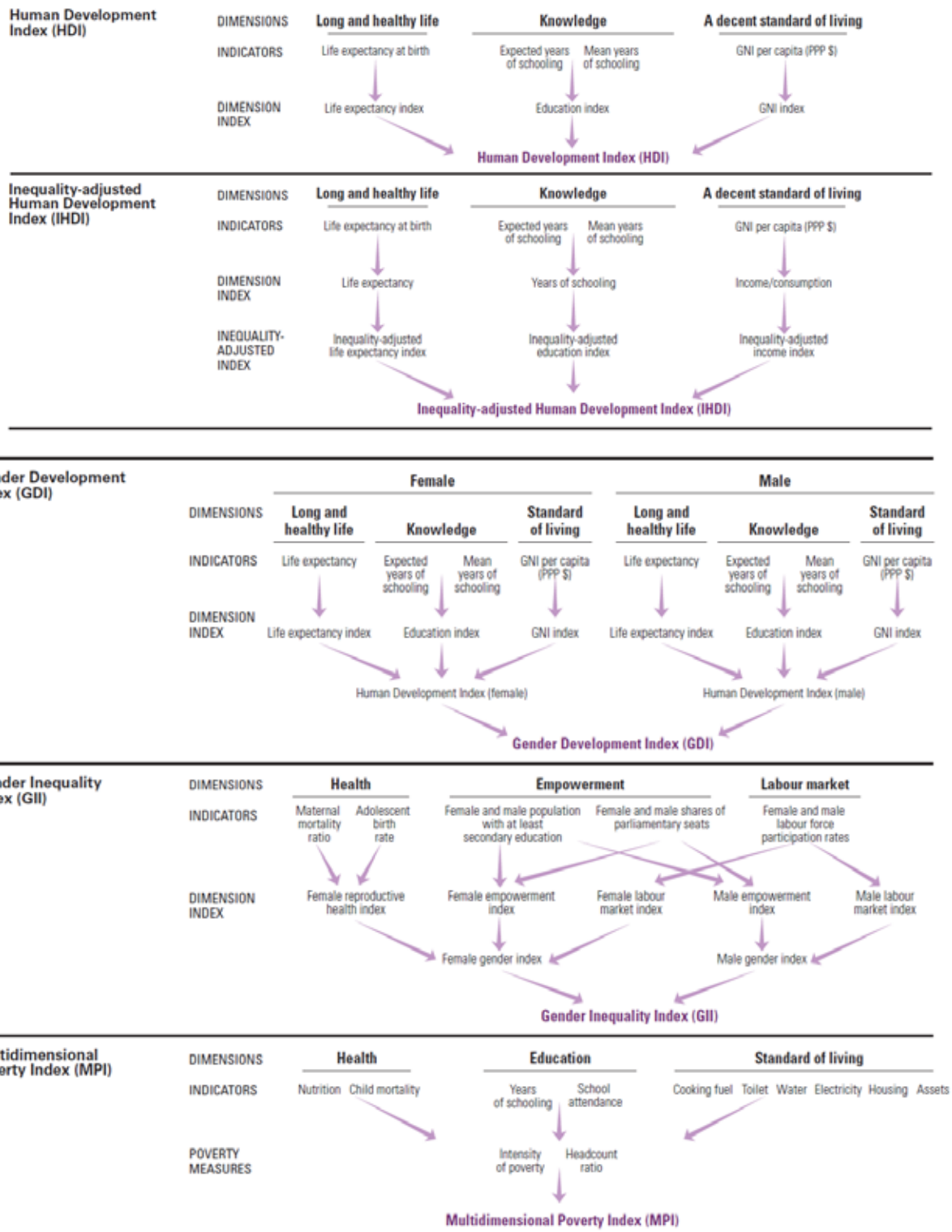
# Technical notes

## Calculating the human development indices—graphical presentation



# Technical note 1

## Human Development Index

The Human Development Index (HDI) is a summary measure of achievements in three key dimensions of human development: a long and healthy life, access to knowledge, and a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions. This technical note describes the data sources, steps to calculating the HDI, and the methodology used to estimate missing values.

### Data sources

Life expectancy at birth: UNDESA (2019)

Expected years of schooling: UNESCO Institute for Statistics (2020), ICF Macro Demographic and Health Surveys (2008-2020), United Nations Children's Fund (UNICEF) Multiple Indicator Cluster Surveys (2008-2020) and OECD (2019).

Mean years of schooling: UNESCO Institute for Statistics (2020), Barro and Lee (2018), ICF Macro Demographic and Health Surveys (2008-2020), UNICEF Multiple Indicator Cluster Surveys (2008-2020) and OECD (2019).

GNI per capita: World Bank (2020), IMF (2020), United Nations Statistics Division (2020)

### Steps to calculate the Human Development Index

There are two steps to calculating the HDI.

***Step 1. Creating the dimension indices***

Minimum and maximum values (goalposts) are set in order to transform the indicators expressed in different units into indices between 0 and 1. These goalposts act as "the natural zeros" and "aspirational targets", respectively, from which component indicators are standardized (see equation 1 below). They are set at the following values:

| Dimension | Indicator | Minimum | Maximum |
|---|---|---|---|
| Health | Life expectancy (years) | 20 | 85 |
| Education | Expected years of schooling (years) | 0 | 18 |
| | Mean years of schooling (years) | 0 | 15 |
| Standard of living | GNI per capita (2011 PPP$) | $100 | $75,000 |

The justification for placing the "natural zero" for life expectancy at 20 years is based on historical evidence that no country in the 20th century had a life expectancy of less than 20 years (Maddison, 2010; Oeppen and Vaupel, 2002; Riley, 2005). The maximum life expectancy set at 85 has been a realistic aspirational target for many countries over the last thirty years. Due to constantly improving living conditions and medical advances, the life expectancy in several countries has already come very close to 85 years – 84.9 years in Hong Kong, China (Special Administrative Region), 84.6 years in Japan.

Societies can subsist without formal education, justifying the education minimum of 0 years. The maximum for expected years of schooling, 18, is equivalent to achieving a master's degree in most countries. The maximum for mean years of schooling, 15, is the projected maximum of this indicator for 2025.

The low minimum value for gross national income (GNI) per capita, $100, is justified by the considerable amount of unmeasured subsistence and nonmarket production in economies close to the minimum, which is not captured in the official data. The maximum is set at $75,000 per capita. Kahneman and Deaton (2010) have shown that there is a virtually no gain in human development and well-being from annual income beyond $75,000 per capita. Currently, only three countries (Liechtenstein, Qatar and Singapore) exceed the $75,000 per capita ceiling.

