

## Research Article,

# Ranking Countries According to Health: A Basis for Universal Primary Care

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**Abstract:**

Country Health is defined as the ratio of life-expectancy at birth to the product of under-five mortality rate and maternal mortality ratio. Forty-nine of the 172 countries studied have Country Health greater than 0.6, and are considered healthy. The remaining 123 countries have Country Health less than 0.6, and are considered sick. The range of values for life-expectancy, under-five mortality rate, and maternal mortality ratio among the 49 healthy countries are considered normal. All 123 sick countries have at least one of these parameters beyond normal limits. Twelve of the sick countries have only one, 27 have two, and 84 have all three parameters beyond normal limits. Country Health Equity is the ratio of Country Health to inequality in life expectancy, and Country Health Efficiency is the ratio of Country Health to annual per capita health expenditure. To achieve universal primary care, countries must work within and across national borders to enhance health, equity, and efficiency.

**Key Words:** Health, Wealth, Nations, Equity, Efficiency**Introduction:**

Sharing of health resources among countries is fundamental to fulfilling the Declaration of Astana and the Sustainable Development Goals [1]. Ideally, resources will flow from countries according to their ability to give help to countries according to their need for help. But this ideal will require a method for ranking countries according to their ability to give help and their need to receive it. No such method currently exists for countries, although an analogous method is employed routinely to distinguish normal from abnormal individuals. It is the purpose of this paper to adapt this diagnostic method to countries, and to rank the countries according to health.

Diagnostic tests for individual subjects are interpreted relative to normal ranges. Fasting plasma glucose concentrations, for example, between 70 and 115 mg/dl are typically considered normal. Subjects with fasting concentrations below 70 or above 115 are suspicious of pathology. This same process is applicable to public health. Countries report values with diagnostic potential, e.g., life-expectancy at birth (LE), under-five mortality rate (U5MR), and maternal mortality ratio (MMR). I call these the vital signs of public health. But normal ranges have not been established. Longer LE and shorter U5MR and MMR suggest better

health. But correlation coefficients among these three vital signs are only moderate [2]. And, at present, we can't specify limits on normal. For that reason, we can't dichotomize countries as healthy and sick, or apply the diagnostic reasoning common to clinical pathology. In this paper, I report a simple objective method for establishing normal ranges for LE, U5MR, and MMR. With this method, I dichotomize the countries of the world as healthy or sick, and rank them according to health.

### Method:

The World Health Organization in 2019 reported health statistics on 194 countries [3]. For 22 of these countries, the data was insufficient for analysis. The remaining 172 countries reported LE, U5MR, MMR, and per capita health expenditure in comparable estimates of US dollars (Health \$/c), and all these countries were included in this study. Of these 172 countries, 161 also reported adolescent birth rates per 1000 women aged 15-19 years. Inequality in life expectancy at birth (IneqLE) and physicians per 10,000 people were obtained from the United Nations Development Program [4]. Two countries, Haiti and South Sudan, did not report physician density. I define Country Health as:  $LE / (U5MR) (MMR)$ . I ignore units and use Country Health as a measure of relative rank. For any country, the higher the value, the better the health. With this parameter, I calculate two additional units-less indices: Country Health Equity = Country Health/IneqLE and Country Health Efficiency = Country Health/Health \$/c.

### Results:

All 172 countries studied are listed in Table 1 in order of Country Health. Values range from 13.73 (Iceland) to .0004 (Sierra Leone). Country Health Equity ranges from 3.99 (Finland) to .0000092 (Sierra Leone), while Country Health Efficiency ranges from .0146 (Belarus) to .0000047 (Sierra Leone). USA leads all countries in Health\$/c at \$9870. Luxembourg leads all countries in IneqLE with the *smallest* value at 2.6. All countries with Country Health > .6 have LE > 74.1, and U5MR <

10, and MMR < 19. I call these 49 countries healthy. All countries with Country Health < .6 have LE < 74.1, and/or U5MR > 10, and/or MMR > 19. I call these 123 countries sick.

