

**OVERALL HEALTH SYSTEM ACHIEVEMENT
FOR 191 COUNTRIES**

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Introduction

The purpose of this paper is to describe how overall health system achievement has been measured for the 191 member countries of the World Health Organization in 1999.¹ In accordance with the WHO Framework for Health System Performance Assessment (1), overall health system achievement needs to be calculated as a first step before health system performance can be estimated using frontier production analysis (2,3). The Framework also argues that overall health system attainment is a function of attainment of three goals: health, responsiveness and fairness of financial contribution. Because societies are concerned with both the level and distribution of health and responsiveness, five components must contribute to overall health system attainment as shown in (Fig. 1).



Fig. 1: Health system goals.

Overall health system attainment is a composite or summary measure. Composite or summary measures are widely used in public policy and health policy debate. Familiar examples include life expectancy, gross domestic product per capita, and the Human Development Index. These measures summarize a broad range of outcomes in a single statistic. One of the chief advantages of composite or summary measures is that they facilitate comparative assessments across countries and over time. Few people would claim that the examples of composite measures cited above

¹ We refer to the concept of overall health system achievement variously as “composite goal achievement”, “composite index score” or “composite/overall goal attainment”

reveal everything of importance concerning, respectively, mortality, wealth or the state of development. Yet because of their comprehensibility and the advantages of simplicity of communication and concision, composite measures have become as much an established part of the policy debate in health as in other fields.

Functional Form for Overall Health System Attainment

The general form of the overall measure of health system attainment is simply:

$$Composite = f(H, HI, R, RI, FF)$$

where H is the level of health, HI is health inequality, R is responsiveness, RI is responsiveness inequality and FF is fairness of financial contribution. Details on how each of these health system goals are conceptualized and measured are available elsewhere (4,5,6,7,8,9,10,11). Nevertheless, an important question is how do measures of each of the five components get combined into a composite measure. The simplest approach would be to define the composite as a linear aggregate of the five components such that:

$$Composite = a_1H + a_2HI + a_3R + a_4RI + a_5FF$$

For example, the Human Development Index is simply a linear aggregate of rescaled life expectancy, income per capita and literacy where the weights are one-third for each (12). The additive form has the tremendous advantage of simplicity of calculation and ease of communication and comprehension. Nevertheless, more complex forms are possible. For example, health might matter more depending on the level of health that has been achieved. We have not pursued the development of more complex options for defining the composite because we have not theoretical or empirical basis to postulate these alternative forms (13).

The choice of the alphas for each component could have been based on some arbitrary choice. For the World Health Report 2000, however, the weights have been based on survey of preferences of informed individuals for these five components (13). The results of this survey in terms of the weights for the five components overall were 0.24 for health, 0.25 for health inequality, 0.13 for level of responsiveness, 0.16 for distribution of responsiveness and 0.22 for fairness of financial contribution. To make the definition of the composite easier to understand, these survey results have been rounded to the nearest one-eighth so that the final weights to be used are 0.25 for health, 0.25 for health inequality, 0.125 for level of responsiveness, 0.125 for distribution of responsiveness and 0.25 for fairness of financial contribution.

Before applying these weights to calculate the composite, each component measure was rescaled on a 0 to 100 scale: for healthy life expectancy, $H_{rescaled} = ((H - 20)/(80 - 20)) \times 100$, for health inequality, $HI_{rescaled} = (1 - HI) \times 100$, for responsiveness level, $R_{rescaled} = (R \div 10) \times 100$, for responsiveness inequality, $RI_{rescaled} = (1 - RI) \times 100$, for fairness in financing, $FF_{rescaled} = FF \times 100$. The overall composite was, therefore, a number on the interval 0 to 100, with 100 being the highest possible level of attainment.

