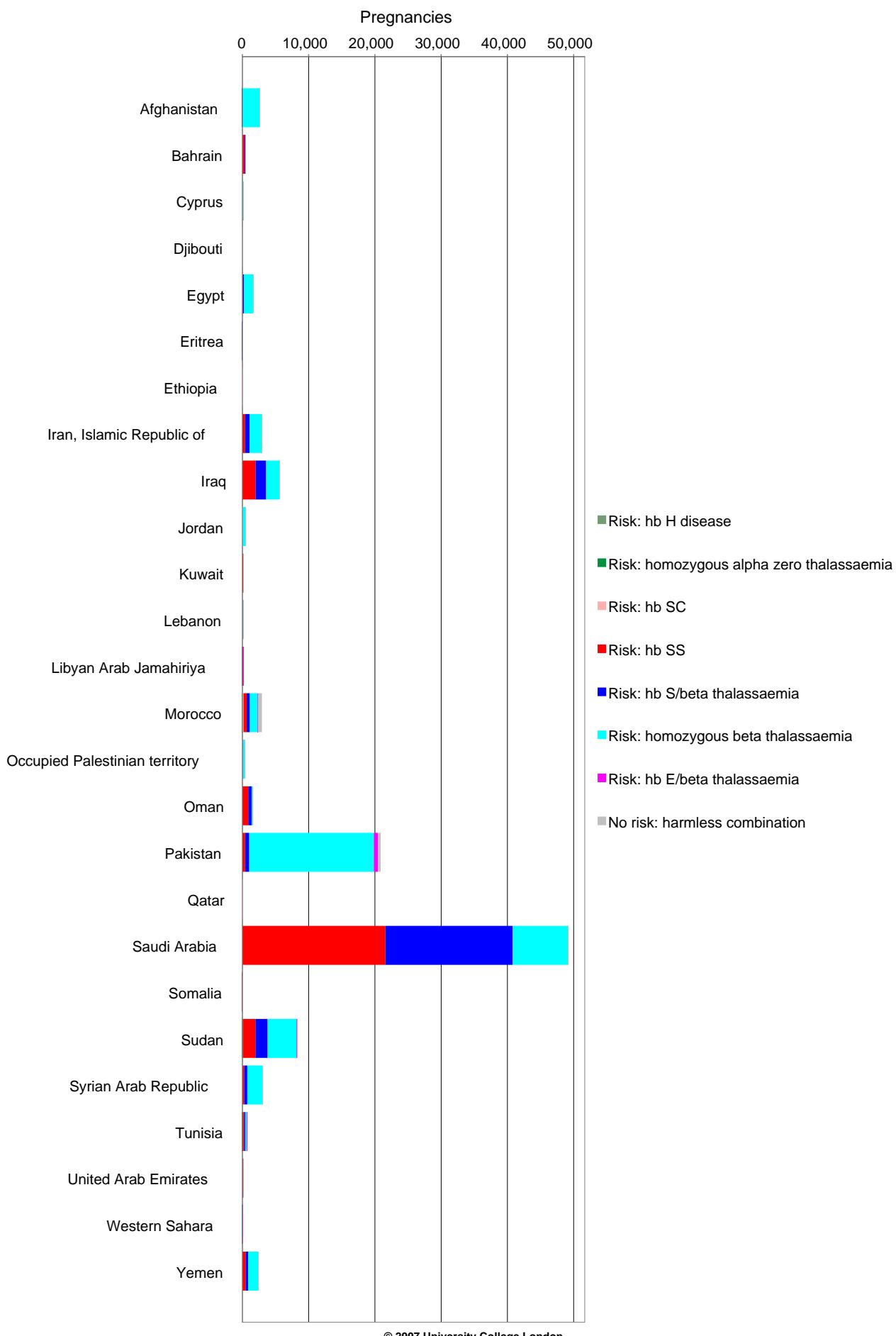


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Indicates requirement for information for carriers, and the offer of partner testing. Also indicates annual carriers detectable by neonatal screening.