**Table1. Country Health, Country Health Equity, and Country Health Efficiency**

| Country     | Health | Equity | Efficiency |
|-------------|--------|--------|------------|
| Iceland     | 13.73  | 3.71   | .0029      |
| Finland     | 13.57  | 3.99   | .0033      |
| Italy       | 6.89   | 2.3    | .0025      |
| Sweden      | 6.86   | 2.08   | .0012      |
| Czechia     | 6.59   | 2.2    | .005       |
| Japan       | 5.61   | 1.75   | .0013      |
| Spain       | 5.53   | 1.58   | .0023      |
| Norway      | 5.50   | 1.67   | .00074     |
| New Zealand | 5.50   | 1.20   | .0015      |
| Greece      | 5.41   | 1.46   | .0035      |
| Poland      | 5.18   | 1.00   | .0064      |
| Austria     | 5.11   | 1.38   | .0011      |
| Belarus     | 4.64   | .80    | .0146      |
| Slovenia    | 4.49   | 1.25   | .0025      |
| Switzerland | 4.17   | 1.10   | .00042     |
| Israel      | 4.12   | 1.06   | .0015      |
| Cyprus      | 3.84   | .96    | .0024      |
| Australia   | 3.45   | .80    | .00069     |
| Denmark     | 3.38   | .89    | .00061     |
| Germany     | 3.37   | .91    | .00072     |
| Netherlands | 2.91   | .79    | .00061     |
| Belgium     | 2.90   | .73    | .0007      |
| Estonia     | 2.88   | .60    | .0024      |
| Singapore   | 2.76   | .92    | .0011      |
| Luxembourg  | 2.75   | 1.06   | .00044     |
| Montenegro  | 2.74   | .53    | .0052      |
| France      | 2.59   | .65    | .00061     |
| Ireland     | 2.55   | .69    | .00054     |
| Rep. Korea  | 2.51   | .68    | .0012      |
| Canada      | 2.37   | .50    | .00053     |
| Kuwait      | 2.34   | .33    | .0022      |
| UK          | 2.26   | .50    | .00057     |
| Slovakia    | 2.15   | .41    | .0018      |
| Portugal    | 2.04   | .52    | .0011      |

|                   |      |      |         |
|-------------------|------|------|---------|
| Croatia           | 1.96 | .43  | .0022   |
| Lithuania         | 1.88 | .34  | .0019   |
| Malta             | 1.51 | .34  | .00065  |
| Unit. Arab Em.    | 1.43 | .25  | .0011   |
| Bosnia & Hers.    | 1.17 | .18  | .0026   |
| Latvia            | 1.04 | .16  | .0012   |
| Saudi Arabia      | .89  | .081 | .00078  |
| Hungary           | .89  | .171 | .00094  |
| Bulgaria          | .85  | .109 | .0014   |
| USA               | .80  | .131 | .000081 |
| Qatar             | .75  | .123 | .00042  |
| Bahrain           | .75  | .119 | .00068  |
| Serbia            | .75  | .095 | .0015   |
| Uruguay           | .65  | .068 | .00047  |
| Lebanon           | .64  | .089 | .00097  |
| Kazakhstan        | .59  | .051 | .0023   |
| Chile             | .52  | .068 | .00044  |
| Oman              | .412 | .059 | .00064  |
| Cuba              | .405 | .074 | .00042  |
| Turkey            | .398 | .034 | .00085  |
| Thailand          | .378 | .036 | .0017   |
| Russia            | .36  | .041 | .00077  |
| Costa Rica        | .358 | .044 | .0004   |
| Ukraine           | .34  | .039 | .0024   |
| China             | .314 | .035 | .00079  |
| Romania           | .303 | .036 | .00064  |
| Brunei Darussalam | .302 | .069 | .00048  |
| Albania           | .293 | .030 | .0011   |
| Sri Lanka         | .279 | .034 | .0018   |
| Malaysia          | .235 | .035 | .00065  |
| Barbados          | .233 | .030 | .0002   |
| Armenia           | .23  | .023 | .00064  |
| Iran              | .202 | .019 | .00029  |
| Moldova           | .194 | .022 | .0011   |
| Georgia           | .184 | .018 | .0006   |
| Belize            | .18  | .016 | .00059  |
| Grenada           | .16  | .018 | .00031  |
| Mexico            | .155 | .012 | .00034  |
| Argentina         | .148 | .015 | .00015  |
| Maldives          | .144 | .020 | .00014  |
| Bahamas           | .135 | .014 | .000074 |