Having defined the minimum and maximum values, the dimension indices are calculated as:

$$Dimension\ index = \frac{actual\ value - minimum\ value}{maximum\ value - minimum\ value} \quad . \quad (1)$$

For the education dimension, equation 1 is first applied to each of the two indicators, and then the arithmetic mean of the two resulting indices is taken. The arithmetic mean of two education indices allows a perfect substitutability between mean years of schooling and expected years of schooling, which seems to be right given that many developing countries have low school attainment among adults but are very eager to achieve universal enrolment at primary and secondary school level for children of school age.

Because each dimension index is a proxy for capabilities in the corresponding dimension, the transformation function from income to capabilities is likely to be concave (Anand and Sen 2000)—that is, each additional dollar of income has a smaller effect on expanding capabilities. Thus, for income, the natural logarithm of the actual, minimum and maximum values is used.

***Step 2. Aggregating the dimensional indices to produce the Human Development Index***

The HDI is the geometric mean of the three dimensional indices:

$$HDI = (I_{Health} \cdot I_{Education} \cdot I_{Income})^{1/3}$$

Example: Sudan

| Indicator | Value |
|---|---|
| **Life expectancy at birth (years)** | 65.3 |
| **Mean years of schooling (years)** | 3.8 |
| **Expected years of schooling (years)** | 7.9 |
| **Gross national income per capita (PPP, 2017$)** | $3,829 |

**Note**: Values are rounded.

**Health index** = $\frac{65.3-20}{85-20}$ =0.6971

**Expected years of schooling index** = $\frac{7.9-0}{18-0}$ =0.4380

**Mean years of schooling index** =$\frac{3.8-0}{15-0}$ =0.2513

**Education index** = $\frac{0.4380+0.2513}{2}$ =0.3447

**Income index** = $\frac{\ln(3{,}829)-\ln(100)}{\ln(75{,}000)-\ln(100)}$ =0.5506

**Human Development Index** =$(0.6971 \cdot 0.3447 \cdot 0.5506)^{1/3} = 0.510$

### Methodology used to express income

The World Bank's 2020 World Development Indicators (WDI) database contains estimates of GNI per capita in constant 2017 purchasing power parity (PPP) terms for many countries. For countries missing this indicator (entirely or partly), the Human Development Report Office (HDRO) calculates it by converting GNI per capita in local currency unit from current to constant terms using the following two steps. First, the value of GNI per capita in current terms is converted into PPP terms for the base year (2017). Second, a time series of GNI per capita in 2017 PPP constant terms is constructed by applying the real growth rates to the GNI per capita in PPP terms for the base year. The real growth rate is implied by the ratio of the nominal growth of GNI per capita in current local currency terms to the GDP deflator.

For several countries without a value of GNI per capita in constant 2017 PPP terms for 2019 reported in the WDI database, the real growth rates of GDP per capita available in the WDI or in the Economic Outlook database of International Monetary Fund are applied to the most recent GNI values in constant PPP terms.

Official PPP conversion rates are produced by the International Comparison Program, whose surveys periodically collect thousands of prices of matched goods and services in many countries. The last round of this exercise refers to 2017 and covered 176 economies.

### Estimating missing values

For a small number of countries missing one of the four indicators, the HDRO estimated the missing values using cross-country regression models.

In this Report expected years of schooling were estimated for Bahamas, Congo, Equatorial Guinea, Fiji, Gabon, Haiti, Liberia, Libya, and Vanuatu. Mean years of schooling were estimated for Comoros, Djibouti, Eritrea, Grenada, Lebanon, Madagascar, Micronesia (Federated States), Saint Kitts and Nevis, South Sudan and Syria.

### Human development categories

The 2014 Human development Report introduced a system of fixed cut-off points for the four categories of human development achievements. The cut-off points (COP) were obtained as the HDI values

calculated using the quartiles (q) of the distributions of component indicators. The resulting HDI values are averaged over the 10-year interval (2004-2013):

$$COP_q = HDI(LE_q, MYS_q, EYS_q, GNIpc_q)\ ,\ q=1,2,3$$

For example, $LE_1, LE_2, LE_3$ denote three quartiles of the distribution of life expectancy across countries.

The 2020 Report keeps the same cut-off points of the HDI for grouping the countries as introduced in the 2014 HDR:

| | |
|---|---|
| Very high human development | 0.800 and above |
| High human development | 0.700 to 0.799 |
| Medium human development | 0.550 to 0.699 |
| Low human development | Below 0.550 |

### Human Development Index aggregates

Aggregate HDI values for country groups (by human development category, region and the like) are calculated by applying the HDI formula to the weighted group averages of component indicators. Life expectancy and GNI per capita are weighted by total population, expected years of schooling is weighted by population ages 5–24 and mean years of schooling is weighted by population ages 25 and older.

# Technical note 2

Inequality-adjusted Human Development Index

The Inequality-adjusted Human Development Index (IHDI) adjusts the Human Development Index (HDI) for inequality in the distribution of each dimension across the population. It is based on a distribution-sensitive class of composite indices proposed by Foster, Lopez-Calva and Szekely (2005), which draws on the Atkinson (1970) family of inequality measures. It is computed as a geometric mean of inequality-adjusted dimensional indices.

The IHDI accounts for inequalities in HDI dimensions by "discounting" each dimension's average value according to its level of inequality. The IHDI equals the HDI when there is no inequality across people but falls below the HDI as inequality rises. In this sense, the IHDI measures the level of human development when inequality is accounted for.

### Data sources

Since the HDI relies on country-level aggregates such as national accounts for income, the IHDI must draw on additional sources of data to obtain insights into the distribution. The distributions are observed over different units—life expectancy is distributed across a hypothetical cohort, while years of schooling and income are distributed across individuals.

Inequality in the distribution of HDI dimensions is estimated for:

> Life expectancy, using data from abridged life tables provided by UNDESA (2019a). This distribution is presented over age intervals (0–1, 1–5, 5–10, ... , 100+), with the mortality rates and average age at death specified for each interval.
>
> Mean years of schooling, using household surveys data harmonized in international databases, including the Luxembourg Income Study, Eurostat's European Union Survey of Income and Living Conditions, the World Bank's International Income Distribution Database, United Nations Children's Fund's Multiple Indicators Cluster Survey, ICF Macro's Demographic and Health Survey, the Center for Distributive, Labour and Social Studies and the World bank's Socio-economic database for Latin America and the Caribbean , UNESCO Institute for Statistics Educational Attainment Table and the United Nations University's World Income Inequality Database.
>
> Disposable household income or consumption per capita using the above listed databases and household surveys—and for a few countries, income imputed based on an asset index matching methodology using household survey asset indices (Harttgen and Vollmer 2011).