Calculation of Overall Health System Attainment

For each of the five components, the measurement and estimation efforts had generated an uncertainty interval. This uncertainty has been propagated forward into the computation of the composite measure of overall health system attainment. For each country, the distribution of each component was randomly sampled to generate 1000 draws of each. This process resulted in the compilation of five component matrices (191 columns \times 1000 rows), the column values of which represented all available information, for 191 countries, about the uncertainty surrounding each component of the composite index. Each component matrix was sampled a row at a time without replacement, and the overall achievement health system attainment was computed 1000 times for the 191 countries. This yielded a composite achievement matrix (191 columns \times 1000 rows). The latter was likewise sampled a row at a time, and for each row, the rank order implied by the composite scores in that row was calculated for each country. The composite achievement matrix was also used to calculate by column the mean value and uncertainty intervals (10th and 90th percentiles) of attainment for each country. Rank was calculated on the basis of mean achievement, but the 1000 individual row-wise ranks calculated for each country were used to determine uncertainty intervals (10th and 90th percentiles) around rank.

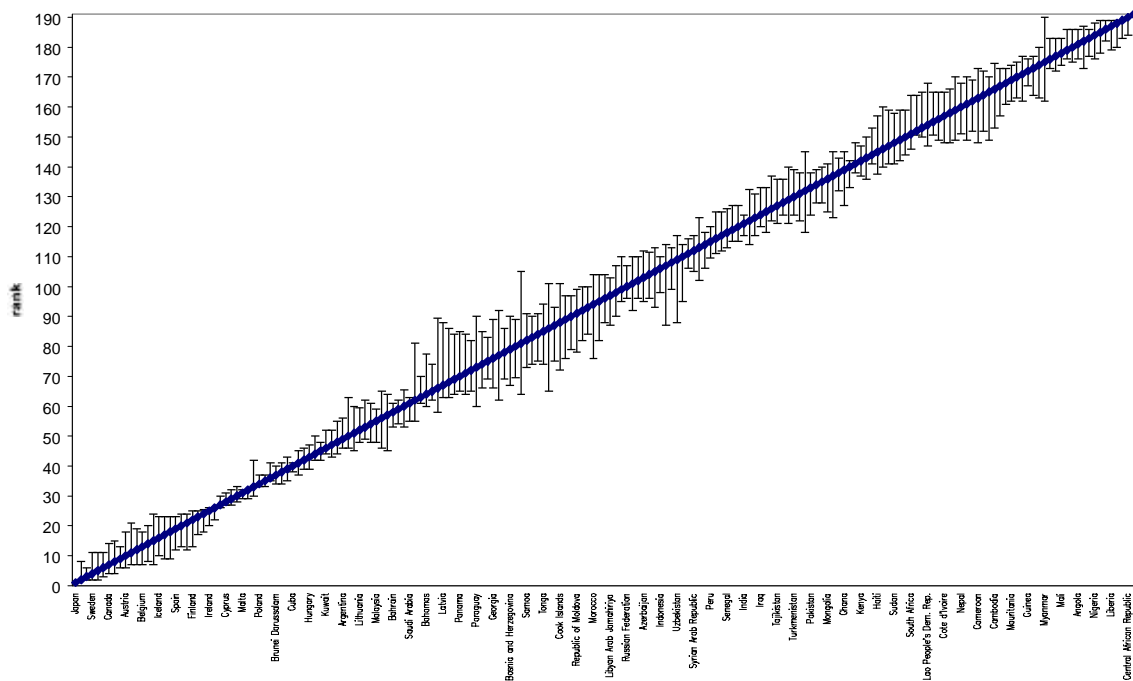
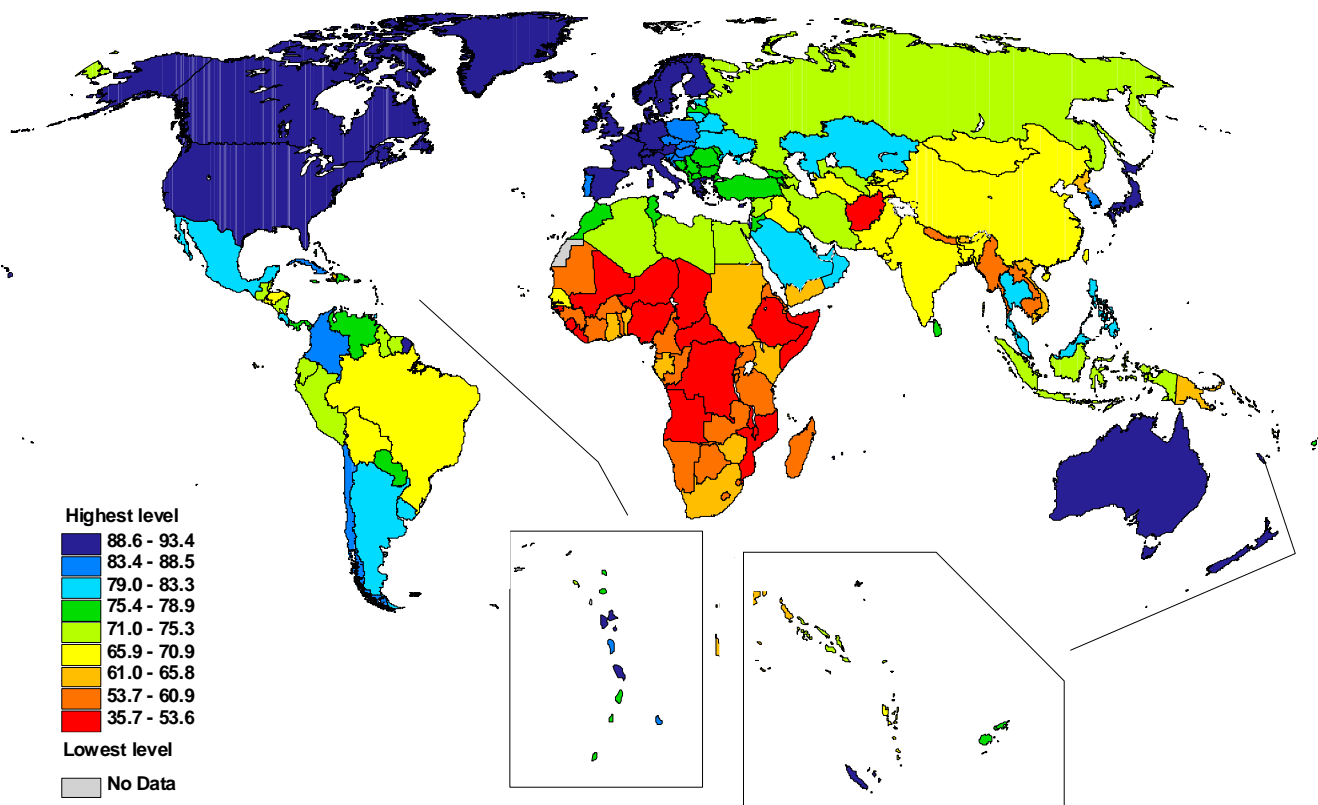