Country	<i>Alpha zero thalassaemia carrier</i>	<i>Hb AC</i>	<i>Hb AS</i>	<i>Beta thalassaemia carrier</i>	<i>Hb AE</i>	<i>Hb A/other</i>	<i>Total carriers</i>
Afghanistan	0	0	0	35,289	0	352	35,641
Bahrain	9	0	1,949	409	0	4	2,371
Cyprus	80	0	80	1,211	0	2	1,373
Djibouti	0	0	0	23	0	9	32
Egypt	0	0	3,548	35,483	0	532	39,563
Eritrea	0	0	151	756	0	45	952
Ethiopia	0	0	2,379	11,897	0	713	14,989
Iran, Islamic Republic of	0	0	11,700	35,101	0	351	47,152
Iraq	0	0	27,095	27,095	0	270	54,460
Jordan	0	0	325	5,182	0	44	5,551
Kuwait	0	0	1,785	33	0	13	1,831
Lebanon	0	0	770	2,310	0	23	3,103
Libyan Arab Jamahiriya	0	221	2,215	332	0	33	2,801
Morocco	0	5,596	8,394	16,789	0	167	30,946
Occupied Palestinian territory	0	0	667	4,007	0	40	4,714
Oman	0	0	7,172	2,963	0	26	10,161
Pakistan	0	0	7,043	178,371	7,043	1,173	193,630
Qatar	0	0	386	386	0	3	775
Saudi Arabia	0	0	75,610	51,687	0	229	127,526
Somalia	0	0	504	2,524	0	151	3,179
Sudan	0	1,156	24,290	45,110	0	347	70,903
Syrian Arab Republic	0	0	4,931	24,657	0	147	29,735
Tunisia	0	391	3,522	3,562	0	49	7,524
United Arab Emirates	0	0	1,412	1,278	0	22	2,712
Western Sahara	0	178	133	267	0	2	580
Yemen	0	0	8,834	21,945	0	278	31,057
WHO Eastern Mediterranean Region total pregnant carriers	89	7,542	194,895	508,667	7,043	5,025	723,261

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

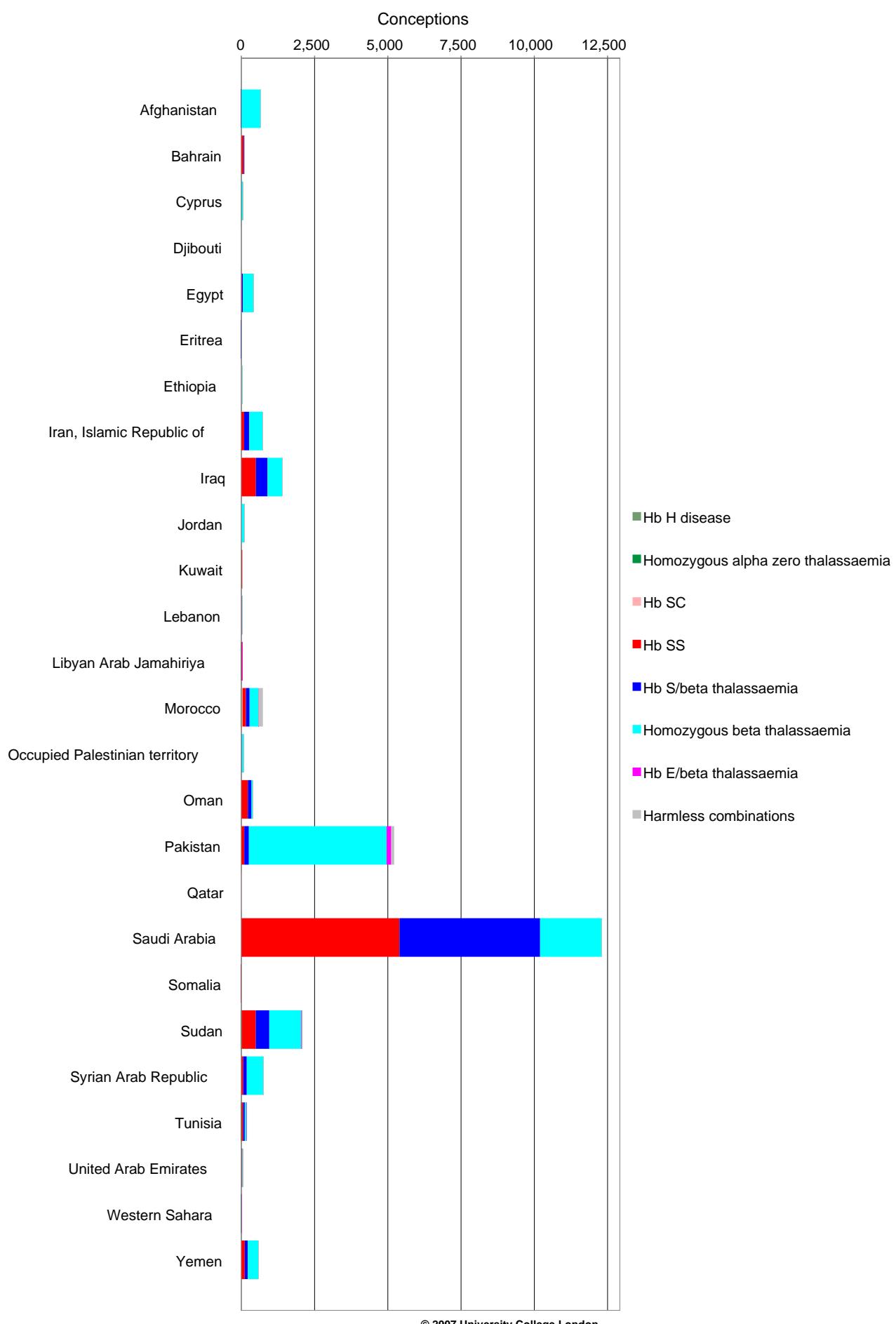


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Indicates requirement for expert risk assessment, genetic counselling and the offer of prenatal diagnosis.