A full account of data sources used for estimating inequality for 2019IHDI is available at http://hdr.undp.org/en/statistics/ihdi/ .

### Steps to calculate the Inequality-adjusted Human Development Index

There are three steps to calculating the IHDI.

***Step 1. Estimating inequality in the dimensions of the Human Development Index***

The IHDI draws on the Atkinson (1970) family of inequality measures and sets the aversion parameter ε equal to 1.[1] In this case the inequality measure is $A = 1 - g/\mu$, where $g$ is the geometric mean and is the arithmetic mean of the distribution. This can be written as:

$$A_x \quad 1 \quad \frac{\sqrt[n]{X_1 \ldots X_n}}{\overline{X}} \qquad (1)$$

where $\{X_1, \ldots, X_n\}$ denotes the underlying distribution in the dimension of interest. $A_x$ is obtained for each variable (life expectancy, mean years of schooling and disposable income or consumption per capita).

The geometric mean in equation 1 does not allow zero values. For mean years of schooling one year is added to all valid observations to compute the inequality. For income per capita the negative and zero incomes and incomes in the bottom 0.5 percentile are replaced with the minimum value of the second bottom 0.5 percentile of the distribution of positive incomes. The top 0.5 percentile of the distribution is truncated to reduce the impact of measurement errors when recording extremely high incomes. Sensitivity analysis of the IHDI is given in Kovacevic (2010).

***Step 2. Adjusting the dimension indices for inequality***

The inequality-adjusted dimension indices are obtained from the HDI dimension indices, $I_x$, by multiplying them by $(1 - A_x)$, where $A_x$ , defined by equation 1, is the corresponding Atkinson measure:

$$I_x^* = (1 - A_x) \cdot I_x.$$

The inequality-adjusted income index, $I_{income}^*$, is based on the index of logged income values, $I_{inc^*}$ and inequality in income distribution computed using income in levels. This enables the IHDI to account for the full effect of income inequality.

***Step 3. Combining the dimension indices to calculate the Inequality-adjusted Human Development Index***

The IHDI is the geometric mean of the three dimension indices adjusted for inequality:

$$\begin{aligned} IHDI &= (I_{Health}^* \cdot I_{Education}^* \cdot I_{Income}^*)^{1/3} \\ &= \{(1 - A_{Health}) \cdot (1 - A_{Education}) \cdot (1 - A_{Income})\}^{1/3} \cdot HDI \end{aligned}$$

The loss in the Human Development Index due to inequality is:

$$Loss \ = 1 - \{(1 - A_{Health}) \cdot (1 - A_{Education}) \cdot (1 - A_{Income})\}^{1/3} \cdot$$

## Coefficient of human inequality

An unweighted average of inequalities in health, education and income is denoted as the Coefficient of Human Inequality. It averages these inequalities using the arithmetic mean:

$$Coefficient\ of\ human\ inequality = (A_{Health} + A_{Education} + A_{Income})/3$$

[1] The inequality aversion parameter affects the degree to which lower achievements are emphasized and higher achievements are de-emphasized.

When all inequalities in dimensions are of a similar magnitude, the coefficient of human inequality and the loss in HDI differ negligibly. When inequalities differ in magnitude, the loss in HDI tends to be higher than the coefficient of human inequality.

### Notes on methodology and caveats

The IHDI is based on the Atkinson index, which satisfies subgroup consistency. This property ensures that improvements (deteriorations) in the distribution of human development within only a certain group of the society imply improvements (deteriorations) in the distribution across the entire society.

The main disadvantage is that the IHDI is not association-sensitive, so it does not capture overlapping inequalities. To make the measure association-sensitive, all the data for each individual must be available from a single survey source, which is not currently possible for a large number of countries.

### Example: Barbados

| | Indicator | Dimension index | Inequality measure (A)[a] | Inequality-adjusted index ($I^*$) |
|---|---|---|---|---|
| **Life expectancy (years)** | 79.2 | 0.9106 | 0.087 | (1–0.087) · 0.8190 = 0.8314 |
| **Mean years of schooling (years)** | 10.6 | 0.7095 | 0.055 | |
| **Expected years of schooling (years)** | 15.4 | 0.8552 | | |
| **Education index** | | 0.7823 | 0.055 | (1–0.055) · 0.7823 = 0.7393 |
| **Gross national income per capita (PPP, 2011$)** | $22168 | 0.7562 | 0.336 | (1–0.336) · 0.7562 = 0.5021 |
| **Human Development Index:** $(0.9106 \cdot 0.7823 \cdot 0.7562)^{1/3} =$ 0.814 | | | **Inequality-adjusted Human Development Index:** $(0.8314 \cdot 0.7393 \cdot 0.5021)^{\frac{1}{3}} =$ 0.676 | |
| **Loss due to inequality (%):** $100\left(1 - \frac{0.676}{0.814}\right) = 17.0$ | | | **Coefficient of human inequality (%)** $\frac{100(0.087 + 0.055 + 0.336)}{3} = 15.9$ | |

**Note**: Values are rounded.

[a] Inequalities are estimated from micro data.

# Technical note 3

## Gender Development Index

The Gender Development Index (GDI) measures gender inequalities in achievement in three basic dimensions of human development: health, measured by female and male life expectancy at birth; education, measured by female and male expected years of schooling for children and female and male mean years of schooling for adults ages 25 years and older; and command over economic resources, measured by female and male estimated earned income.

### Data sources

• Life expectancy at birth: UNDESA (2019).

• Expected years of schooling: UNESCO Institute for Statistics (2020), ICF Macro Demographic and Health Surveys, United Nations Children's Fund (UNICEF) Multiple Indicator Cluster Surveys and OECD (2019).

• Mean years of schooling for adults ages 25 and older: UNESCO Institute for Statistics (2020), Barro and Lee (2018), ICF Macro Demographic and Health Surveys, UNICEF's Multiple Indicator Cluster Surveys and OECD (2019).

• Estimated earned income: Human Development Report Office estimates based on female and male shares of the economically active population, the ratio of the female to male wage in all sectors and gross national income in 2017 purchasing power parity (PPP) terms, and female and male shares of population from ILO (2020), UNDESA (2019), World Bank (2020), United Nations Statistics Division (2020) and IMF (2020).

### Steps to calculate the Gender Development Index

There are four steps to calculating the GDI.