Fig. 2: Uncertainty of rank order on the composite index achievement score.



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Fig. 3: Global distribution of overall health system attainment, 191 member countries of WHO, estimates for 1997.

Table 1 (Annex) provides a summary of the mean rank and score for overall health system attainment for 191 countries. It also provides the 80% uncertainty interval for both rank and the score. Figure 2 shows the rank uncertainty intervals for countries ordered by the mean rank for each country. Note that the x-axis lists only a subset of country names but data for all 191 countries are shown. Measurement uncertainty for

each of the five components even for countries with high levels of attainment is such that the four countries could be second (Switzerland, Norway, Sweden and Luxembourg) and even the second ranked country Switzerland (rank interval 2-8) could in fact be doing worse than the 15th ranked country the United States (rank interval 7-24).

An easier way to interpret the results may be to examine the map in **Fig. 3** which divides overall attainment into nine bands from the lowest level of attainment of 35.7 in Sierra Leone to the highest level of attainment of 93.4 in Japan. The top ten countries in order are Japan, Switzerland, Norway, Sweden, Luxembourg, France, Canada, Netherlands, United Kingdom and Austria. Countries with the lowest levels of attainment are concentrated in sub-Saharan Africa.

It is interesting to note that this composite measure of overall health system attainment is highly rank correlated with UNDP's Human Development Index (**Fig. 4**). Both are measures of the social effort of society so that this is not surprising; the Human Development Index is constructed from measures of longevity, education, and income, all of which are likely to be correlated with not only population health outcomes but also with attainment of the non-health goals of health systems.