|                  |      |        |         |
|------------------|------|--------|---------|
| Azerbaijan       | .127 | .0059  | .00047  |
| Brazil           | .114 | .0079  | .00011  |
| Mauritius        | .109 | .0111  | .00020  |
| Cabo Verde       | .103 | .0077  | .00064  |
| St. VIN. & Gren. | .100 | .0079  | .00040  |
| Egypt            | .097 | .0072  | .00074  |
| Tunisia          | .094 | .0077  | .00037  |
| Mongolia         | .093 | .0054  | .00066  |
| Fiji             | .093 | .0076  | .00052  |
| St. Lucia        | .093 | .0092  | .00019  |
| El Salvador      | .091 | .0066  | .00031  |
| Uzbekistan       | .087 | .0036  | .00064  |
| Samoa            | .087 | .0065  | .00038  |
| Ecuador          | .080 | .0052  | .00016  |
| Jordan           | .075 | .0063  | .00034  |
| Peru             | .074 | .0052  | .00023  |
| Columbia         | .078 | .0054  | .00023  |
| Viet Nam         | .067 | .0047  | .00055  |
| Tajikistan       | .065 | .0028  | .0016   |
| Jamaica          | .057 | .0048  | .00019  |
| Panama           | .052 | .0045  | .00005  |
| Iraq             | .047 | .0024  | .00031  |
| Kyrgyzstan       | .047 | .0035  | .00064  |
| Trin. & Tobago   | .044 | .0027  | .000041 |
| Tonga            | .037 | .0027  | .00018  |
| Turkmenistan     | .035 | .0014  | .000083 |
| Vanuatu          | .034 | .0022  | .00031  |
| Honduras         | .032 | .0016  | .00016  |
| Solomon          | .030 | .0013  | .00028  |
| Nicaragua        | .030 | .0021  | .00016  |
| Guatemala        | .030 | .0018  | .00012  |
| Morocco          | .027 | .0017  | .00016  |
| Paraguay         | .027 | .0015  | .000083 |
| Dominican Rep.   | .027 | .0016  | .000065 |
| Algeria          | .023 | .0012  | .000089 |
| Suriname         | .023 | .0017  | .000065 |
| Micronesia       | .022 | .0011  | .000057 |
| Indonesia        | .022 | .0013  | .00020  |
| Philippines      | .022 | .0014  | .00017  |
| Bhutan           | .015 | .00073 | .00017  |
| Cambodia         | .015 | .00076 | .00019  |
| Sao Tome         | .014 | .00052 | .00013  |

|              |      |         |          |
|--------------|------|---------|----------|
| Botswana     | .014 | .00067  | .000037  |
| Bangladesh   | .013 | .00065  | .00038   |
| Kiribati     | .013 | .00050  | .000069  |
| South Africa | .013 | .00051  | .000030  |
| India        | .010 | .00042  | .00016   |
| Bolivia      | .010 | .00035  | .000047  |
| Guyana       | .009 | .00044  | .000047  |
| Myanmar      | .008 | .00031  | .00013   |
| Nepal        | .008 | .00041  | .00018   |
| Timor-Leste  | .007 | .00029  | .000088  |
| Papua        | .006 | .00023  | .00011   |
| Rwanda       | .006 | .00036  | .000015  |
| Namibia      | .006 | .00028  | .000014  |
| Pakistan     | .005 | .00015  | .00013   |
| Laos         | .005 | .00019  | .000091  |
| Senegal      | .005 | .00020  | .000095  |
| Gabon        | .005 | .00018  | .000023  |
| Djibouti     | .005 | .00015  | .000071  |
| Zambia       | .005 | .00015  | .000088  |
| Ghana        | .004 | .00016  | .00017   |
| Uganda       | .004 | .00011  | .00011   |
| Madagascar   | .004 | .00016  | .00017   |
| Eritrea      | .003 | .00012  | .00010   |
| Sudan        | .003 | .000094 | .000020  |
| Ethiopia     | .003 | .000099 | .00011   |
| Kenya        | .003 | .000094 | .000045  |
| Comoros      | .003 | .000097 | .000051  |
| Congo        | .003 | .000097 | .000043  |
| Tanzania     | .003 | .00012  | .000086  |
| Haiti        | .003 | .000097 | .000079  |
| Zimbabwe     | .003 | .000096 | .000032  |
| Afghanistan  | .002 | .000056 | .000035  |
| Togo         | .002 | .000062 | .000051  |
| Burkina Faso | .002 | .00006  | .000049  |
| Malawi       | .002 | .000061 | .000067  |
| Angola       | .002 | .000050 | .000021  |
| Benin        | .002 | .000054 | .000067  |
| Eq. Guinea   | .002 | .000052 | .0000071 |
| Mozambique   | .002 | .000055 | .00011   |
| Mauritania   | .001 | .000030 | .000021  |
| Gambia       | .001 | .000032 | .000048  |
| Niger        | .001 | .000036 | .000044  |