***Step 1. Estimating the female and male earned incomes***

To calculate estimated earned incomes, the share of the wage bill is calculated for each gender. The female share of the wage bill ($S_f$) is calculated as follows:

$$S_f = \frac{W_f/W_m \cdot EA_f}{\frac{W_f}{W_m} \cdot EA_f + EA_m}$$

where $W_f/W_m$ is the ratio of female to male wage, $EA_f$ is the female share of the economically active population and $EA_m$ is the male share.

The male share of the wage bill is calculated as:

$S_m = 1 - S_f$.

Estimated female earned income per capita ($GNIpc_f$) is obtained from GNI per capita ($GNIpc$), first by multiplying it by the female share of the wage bill, $S_f$, and then rescaling it by the female share of the population, $P_f = N_f/N$:

$$GNI_{pc,f} = GNI_{pc} \cdot S_f / P_f.$$

Estimated male earned income per capita is obtained in the same way:

$$GNI_{pc,m} = GNI_{pc} \cdot S_m / P_m$$

where $P_m = 1 - P_f$ is the male share of population.

***Step 2. Normalizing the indicators***

To construct the female and male HDI values, first the indicators, which are in different units, are transformed into indices and then dimension indices for each sex are aggregated by taking the geometric mean.

The indicators are transformed into indices on a scale of 0 to 1 using the same goalposts that are used for the HDI, except life expectancy at birth, which is adjusted for the average five-year biological advantage that women have over men.

**Goalposts for the Gender Development Index in this Report**

| Indicator | Minimum | Maximum |
|---|---|---|
| Life expectancy at birth (years) | | |
| Female | 22.5 | 87.5 |
| Male | 17.5 | 82.5 |
| Expected years of schooling (years) | 0 | 18 |
| Mean years of schooling (years) | 0 | 15 |
| Estimated earned income (2017 PPP $) | 100 | 75,000 |

**Note:** For the rationale on choice of minimum and maximum values, see *Technical note 1*.

Having defined the minimum and maximum values, the subindices are calculated as follows:

$$Dimension\ index = \frac{actual\ value - minimum\ value}{maximum\ value - minimum\ value}.$$

For education the dimension index is first obtained for each of the two subcomponents, and then the unweighted arithmetic mean of the two resulting indices is taken.

***Step 3. Calculating the female and male Human Development Index values***

The female and male HDI values are the geometric means of the three dimensional indices for each gender:

$$HDI_f = (I_{Health_f} \cdot I_{Education_f} \cdot I_{Income_f})^{1/3}$$

$$HDI_m = (I_{Health_m} \cdot I_{Education_m} \cdot I_{Income_m})^{1/3}$$

***Step 4. Calculating the Gender Development Index***

The GDI is simply the ratio of female HDI to male HDI:

$$GDI = \frac{HDI_f}{HDI_m}.$$

**Example: Mongolia**

| Indicator | Female value | Male vale |
|---|---|---|
| Life expectancy at birth (years) | 74.1 | 65.8 |
| Expected years of schooling (years) | 14.8 | 13.7 |

| | | |
|---|---|---|
| Mean years of schooling (years) | 10.7 | 9.7 |
| Wage ratio (female/male) | 0.821 | |
| Gross national income per capita (2017 PPP $) | 10,838.6743 | |
| Share of economically active population | 0.458 | 0.542 |
| Share of population | 0.50702 | 0.49298 |

**Female wage bill:**

$S_f$ = (0.821 · 0.458) / [(0.821 · 0.458) + 0.542] = 0.4096

**Estimated female earned income per capita:**

$GNIpc_f$ = 10,838.6743 · 0.4096 / 0.507 = 8,756.106

**Male wage bill:**

$S_m$ = 1 – 0.4096 = 0.5904

**Estimated male earned income per capita:**

$GNIpc_m$ = 10,838.6743 · 0.5904 / 0.493 = 12,980.55

**Female health index** = (74.1 – 22.5) / (87.5 – 22.5) = 0.7938

**Male health index** = (65.8 – 17.5) / (82.5 – 17.5) = 0.7431

**Female education index** = [(14.8 / 18) + (10.7 / 15)] / 2 = 0.7678

**Male education index** = [(13.7 / 18) + (9.7 / 15)] / 2 = 0.7039

**Estimated female earned income index:**

[ln(8,756.106) – ln(100)] / [ln(75,000) – ln(100)] = 0.6756

**Estimated male earned income index:**

[ln(12,980.55) – ln(100)] / [(ln(75,000) – ln(100)] = 0.7350

**Female HDI =** $(0.7938 \cdot 0.7678 \cdot 0.6756)^{1/3}$ = 0.744

**Male HDI =** $(0.7431 \cdot 0.7039 \cdot 0.7350)^{1/3}$ = 0.727

**GDI =** 0.744/0.727 = 1.023

**Note**: Values are rounded.

### Gender Development Index groups

The GDI groups are based on the absolute deviation of GDI from gender parity, 100 · |GDI – 1|. Countries with absolute deviation from gender parity of 2.5 percent or less are considered countries with high equality in HDI achievements between women and men and are classified as group 1. Countries with absolute deviation from gender parity of 2.5–5 percent are considered countries with medium-high equality in HDI achievements between women and men and are classified as group 2. Countries with absolute deviation from gender parity of 5–7.5 percent are considered countries with medium equality in

HDI achievements between women and men and are classified as group 3. Countries with absolute deviation from gender parity of 7.5–10 percent are considered countries with medium-low equality in HDI achievements between women and men and are classified as group 4. Countries with absolute deviation from gender parity of more than 10 percent are considered countries with low equality in HDI achievements between women and men and are classified as group 5.

# Technical note 4

## Gender Inequality Index

The Gender Inequality Index (GII) reflects gender-based disadvantage in three dimensions—reproductive health, empowerment and the labour market—for as many countries as data of reasonable quality allow. It shows the loss in potential human development due to inequality between female and male achievements in these dimensions. It ranges from 0, where women and men fare equally, to 1, where one gender fares as poorly as possible in all measured dimensions.

The GII is computed using the association-sensitive inequality measure suggested by Seth (2009), which implies that the index is based on the general mean of general means of different orders—the first aggregation is by a geometric mean across dimensions; these means, calculated separately for women and men, are then aggregated using a harmonic mean across genders.

**Data sources**

• Maternal mortality ratio (*MMR*): WHO, UNICEF, UNFPA, World Bank Group and United Nations Population Division (2019).

• Adolescent birth rate (*ABR*): UNDESA (2019).

• Share of parliamentary seats held by each sex (*PR*): IPU (2020).

• Population with at least some secondary education (*SE*): UNESCO Institute for Statistics (2020) and Barro and Lee (2018).

• Labour force participation rate (*LFPR*): ILO (2020).