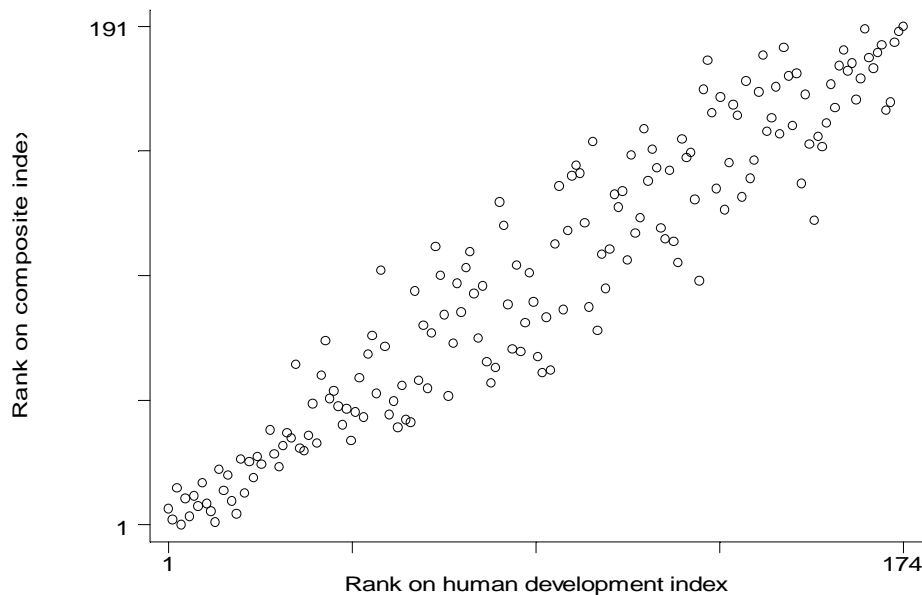


Fig. 4: Rank correlation between overall health system achievement and the Human Development Index.

Sensitivity analysis

Because the empirical basis for the measurement of the weights used to calculate the composite measure is limited, it is useful to explore the sensitivity of the results to plausible variation in the weights. We first identified plausible ranges on the weights for each of the five components based on consultation with those who developed the survey of health system preferences and expert consultation within WHO.

Sensitivity of the composite index to the values of weights was investigated using random weights drawn from beta distributions. The two parameters of the beta distribution were chosen so as to ensure reasonably complete sampling over the ranges identified, i.e. “fat tails” were selected for skewed distributions. The sampling ranges, shown in **Table 2**, are much greater than the range of systematic variation in the survey results and as such are likely to exaggerate the sensitivity to the results to variation in weights.²

² While the beta distribution is restricted to the interval [0,1], a linear function of a beta-distributed random variable can be used to scale the sampling interval appropriately.

One hundred random draws were made from each of the five distributions. Taken row-wise, the resulting ordered quintuples ($\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$) were rescaled to ensure additivity to 100 while preserving relative magnitudes.

Table 2: Means, upper and lower bounds and the parameters of the beta distributions used to draw random weights.

Component	Mean	Minimum	Maximum	Distribution
Health	25	20	40	$20+[20*\text{Beta}(0.368, 1.1)]$
Health inequalities	30	20	30	$20+[20*\text{Beta}(2, 2)]$
Responsiveness level	12.5	5	15	$5+[10*\text{Beta}(1.1, 0.368)]$
Responsiveness distribution	12.5	5	15	$5+[10*\text{Beta}(1.1, 0.368)]$
Fair financing	25	15	35	$15+[20*\text{Beta}(2, 2)]$

The distributions of the rescaled weights approximately matched, with respect to the mean values and upper and lower bounds, the beta distributions listed in Table 2.

For each set of weights thus obtained, overall achievement and achievement rank were calculated for each country. This resulted in an achievement matrix (191 columns \times 100 rows), as well as a rank matrix of the same size. The mean value and sensitivity intervals (the 10th and 90th percentiles) of achievement score for each country were computed column-wise from the achievement matrix. Rank was calculated on the basis of mean achievement, but sensitivity intervals for rank were calculated as the 10th and 90th percentiles of the 100 country-specific rank values in the rank matrix.