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
Afghanistan	0	0	0	0	0	2,620	0	0	2,620	2,620
Bahrain	0	0	0	320	108	20	0	0	448	448
Cyprus	4	0	0	0	24	180	0	0	208	208
Djibouti	0	0	0	0	0	0	0	0	0	0
Egypt	0	0	0	76	140	1,416	0	0	1,632	1,632
Eritrea	0	0	0	0	0	4	0	0	4	4
Ethiopia	0	0	0	4	20	76	0	0	100	100
Iran, Islamic Republic of	0	0	0	384	692	1,856	0	0	2,932	2,932
Iraq	0	0	0	1,992	1,588	1,992	0	0	5,572	5,572
Jordan	0	0	0	12	20	408	0	0	440	440
Kuwait	0	0	0	148	0	0	0	0	148	148
Lebanon	0	0	0	24	44	120	0	0	188	188
Libyan Arab Jamahiriya	0	0	8	136	12	12	0	8	168	176
Morocco	0	0	164	472	492	1,196	0	616	2,324	2,940
Occupied Palestinian territory	0	0	0	32	36	296	0	0	364	364
Oman	0	0	0	888	500	200	0	0	1,588	1,588
Pakistan	0	0	0	404	632	18,800	632	404	20,468	20,872
Qatar	0	0	0	28	20	28	0	0	76	76
Saudi Arabia	0	0	0	21,588	19,204	8,424	0	0	49,216	49,216
Somalia	0	0	0	0	4	16	0	0	20	20
Sudan	0	0	44	1,932	1,836	4,400	0	156	8,212	8,368
Syrian Arab Republic	0	0	0	264	480	2,308	0	0	3,052	3,052
Tunisia	0	0	20	248	204	260	0	40	732	772
United Arab Emirates	0	0	0	92	44	80	0	0	216	216
Western Sahara	0	0	4	4	4	16	0	20	28	48
Yemen	0	0	0	472	404	1,488	0	0	2,364	2,364
WHO Eastern Mediterranean Region total pregnancies	4	0	240	29,520	26,508	46,216	632	1,244	103,120	104,364

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
Afghanistan	0	0	0	0	0	655	0	0	655	655
Bahrain	0	0	0	80	27	5	0	0	112	112
Cyprus	1	0	0	0	6	45	0	0	52	52
Djibouti	0	0	0	0	0	0	0	0	0	0
Egypt	0	0	0	19	35	354	0	0	408	408
Eritrea	0	0	0	0	0	1	0	0	1	1
Ethiopia	0	0	0	1	5	19	0	0	25	25
Iran, Islamic Republic of	0	0	0	96	173	464	0	0	733	733
Iraq	0	0	0	498	397	498	0	0	1,393	1,393
Jordan	0	0	0	3	5	102	0	0	110	110
Kuwait	0	0	0	37	0	0	0	0	37	37
Lebanon	0	0	0	6	11	30	0	0	47	47
Libyan Arab Jamahiriya	0	0	2	34	3	3	0	2	42	44
Morocco	0	0	41	118	123	299	0	154	581	735
Occupied Palestinian territory	0	0	0	8	9	74	0	0	91	91
Oman	0	0	0	222	125	50	0	0	397	397
Pakistan	0	0	0	101	158	4,700	158	101	5,117	5,218
Qatar	0	0	0	7	5	7	0	0	19	19
Saudi Arabia	0	0	0	5,397	4,801	2,106	0	0	12,304	12,304
Somalia	0	0	0	0	1	4	0	0	5	5
Sudan	0	0	11	483	459	1,100	0	39	2,053	2,092
Syrian Arab Republic	0	0	0	66	120	577	0	0	763	763
Tunisia	0	0	5	62	51	65	0	10	183	193
United Arab Emirates	0	0	0	23	11	20	0	0	54	54
Western Sahara	0	0	1	1	1	4	0	5	7	12
Yemen	0	0	0	118	101	372	0	0	591	591
WHO Eastern Mediterranean Region total pregnancies	1	0	60	7,380	6,627	11,554	158	311	25,780	26,091