### Steps to calculate the Gender Inequality Index

There are five steps to calculating the GII.

***Step 1. Treating zeros and extreme values***

Because a geometric mean cannot be computed from zero values, a minimum value of 0.1 percent is set for all component indicators. Further, as higher maternal mortality suggests poorer maternal health, for the maternal mortality ratio the maximum value is truncated at 1,000 deaths per 100,000 births and the minimum value at 10. The rationale is that countries where maternal mortality ratios exceed 1,000 do not differ in their inability to create conditions and support for maternal health and that countries with 10 or fewer deaths per 100,000 births are performing at essentially the same level and that small differences are random. Sensitivity analysis of the GII is given in Gaye et al. (2010).

***Step 2. Aggregating across dimensions within each gender group, using geometric means***

Aggregating across dimensions for each gender group by the geometric mean makes the GII association sensitive (see Seth 2009).

For women and girls, the aggregation formula is:

$$G_F = \sqrt[3]{\left(\frac{10}{MMR} \cdot \frac{1}{ABR}\right)^{1/2} \cdot (PR_F \cdot SE_F)^{1/2} \cdot LFPR_F}\,, \qquad (1)$$

and for men and boys the formula is

$$G_M = \sqrt[3]{1 \cdot (PR_M \cdot SE_M)^{1/2} \cdot LFPR_M}\,.$$

The rescaling by 0.1 of the maternal mortality ratio in equation 1 is needed to account for the truncation of the maternal mortality ratio at 10.

***Step 3. Aggregating across gender groups, using a harmonic mean***

The female and male indices are aggregated by the harmonic mean to create the equally distributed gender index

$$HARM\,(G_F, G_M) = \left[\frac{(G_F)^{-1} + (G_M)^{-1}}{2}\right]^{-1}.$$

Using the harmonic mean of within-group geometric means captures the inequality between women and men and adjusts for association between dimensions—that is, it accounts for the overlapping inequalities in dimensions.

***Step 4. Calculating the geometric mean of the arithmetic means for each indicator***

The reference standard for computing inequality is obtained by aggregating female and male indices using equal weights (thus treating the genders equally) and then aggregating the indices across dimensions:

$$G_{\overline{F},\overline{M}} = \sqrt[3]{\overline{Health} \cdot \overline{Empowerment} \cdot \overline{LFPR}}$$

where $\overline{Health} = \left(\sqrt{\frac{10}{MMR} \cdot \frac{1}{ABR}} + 1\right)/2$, $\overline{Empowerment} = \sqrt{PR_F \cdot SE_F} + \sqrt{PR_M \cdot SE_M}\,/\,2$ and $\overline{LFPR} = \frac{LFPR_F + LFPR_M}{2}$.

$\overline{Health}$ should not be interpreted as an average of corresponding female and male indices but rather as half the distance from the norms established for the reproductive health indicators—fewer maternal deaths and fewer adolescent pregnancies.

***Step 5. Calculating the Gender Inequality Index***

Comparing the equally distributed gender index to the reference standard yields the GII,

$$1 - \frac{HARM(G_F, G_M)}{G_{\overline{F},\overline{M}}}.$$

**Example: Kenya**

| | Health | | Empowerment | | Labour market |
|---|---|---|---|---|---|
| | **Maternal mortality ratio (deaths per 100,000 live births)** | **Adolescent birth rate (births per 1,000 women ages 15–19** | **Share of seats in parliament (% held by women)** | **Population with at least some secondary education (%)** | **Labour force participation rate (%)** |
| Female | 342 | 75.1 | 23.3 | 29.8 | 72.1 |
| Male | na | na | 76.7 | 37.3 | 77.3 |
| (*F*+*M*)/2 | $\frac{\sqrt{\left(\frac{10}{342}\right)\cdot\left(\frac{1}{75.1}\right)}+1}{2}=0.5099$ | | $\frac{\sqrt{0.233\cdot 0.298}+\sqrt{0.767\cdot 0.373}}{2}=0.3992$ | | $(0.721+0.773)/2 = 0.747$ |

na is not applicable.

Using the above formulas, it is straightforward to obtain:

$G_F$: $\sqrt[3]{\sqrt{\frac{10}{342}\cdot\frac{1}{75.1}}\cdot\sqrt{0.233\cdot 0.298}\cdot 0.721}=0.1553$

$G_M$: $\sqrt[3]{1\cdot\sqrt{0.767\cdot 0.373}\cdot 0.773}=0.7450$

$HARM\ (G_F, G_M)$: $\left[\frac{1}{2}\left(\frac{1}{0.1553}+\frac{1}{0.7450}\right)\right]^{-1}=0.2570$

$G_{\overline{F},\overline{M}}$: $\sqrt[3]{0.5099\cdot 0.3992\cdot 0.747}=0.5337$

*GII :* 1 – (0.2570/ 0.5337) = 0.518

# Technical note 5

Multidimensional Poverty Index

**This technical note is available at**
**http://hdr.undp.org/sites/default/files/mpi2020_technical_notes.pdf**

# Technical note 6

## Human development dashboards 1-5

This Report includes colour-coded dashboards on five topics: quality of human development, life-course gender gap, women's empowerment, environmental sustainability and socioeconomic sustainability.

The dashboards allow partial grouping of countries by an indicator – rather than complete grouping by a composite measure, such as the Human Development Index (HDI) – that combines multiple indicators after making them commensurable. A complete grouping depends on how component indicators are combined, but a partial grouping does not require assumptions about normalization, weighting or the functional form of the composite index. A partial grouping may depend on the predefined values used as thresholds for grouping, such as what is considered good performance or a target to be achieved.

For each indicator in the dashboards, countries are divided into three groups of approximately equal size (terciles): the top third, the middle third and the bottom third. The intention is not to suggest the thresholds or target values for the indicators but to allow a crude assessment of a country's performance relative to others. A country that is in the top third performs better than at least two thirds of countries, a country that is in the middle third performs better than at least one third of countries but worse than at least one third, and a country that is in the bottom third performs worse than at least two thirds of countries. A distinct colour is attached to each of three groups of countries. For indicators expressed as female to male ratio, countries with a value near 1 are classified as top performers, and deviation from parity are treated equally regardless of which gender is overachieving.

Three-colour coding is used to visualize the partial grouping of countries by indicator – a simple tool to help users immediately discern a country's performance. The colour-coding scale graduates from darkest for the top third to medium for the middle third to lightest for the bottom third.

Aggregates for human development categories, regions, least developed countries, small island developing states, Organisation for Economic Co-operation and Development countries and the world are coloured based on which grouping their values fall into for each indicator.