Neither the rank or score of overall health system attainment was sensitive to the variation in the choice of weights. **Fig. 5** shows that for only a small number of countries was there any substantive change in rank. Perhaps, not surprisingly, where countries are closely clustered in their overall health system attainment score, rank sensitivity is greatest. The results in Fig. 5 dramatically demonstrate that overall health system attainment is robust to wide variation in the weights assigned to the five components in the total.

Discussion

Overall health system attainment varies widely across countries. This variation is highly correlated with general levels of human development as captured in the Human Development Index. Perhaps, not surprisingly, richer more educated countries have better levels of health, responsiveness and fairness of financial contribution. In subsequent analyses the efficiency with which these health systems produce these outputs is explored (2,3). But for many citizens, the overall level of health system

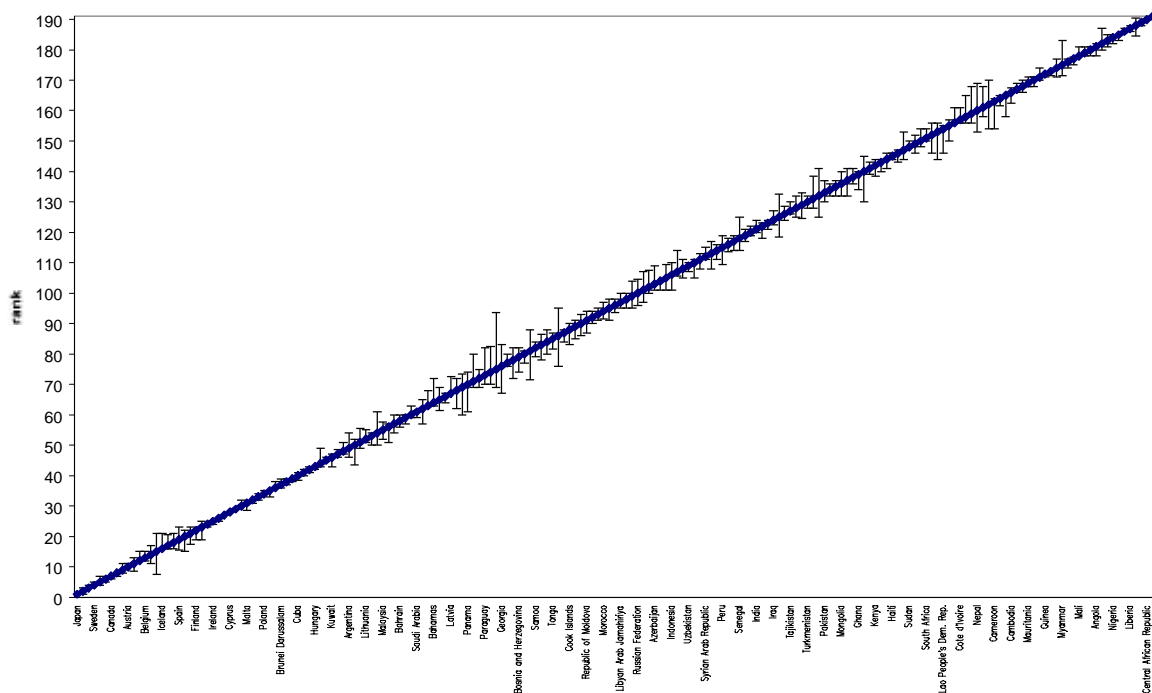


Fig. 5: Sensitivity of rank order on composite index achievement score to the choice of weights.

attainment may be the most important aspect to monitor. This composite measure can best be considered as the health-system-specific analogue of the Human Development Index or GDP per capita.

Calculation of the composite requires a functional form relating the composite to the five components and a set of weights. For this analysis, we used a slight modification of empirically derived weights from a survey of 1007 individuals from 121 countries. Further empirical measurement planned by WHO will provide a wider range of preferences for developing the weights included in the composite measure. Nevertheless, the sensitivity analysis provided in this paper demonstrates that even wide variation in the weights assigned to each component will have little or no effect

on the rankings of countries. This stability is in part due to the fact that each of the components is correlated with each other.