|                |       |              |          |
|----------------|-------|--------------|----------|
| Guinea-Bissau  | .001  | .000022      | .000026  |
| Burundi        | .001  | .000033      | .000044  |
| Guinea         | .001  | .000028      | .000027  |
| D. R. Congo    | .001  | .000026      | .000048  |
| Cameroon       | .001  | .000025      | .000016  |
| Mali           | .001  | .000025      | .000033  |
| Liberia        | .001  | .000030      | .000015  |
| Lesotho        | .001  | .000030      | .000012  |
| South Sudan    | .0008 | .000020      | .00010   |
| Nigeria        | .0007 | .000017      | .0000089 |
| Chad           | .0005 | .000013      | .000016  |
| Cent. Af. Rep. | .0005 | .000012      | .000031  |
| Sierra Leone   | .0004 | .000009<br>2 | .0000047 |

Table 2 lists the total ranges for the vital signs of public health and some other relevant parameters over the 49 healthy (Country Health > .6) countries. Of the 123 sick countries, 12 have one vital sign abnormal, 27 have two vital signs abnormal, and 84 have all three vital signs abnormal. All countries with one abnormal vital sign have Country Health between .52 (Chile) and .135 (Bahamas). All countries with two abnormal vital signs have Country Health between .59 (Kazakhstan) and .023 (Algeria). All countries with three abnormal vital signs have Country Health between .194 (Moldova) and .0004 (Sierra Leone), and all countries with Country Health less than .023 (Suriname) have three abnormal vital signs. Of the 12 countries with one abnormal vital sign, 10 have high MMR, and two have high U5MR. Of the 27 countries with two abnormal vital signs, 24 have high MMR and U5MR, and three have short LE with either high MMR or U5MR. Of the 12 sick countries with one abnormal vital sign, three, or 25%, are below normal in Health \$/c *and/or* physician density *and/or* above normal in adolescent birth rate, *and/or* above normal in IneqLE. Of the 27 sick countries with two abnormal vital signs, 23, or 85%, are below normal in Health \$/c *and/or* physician density *and/or* above normal in adolescent birth rate, *and/or* above normal in IneqLE. Of the 84 sick countries with three abnormal vital signs, all, or 100%, are below

normal in Health \$/c *and/or* physician density *and/or* above normal in adolescent birth rate, *and/or* above normal in IneqLE. Over all countries studied, the correlation coefficient,  $r$ , between Country Health and LE is .547, between Country Health and U5MR is -.419, and between Country Health and MMR is -.333. I define Country Health Equity as Country Health/IneqLE and Country Health Efficiency as Health/Health\$/c. Both Country Health Equity and Country Health Efficiency are listed with Country Health in Table 1. Of the 123 sick countries, only Chile, Cuba, and Brunei Darussalam have normal Country Health Equity. The remaining 120 sick countries have below normal Country Health Equity. Of the 123 sick countries, 82 have normal Country Health Efficiency. The remaining 41 sick countries have below normal Country Health Efficiency.

**Table 2. Normal Ranges (Ranges of Values among Healthy Nations)**

| Parameter                                    | Normal Range                           |
|--|--|
| LE   | 74.2 (Belarus) – 84.2 (Japan)          |
| U5MR   | 2 (Finland) – 9 (United Arab Emirates) |
| MMR  | 3 (Finland) – 18 (Latvia)              |
| IneqLE                                       | 2.6 (Luxembourg) – 11 (Saudi Arabia)   |
| Health \$/c                                  | 318 (Belarus) – 9870 (USA)             |
| Physicians/10,000                            | 9.2 (Bahrain) – 61.7 (Greece)          |
| Adolescent Birth Rate<br>1.3 (Rep. Korea)    | 51.3 (Uruguay)- 1.3 (Rep. Korea)       |
| Country Health<br>Efficiency.000081<br>(USA) | .0146 (Belarus)-<br>.00008 (USA)       |
| Country Health<br>Equity.068 (Uruguay)       | 3.99 (Finland) - .068<br>(Uruguay)     |
| Country Health.64<br>(Lebanon)               | 13.73 (Iceland) - .64<br>(Lebanon)     |

Table 3 lists relevant  $r$  values. National Health is a preliminary version of Country Health, which utilized adult mortality rate in addition to LE, U5MR, and MMR [1]. The high correlation between Country Health and National Health shows adult mortality rate to be unnecessary.