**Dashboard 1: Quality of human development**

Dashboard 1 contains a selection of 14 indicators associated with the quality of health, education and standard of living. The three indicators on quality of health are: lost health expectancy, number of physicians and number of hospital beds. The seven indicators on quality of education are: pupil-teacher ratio in primary schools; primary school teachers trained to teach; proportion of primary schools with access to the Internet; proportion of secondary schools with access to the Internet; and Programme for International Student Assessment (PISA) scores in mathematics, reading and science. The four indicators on quality of standard of living are: proportion of employment that is in vulnerable employment, proportion of rural population with access to electricity, proportion of population using improved drinking-water sources and proportion of population using improved sanitation facilities.

Aggregates are not published for proportion of schools with access to the Internet and PISA scores.

The following table shows the ranges of values that define tercile groups and the number of countries in each tercile group for each indicator in dashboard 1.

**Observed ranges of values and number of countries in each tercile group, by indicator in Dasboard1: Quality of human development**

| | Top group | | Middle group | | Bottom group | | Number of countries with missing values |
|---|---|---|---|---|---|---|---|
| | Range | Number of countries | Range | Number of countries | Range | Number of countries | |
| **Lost health expectancy** (%) | <12.6 | 75 | 12.6 - 13.4 | 62 | >=13.4 | 56 | 2 |
| **Physicians** (per 100,000 people) | >=24.45 | 65 | 6.45-24.45 | 62 | <6.45 | 63 | 5 |
| **Hospital beds** (per 100,000 people) | >=31.5 | 57 | 13.5-31.5 | 60 | <13.5 | 50 | 28 |
| **Pupil-teacher ratio, primary school** (pupils per teacher) | <15.5 | 61 | 15.5-24.5 | 55 | >=24.5 | 69 | 10 |
| **Primary school teachers trained to teach** (%) | >=96.5 | 48 | 79.5-96.5 | 37 | <79.5 | 38 | 72 |
| **Primary schools with access to the Internet** (%) | >=99 | 34 | 41-99 | 26 | <41 | 30 | 105 |
| **Secondary schools with access to the Internet** (%) | >=99 | 33 | 71-99 | 28 | <71 | 30 | 104 |
| **Programme for International Student Assessment (PISA) score,** reading | >=484 | 25 | 422-484 | 24 | <422 | 25 | 121 |
| **Programme for International Student Assessment (PISA) score,** mathematics | >=493 | 25 | 430-493 | 24 | <430 | 26 | 120 |
| **Programme for International Student Assessment (PISA) score,** science | >=490 | 25 | 427-490 | 25 | <427 | 25 | 120 |
| **Vulnerable employment** (% of total employment) | <20.5 | 64 | 20.5-48.95 | 56 | >=48.95 | 60 | 15 |
| **Rural population with access to electricity** (%) | >=99.95 | 110 | 90.5-99.95 | 20 | <90.5 | 65 | 0 |
| **Population using safely managed drinking-water services** (%) | >=96.5 | 34 | 73.5-96.5 | 31 | <73.5 | 32 | 98 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Population using safely managed sanitation services** (%) | >=89.5 | 30 | 57.5-89.5 | 29 | <57.5 | 29 | 107 |

**Dashboard 2**. **Life-course gender gap**

Dashboard 2 contains 13 indicators that display gender gaps in choices and opportunities over the life course—childhood and youth, adulthood and older age. The five indicators on childhood and youth are sex ratio at birth; gross enrolment ratios in pre-primary, primary and secondary school; and youth unemployment rate. The seven indicators on adulthood are population with at least some secondary education, total unemployment rate, female share of employment in nonagriculture, share of seats held by women in parliament and in local government, and time spent on unpaid domestic chores and care work (expressed two ways). The indicator on older age is old-age pension recipients. Nine indicators are presented as a ratio of female to male values, and four are presented as values for women only. Sex ratio at birth (male to female births) is an exception to grouping by tercile—countries are divided into two groups: the natural group (countries with a value of 1.04–1.07, inclusive) and the gender-biased group (all other countries). Deviations from the natural sex ratio at birth have implications for population replacement levels, suggest possible future social and economic problems and may indicate gender bias.

Aggregates are not presented for share of seats held by women in local government and for time spent on unpaid domestic chores and care work.

The following table shows the ranges of values that define each tercile group and the number of countries in each tercile group for each indicator in dashboard 2.

**Observed ranges of values and number of countries in each tercile group, by indicator, dashboard 2: life-course gender gap**

| Indicator | Top group | | Middle group | | Bottom group | | Countries with missing values |
|---|---|---|---|---|---|---|---|
| | Range | Number of countries | Range | Number of countries | Range | Number of countries | |
| Sex ratio at birth (male to female births) | 1.04–1.07 | 135 | — | — | <1.04<br>>1.07 | 50 | 10 |
| Gross enrolment ratio, pre-primary (female to male ratio) | 0.988–1.013 | 55 | 0.963–0.988<br>1.013–1.036 | 55 | <0.963<br>>1.036 | 54 | 31 |
| Gross enrolment ratio, primary (female to male ratio) | 0.993–1.008 | 58 | 0.968–0.993<br>1.008–1.030 | 59 | <0.968<br>>1.030 | 60 | 18 |
| Gross enrolment ratio, secondary (female to male ratio) | 0.975–1.025 | 52 | 0.934–0.975<br>1.025–1.075 | 52 | <0.934<br>>1.075 | 54 | 37 |
| Youth unemployment rate (female to male ratio) | 0.842–1.159 | 60 | 0.600–0.842<br>1.159–1.398 | 59 | <0.600<br>>1.398 | 61 | 15 |
| Population with at least some secondary education (female to male ratio) | 0.968–1.035 | 55 | 0.850–0.968<br>1.035–1.153 | 55 | <0.850<br>>1.153 | 57 | 28 |
| Total unemployment rate (female to male ratio) | 0.855–1.148 | 61 | 0.630–0.855<br>1.148–1.390 | 59 | <0.630<br>>1.390 | 60 | 15 |
| Share of employment in nonagriculture, female (% of total employment in nonagriculture) | ≥46.674 | 60 | 41.570–46.674 | 60 | <41.570 | 60 | 15 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Share of seats held by women in parliament (%) | ≥26.3 | 64 | 17.0–26.3 | 64 | <17.0 | 65 | 2 |
| Share of seats held by women in local government (%) | ≥31.0 | 43 | 18.3–31.0 | 44 | <18.3 | 44 | 64 |
| Time spent on unpaid domestic chores and care work, women ages 15 and older (% of 24-hour day) | ≤15.8 | 25 | 15.8–19.0 | 24 | >19.0 | 24 | 122 |
| Time spent on unpaid domestic chores and care work (female to male ratio) | ≤2.10 | 25 | 2.10–2.95 | 24 | >2.95 | 24 | 122 |
| Old-age pension recipients (female to male ratio) | 0.997–1.020 | 18 | 0.800–0.997<br>1.020–1.200 | 18 | <0.800<br>>1.200 | 18 | 141 |