Some critics of the development of a composite measure of overall health system attainment may argue that global comparisons should not be undertaken because every society will have dramatically different weights on the five components. The survey work to date does not support such wide variation in population average weights. If more extensive health system preference measurement does demonstrate that average weights on the five components vary across populations in a substantive fashion, it will still be useful to compare countries using the global average weights and provide the detailed information on each component (which WHO already does) so that different countries could calculate alternative variants for their own use.

The uncertainty analysis demonstrates that uncertainty in the measurement of the components contributes much more to rank uncertainty than potential variation in the weights attached to the five components. Improving the measurement of healthy life expectancy, inequality in child survival, responsiveness level and inequality and fairness of financial contribution will help narrow the rank uncertainty in the overall health system attainment. As noted elsewhere in this series of technical papers, efforts are underway in many countries to improve the measurement by reanalysis of existing data and the collection of new data.

Annex

Table 1: Overall health system achievement with uncertainty intervals, 191 member states of WHO.

Rank	Uncertainty Interval (80%)	Member State	Achievement Index	Uncertainty Interval (80%)
1	1 - 1	Japan	93.4	92.6 - 94.3
2	2 - 8	Switzerland	92.2	91.2 - 93.3
3	2 - 6	Norway	92.2	91.4 - 93.1
4	2 - 11	Sweden	92.0	91.1 - 93.0
5	2 - 11	Luxembourg	92.0	91.0 - 93.0
6	3 - 11	France	91.9	91.0 - 92.9
7	4 - 14	Canada	91.7	90.8 - 92.6
8	4 - 15	Netherlands	91.6	90.7 - 92.5
9	6 - 13	United Kingdom	91.6	90.9 - 92.3
10	6 - 18	Austria	91.5	90.5 - 92.4
11	7 - 21	Italy	91.4	90.5 - 92.2
12	7 - 19	Australia	91.3	90.4 - 92.2
13	7 - 18	Belgium	91.3	90.2 - 92.3
14	8 - 20	Germany	91.3	90.4 - 92.2
15	7 - 24	United States of America	91.1	89.9 - 92.3
16	10 - 23	Iceland	91.0	90.0 - 92.1
17	9 - 23	Andorra	91.0	90.1 - 92.0
18	9 - 23	Monaco	91.0	90.0 - 92.0
19	12 - 23	Spain	91.0	90.1 - 91.8
20	13 - 24	Denmark	90.9	90.0 - 91.8
21	12 - 24	San Marino	90.9	90.0 - 91.7
22	13 - 25	Finland	90.8	89.8 - 91.7
23	17 - 25	Greece	90.5	89.7 - 91.3
24	18 - 26	Israel	90.5	89.6 - 91.3
25	20 - 26	Ireland	90.2	89.3 - 91.1
26	22 - 26	New Zealand	90.1	89.3 - 91.0
27	26 - 30	Singapore	88.9	87.4 - 90.3
28	27 - 31	Cyprus	88.6	87.4 - 89.6
29	27 - 32	Slovenia	87.9	86.5 - 89.2
30	28 - 33	Czech Republic	87.8	86.9 - 88.7
31	29 - 32	Malta	87.7	86.9 - 88.5
32	29 - 32	Portugal	87.6	86.3 - 88.9
33	30 - 42	Chile	86.0	84.6 - 87.2
34	33 - 37	Poland	85.8	85.0 - 86.6
35	33 - 37	Republic of Korea	85.7	83.4 - 87.7
36	35 - 41	Croatia	85.1	83.8 - 86.4
37	34 - 40	Brunei Darussalam	84.9	83.4 - 86.3
38	34 - 41	Barbados	84.9	83.7 - 86.0
39	35 - 43	Slovakia	84.7	83.0 - 86.0
40	38 - 41	Cuba	84.2	83.5 - 85.0
41	37 - 45	Colombia	83.8	82.6 - 84.9
42	39 - 46	Dominica	83.4	82.0 - 84.6
43	39 - 47	Hungary	83.4	82.2 - 84.4
44	42 - 50	United Arab Emirates	82.8	81.8 - 83.7
45	42 - 48	Costa Rica	82.5	81.7 - 83.4
46	44 - 52	Kuwait	82.3	81.2 - 83.3
47	43 - 52	Qatar	82.2	81.2 - 83.2
48	44 - 55	Estonia	81.7	80.2 - 83.1
49	46 - 56	Argentina	81.6	80.4 - 82.7
50	46 - 63	Uruguay	81.2	79.7 - 82.8
51	45 - 60	Mexico	81.1	79.2 - 82.7
52	48 - 60	Lithuania	81.0	79.5 - 82.5
53	49 - 62	Belarus	81.0	80.0 - 82.0
54	48 - 61	Philippines	80.9	79.6 - 82.0
55	48 - 59	Malaysia	80.8	79.2 - 82.2