**Table 3. Relevant Correlation Coefficients across All 172 Countries**

| Correlated Parameters                              | $r$  |
|--|------|
| Country Health vs Country Health Equity            | .987 |
| Country Health vs Country Health Efficiency        | .536 |
| Country Health Equity vs Country Health Efficiency | .458 |
| Country Health vs Health \$/c                      | .636 |
| Country Health vs IneqLE                           | -    |
|  | .515 |
| Country Health vs National Health                  | .967 |

### Discussion/Conclusion:

Because the  $r$  values among the vital signs of public health are only moderate [2], and because the  $r$  values between Country Health and each of these vital signs is only moderate, the information in Country Health is unique. Is it also useful? The utility of a diagnostic test is captured in two parameters, sensitivity, the percentage of results that are positive among sick subjects, and specificity, the percentage of results that are negative among healthy subjects. If we define healthy countries as those with LE, U5MR, *and* MMR within the normal ranges, and if we define Country Health greater than .6 as a negative result. Then, because all 49 healthy countries, have Country Health greater than .6, Country Health is 100% specific, i.e., it's negative in all healthy countries. By the above definition, any country with LE less than the normal limit *and/or* U5MR greater than the normal limit *and/or* MMR greater than the normal limit is sick. Then because Country Health less than .6 is a positive result, and because all 123 sick countries have Country Health less than .6, Country Health is 100%

sensitive, i.e., it's positive in all sick countries. Diagnostic tests don't get more useful than that. Country Health Equity is almost as good with 100% specificity and 97.6% sensitivity. Country Health Efficiency is less useful as a diagnostic test with 100% specificity but only 33.3% sensitivity. The problem with efficiency is USA, a healthy country with extremely low efficiency (.000081). If we ignore USA because it is so unusually inefficient, and set the lower limit of normal efficiency at the healthy countries just above USA in efficiency, this new lower limit is .00042 (Switzerland and Qatar). With this new limit, 112 of the 123 sick countries have below normal Country Health Efficiency for a sensitivity of 91.1%. But the utility of Country Health Efficiency is not so much in distinguishing healthy from sick countries, as in recognizing waste. Belarus is the efficiency champion. If countries operated more like Belarus, they would get more health for their dollars and have more dollars to donate to sick countries. I suggest that countries with LE and U5MR and MMR all abnormal are sicker than countries with only two of these three vital signs abnormal, and that countries with two abnormal signs are sicker than those with only one abnormal vital sign. The relevant Health parameters, Health \$/c, physician density, adolescent birth rate, and IneqLE, support this suggestion. Of the 12 countries with one abnormal vital sign, only 25% were abnormal in one or more of the above parameters. Of the 27 countries with two abnormal vital signs, 85% were abnormal in one or more of the above parameters. Of the 84 countries with three abnormal vital signs, 100% were abnormal in one or more of the above health parameters. Because MMR is the most common abnormal vital sign, therapy should target this abnormality first. Empower women, reduce adolescent birth rates, and increase the density of female physicians. U5MR and IneqLE will fall and LE will rise automatically as consequences. To fulfill the Declaration of Astana, each country should work to enhance Country Health Equity and Efficiency by reducing barriers to health promotion and care,

and diminishing wasteful expenditure. But that alone will not be sufficient. To achieve universal primary care, we must reach across national borders to cultivate international triage [5]. USA, with its abysmal health efficiency, must lead the way by curtailing inefficient domestic health expenditure in order to fund more efficient expenditure in sick countries [6]. A world health tax from rich countries according to their ability to help to poor countries according to their need for help might be necessary. But "tax" is too mild a word. A *fine* on wealthy waste, perhaps as a percentage of country health inefficiency, will better express the world's rage at millions of children dying annually from lack of minimum essentials while American healthcare executives pursue obscene profits [7].

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