**Dashboard 3. Women's empowerment**

Dashboard 3 contains 13 woman-specific empowerment indicators that allow empowerment to be compared across three dimensions: reproductive health and family planning, violence against girls and women and socioeconomic empowerment. The four indicators on reproductive health and family planning are coverage of at least one antenatal care visit, proportion of births attended by skilled health personnel, contraceptive prevalence (any method) and unmet need for family planning. The four indicators on violence against girls and women are women married by age 18, prevalence of female genital mutilation/cutting among girls and women, violence against women ever experienced from an intimate partner and violence against women ever experienced from a nonintimate partner. The five indicators on socioeconomic empowerment are female share of graduates in science, technology, engineering and mathematics programmes at tertiary level; share of graduates from science, technology, engineering and mathematics programmes in tertiary education who are female; female share of employment in senior and middle management; women with account at financial institution or with mobile money-service provider; and mandatory paid maternity leave.

Most countries have at least one indicator in each tercile, which implies that women's empowerment is unequal across indicators and across countries.

The following table shows the ranges of values that define each tercile group and the number of countries in each tercile group for each indicator in dashboard 3.

**Observed ranges of values and number of countries in each tercile group, by indicator, dashboard 3: women's empowerment**

| Indicator | Top group | | Middle group | | Bottom group | | Countries with missing values |
|---|---|---|---|---|---|---|---|
| | Range | Number of countries | Range | Number of countries | Range | Number of countries | |
| Antenatal care coverage, at least one visit (%) | ≥97.25 | 42 | 90.90–97.25 | 42 | <90.90 | 43 | 68 |
| Proportion of births attended by skilled health personnel (%) | ≥99.55 | 52 | 92.45–99.55 | 53 | <92.45 | 55 | 35 |
| Contraceptive prevalence, any method (% of married or in-union women of reproductive age, 15-49 years) | ≥63.0 | 50 | 39.3–63.0 | 50 | <39.3 | 50 | 45 |
| Unmet need for family planning (% of married or in-union women of reproductive age, 15-49 years) | ≤14.50 | 41 | 14.50–23.15 | 39 | >23.15 | 40 | 75 |
| Women married by age 18 (% of women ages 20–24 who are married or in union) | ≤15.7 | 42 | 15.7–28.6 | 42 | >28.6 | 42 | 69 |
| Prevalence of female genital mutilation/cutting among girls and women (% of girls and women ages 15–49) | ≤19.0 | 10 | 19.0–71.2 | 10 | >71.2 | 10 | 165 |
| Violence against women ever experienced, intimate partner (% of female population ages 15 and older) | ≤21.25 | 43 | 21.25–29.90 | 42 | >29.90 | 42 | 68 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Violence against women ever experienced, nonintimate partner (% of female population ages 15 and older) | ≤3.9 | 22 | 3.9–8.2 | 23 | >8.2 | 21 | 129 |
| Share of graduates in science, technology, engineering and mathematics programmes at tertiary level, female (%) | ≥15.3 | 41 | 11.0–15.30 | 41 | <11.0 | 42 | 71 |
| Share of graduates from science, technology, engineering and mathematics programmes in tertiary education who are female (%) | ≥38.50 | 42 | 31.14–38.50 | 42 | <31.14 | 43 | 68 |
| Female share of employment in senior and middle management (%) | ≥35.15 | 34 | 27.00–35.15 | 34 | <27.00 | 35 | 92 |
| Women with account at financial institution or with mobile money-service provider (% of female population ages 15 and older) | ≥73.5 | 52 | 35.9–73.5 | 52 | <35.9 | 52 | 39 |
| Mandatory paid maternity leave (days) | ≥110 | 58 | 91–110 | 52 | <91 | 65 | 20 |

**Dashboard 4. Environmental sustainability**

Dashboard 4 contains 14 indicators that cover environmental sustainability and environmental threats. The nine indicators on environmental sustainability are fossil fuel energy consumption; carbon dioxide emissions (expressed two ways); forest area (expressed two ways); fresh water withdrawals; use of fertilizer nutrient, nitrogen (N) or phosphorus (expressed as P2O5), expressed per area of cropland; and domestic material consumption per capita. The five indicators on environmental threats are mortality rates attributed to household and ambient air pollution and to unsafe water, sanitation and hygiene services; number of deaths and missing persons attributed to disasters; degraded land; and the International Union for Conservation of Nature's Red List Index, which measures aggregate extinction risk across groups of species.

The percentage of total land area under forest is intentionally left without colour because it is meant to provide context for the indicator on change in forest area. Aggregates are not available for the Red List Index indicator.

The following table shows the ranges of values that define each tercile group and the number of countries in each tercile group for each indicator in dashboard 4.

**Observed ranges of values and number of countries in each tercile group, by indicator, dashboard 4: environmental sustainability**

| Indicator | Top group | | Middle group | | Bottom group | | Countries with missing values |
|---|---|---|---|---|---|---|---|
| | Range | Number of countries | Range | Number of countries | Range | Number of countries | |
| Fossil fuel energy consumption (% of total energy consumption) | ≤62.0 | 46 | 62.0–85.0 | 46 | >85.0 | 46 | 57 |
| Carbon dioxide emissions, production emissions per capita (tonnes) | ≤1.262 | 65 | 1.262–4.655 | 64 | >4.655 | 64 | 2 |
| Carbon dioxide emissions, per unit of GDP (kg per 2010 US$ of GDP) | ≤0.158 | 47 | 0.158–0.243 | 46 | >0.243 | 46 | 56 |
| Forest area (% of total land area) | — | — | — | — | — | — | — |
| Forest area, change (%) | ≥4.5 | 61 | -4.7–4.5 | 62 | <-4.7 | 62 | 10 |
| Fresh water withdrawals (% of total renewable water resources) | ≤3.3 | 38 | 3.3–18.5 | 38 | >18.5 | 37 | 82 |
| Use of fertilizer nutrient nitrogen (N), per area of cropland (kg per hectare) | ≤24.0 | 51 | 24.0–71.2 | 51 | >71.2 | 50 | 43 |
| Use of fertilizer nutrient phosphorus (expressed as P2O5), per area of cropland (kg per hectare) | ≤6.5 | 51 | 6.5–20.2 | 51 | >20.2 | 50 | 43 |
| Domestic material consumption per capita (tonnes) | ≤6.0 | 62 | 6.0–12.8 | 62 | >12.8 | 61 | 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mortality rate attributed to household and ambient air pollution (per 100,000 population, age-standardized) | ≤47.5 | 63 | 47.5–117.0 | 59 | >117.0 | 61 | 12 |
| Mortality rate attributed to unsafe water, sanitation and hygiene services (per 100,000 population) | ≤0.35 | 61 | 0.35–6.4 | 61 | >6.4 | 61 | 12 |
| Number of deaths and missing persons attributed to disasters (per 100,000 population) | ≤0.133 | 45 | 0.133–0.780 | 45 | >0.780 | 45 | 60 |
| Degraded land (% of total land area) | ≤12 | 45 | 12–22 | 38 | >22 | 40 | 72 |
| Red List Index (value) | ≥0.908 | 65 | 0.825–0.908 | 65 | <0.825 | 65 | 0 |