56	46 - 65	Trinidad and Tobago	80.8	79.2 - 82.5
57	45 - 64	Thailand	80.7	78.8 - 82.5
58	53 - 61	Bahrain	80.4	79.3 - 81.3
59	54 - 62	Oman	80.2	79.2 - 81.1
60	53 - 66	Ukraine	80.1	78.5 - 81.5
61	55 - 63	Saudi Arabia	80.0	79.0 - 80.9
62	55 - 81	Kazakhstan	79.0	76.7 - 81.1
63	61 - 70	Palau	78.8	77.8 - 79.8
64	60 - 78	Bahamas	78.6	77.2 - 80.0
65	62 - 74	Venezuela, Bolivarian Republic of	78.5	77.4 - 79.6
66	58 - 90	Dominican Republic	78.1	76.0 - 80.3
67	63 - 88	Latvia	78.0	76.2 - 79.9
68	63 - 86	Grenada	77.9	76.8 - 78.9
69	64 - 84	Jamaica	77.9	76.4 - 79.4
70	65 - 85	Panama	77.9	76.9 - 78.8
71	64 - 84	Antigua and Barbuda	77.9	76.6 - 79.1
72	65 - 82	Romania	77.8	75.9 - 79.5
73	60 - 90	Paraguay	77.8	76.5 - 79.0
74	66 - 85	Bulgaria	77.6	76.9 - 78.4
75	69 - 83	Nauru	77.6	75.6 - 79.6
76	66 - 89	Georgia	77.5	76.6 - 78.4
77	62 - 92	Tunisia	77.5	76.4 - 78.5
78	69 - 86	Fiji	77.4	76.0 - 78.7
79	67 - 90	Bosnia and Herzegovina	77.3	75.8 - 78.7
80	70 - 89	Sri Lanka	77.3	76.1 - 78.3
81	64 - 105	Armenia	77.0	76.0 - 77.9
82	73 - 91	Samoa	76.9	75.9 - 78.0
83	74 - 90	Seychelles	76.8	75.8 - 77.8
84	75 - 91	Jordan	76.7	74.2 - 79.2
85	74 - 94	Tonga	76.7	75.6 - 77.8
86	65 - 101	Albania	76.7	73.7 - 79.2
87	75 - 93	Saint Lucia	76.7	75.5 - 77.9
88	72 - 101	Cook Islands	76.5	74.4 - 78.1
89	76 - 97	The former Yugoslav Republic of Macedonia	76.4	74.9 - 77.7
90	79 - 97	Mauritius	76.2	75.0 - 77.3
91	78 - 99	Republic of Moldova	76.1	74.6 - 77.6
92	82 - 100	Saint Vincent and the Grenadines	75.9	74.5 - 77.1
93	84 - 100	Lebanon	75.7	74.5 - 76.9
94	76 - 104	Morocco	75.7	73.8 - 77.5
95	82 - 104	Yugoslavia	75.5	73.7 - 77.2
96	88 - 104	Turkey	75.4	74.1 - 76.6
97	87 - 103	Libyan Arab Jamahiriya	75.3	73.9 - 76.5
98	90 - 107	Saint Kitts and Nevis	74.8	73.2 - 76.2
99	95 - 110	Algeria	74.4	73.6 - 75.2
100	96 - 107	Russian Federation	74.3	72.9 - 75.8
101	92 - 110	Nicaragua	74.2	72.7 - 75.5
102	96 - 110	Niue	74.1	72.6 - 75.4
103	95 - 112	Azerbaijan	74.0	72.1 - 75.7
104	96 - 112	Belize	74.0	71.7 - 76.5
105	93 - 113	Suriname	73.9	72.7 - 75.0
106	98 - 110	Indonesia	73.8	71.8 - 75.8
107	87 - 114	Ecuador	73.8	72.3 - 75.3
108	99 - 113	Solomon Islands	73.7	70.8 - 76.5
109	88 - 117	Uzbekistan	73.5	71.6 - 75.4
110	95 - 114	Egypt	73.5	71.8 - 74.9
111	106 - 116	Micronesia, Federated States of	72.4	70.9 - 73.8
112	105 - 117	Syrian Arab Republic	72.4	70.7 - 74.0
113	102 - 123	Guatemala	72.3	70.7 - 73.9
114	106 - 118	Iran, Islamic Republic of	72.0	69.5 - 74.2
115	110 - 120	Peru	71.5	70.3 - 72.7
116	111 - 125	Guyana	71.0	69.0 - 72.5
117	112 - 125	Bolivia	70.7	69.1 - 72.5
118	113 - 126	Senegal	70.5	68.9 - 72.1
119	115 - 127	Marshall Islands	70.3	68.6 - 71.6
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121	117 - 124	India	70.1	69.3 - 71.0
122	114 - 133	El Salvador	69.6	67.1 - 71.9
123	117 - 131	Kiribati	69.5	67.7 - 70.9

124	120 - 133	Iraq	69.0	67.4 - 70.6
125	118 - 133	Brazil	68.9	67.1 - 70.4
126	122 - 137	Cape Verde	68.3	66.1 - 70.1
127	121 - 136	Tajikistan	68.3	66.2 - 70.1
128	124 - 136	Maldives	68.0	66.2 - 69.5
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141	138 - 148	Gabon	64.5	62.7 - 66.2
142	137 - 147	Kenya	64.3	62.4 - 66.0
143	136 - 150	Benin	64.2	61.5 - 66.6
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145	138 - 157	Haiti	62.8	59.7 - 66.2
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147	141 - 159	Zimbabwe	62.3	59.1 - 65.3
148	141 - 158	Sudan	62.3	59.4 - 65.0
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153	150 - 165	Gambia	60.2	58.1 - 62.5
154	147 - 168	Lao People's Democratic Republic	60.1	57.9 - 62.1
155	151 - 165	Congo	60.1	57.9 - 62.2
156	149 - 165	Togo	60.0	57.3 - 62.5
157	148 - 165	Côte d'Ivoire	60.0	57.7 - 62.1
158	148 - 166	United Republic of Tanzania	60.0	58.0 - 62.1
159	149 - 170	Burkina Faso	59.4	57.5 - 61.4
160	151 - 168	Nepal	59.3	56.4 - 62.1
161	149 - 170	Burundi	59.3	56.4 - 62.1
162	152 - 169	Uganda	59.3	56.4 - 62.1
163	148 - 173	Cameroon	59.1	54.9 - 62.8
164	152 - 172	Swaziland	59.0	56.7 - 61.3
165	149 - 170	Namibia	58.8	55.7 - 61.3
166	153 - 175	Cambodia	58.2	54.3 - 61.3
167	157 - 173	Madagascar	57.8	55.3 - 60.2
168	161 - 173	Botswana	57.4	55.5 - 58.9
169	162 - 174	Mauritania	57.2	55.0 - 59.2
170	163 - 175	Djibouti	56.8	54.9 - 58.4
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173	164 - 177	Lesotho	56.0	54.0 - 57.7
174	163 - 180	Zambia	55.6	53.0 - 58.4
175	162 - 190	Myanmar	53.7	51.3 - 56.0
176	173 - 183	Eritrea	53.7	51.5 - 55.5
177	172 - 183	Chad	53.6	46.7 - 59.2
178	174 - 183	Mali	53.3	50.9 - 55.6
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188	180 - 189	Niger	50.1	47.0 - 53.4
189	183 - 189	Somalia	49.4	46.1 - 52.4
190	184 - 190	Central African Republic	45.9	39.0 - 52.0
191	191 - 191	Sierra Leone	35.7	23.7 - 43.8

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