## Dashboard 5: Socioeconomic sustainability

**Dashboard 5** contains 11 indicators that cover economic and social sustainability. The six indicators on economic sustainability are adjusted net savings, total debt service, gross capital formation, skilled labour force, export concentration index, research and development expenditure and dependency ratio. The five indicators on social sustainability are old age dependency ratio, ratio of education and health expenditure to military expenditure, change in overall loss in HDI value due to inequality, change in Gender Inequality Index and change in income share of the poorest 40%.

The military expenditure is intentionally left without colour because it is meant to provide context for the indicator on education and health expenditure. Aggregates are not presented for export concentration index and the change in income share of the poorest 40 percent.

The following table shows the ranges of values that define each tercile group and the number of countries in each tercile group for each indicator in dashboard 5.

**Observed ranges of values and number of countries in each tercile group, by indicator in Dashboard 5: Socioeconomic sustainability**

| | Top group | | Middle group | | Bottom group | | Number of countries with missing values |
|---|---|---|---|---|---|---|---|
| | Range | Number of countries | Range | Number of countries | Range | Number of countries | |
| **Adjusted net savings** (% of GNI) | >=14 | 54 | 3.5-14 | 49 | <3.5 | 51 | 41 |
| **Total debt service** (% of exports of goods, services and primary income) | <8 | 38 | 8-16.5 | 39 | >=16.5 | 39 | 79 |
| **Gross capital formation** (% of GDP) | >=26 | 65 | 21-26 | 52 | <21 | 57 | 21 |
| **Skilled labour force** (% of labour force) | >=76 | 55 | 38.5-76 | 54 | <38.5 | 53 | 33 |
| **Concentration index (exports)**, value | <0.215 | 63 | 0.215-0.385 | 67 | >=0.385 | 61 | 4 |
| **Research and development expenditure** (% of GDP) | >=0.75 | 48 | 0.27-0.75 | 44 | <0.27 | 44 | 59 |
| **Old-age dependency ratio** | <8.5 | 59 | 8.5-21 | 64 | >=21 | 62 | 10 |
| **Military expenditure** (% of GDP) | — | — | — | — | — | — | — |
| **Ratio of education and health expenditure to military expenditure** | >=9.4 | 49 | 5-9.4 | 49 | <5 | 43 | 54 |
| **Overall loss in HDI due to inequality**, average annual change (%) | <=-2.24 | 45 | -2.24 - 0.77 | 43 | >-0.77 | 44 | 63 |
| **Gender Inequality Index**, average annual change (%) | <=-1.95 | 52 | -1.95 - -0.85 | 49 | >-0.85 | 43 | 51 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Income share of the poorest 40 percent**, average annual change (%) | >=0.65 | 50 | -0.14 - 0.65 | 44 | <-0.14 | 45 | 56 |

**References**

Alkire, S., and S. Jahan. 2018. "The New Global MPI 2018: Aligning with the Sustainable Development Goals." Human Development Research Paper. UNDP-HDRO, New York. http://hdr.undp.org/en/content/new-global-mpi-2018-aligning-sustainable-development-goals.

Anand, S., and A. Sen. 2000. "The Income Component of the Human Development Index." *Journal of Human Development and Capabilities* (1)1: 83–106.

Atkinson, A. 1970. "On the Measurement of Economic Inequality." *Journal of Economic Theory* 2(3): 244–263.

Barro, R.J., and J.-W. Lee. 2018. Dataset of Educational Attainment, June 2018 Revision. www.barrolee.com. Accessed 20 July 2020.

Foster, J., L. Lopez-Calva and M. Szekely. 2005. "Measuring the Distribution of Human Development: Methodology and an Application in Mexico." *Journal of Human Development and Capabilities* 6(1): 5–25.

Gaye, A., J. Klugman, M. Kovacevic, S. Twigg and E. Zambrano. 2010. "Measuring Key Disparities in Human Development: The Gender Inequality Index." Human Development Research Paper. UNDP-HDRO, New York http://hdr.undp.org/sites/default/files/hdrp_2010_46.pdf

Harttgen, K., and S. Vollmer. 2013. "Using an Asset Index to Simulate Household Income." *Economic Letters* 121(2): 257–262.

ICF Macro. Various years. Demographic and Health Surveys. www.measuredhs.com. Accessed 15 July 2020.

ILO (International Labour Organization). 2020. ILOSTAT database. https://ilostat.ilo.org/data/. Accessed 21 July 2020.

IMF (International Monetary Fund). 2020. World Economic Outlook database. Washington, DC. www.imf.org/external/pubs/ft/weo/2020/01/weodata/index.aspx. Accessed 15 July 2020.

IPU (Inter-Parliamentary Union). 2020. Parline database: Monthly ranking of women in national parliaments. https://data.ipu.org/women-ranking. Accessed 29 July 2020.

Kahneman, D., and A. Deaton. 2014. "High Income Improves Evaluation of Life But Not Emotional Well-being." *Proceedings of National Academy of Sciences* 107(38): 16489–16493.

Kovacevic, M. 2010. Measurement of Inequality in Human Development—A Review. Human Development Research Paper UNDP-HDRO, New York. http://hdr.undp.org/sites/default/files/hdrp_2010_35.pdf.

Lohr, S. 2010. *Sampling: Design and Analysis*, 2nd ed. Boston, MA: Brooks/Cole.

Maddison, A. 2010. *Historical Statistics of the World Economy, 1–2030 AD*. Paris: Organisation for Economic Co-operation and Development.

OECD (Organisation for Economic Co-operation and Development). 2019. *Education at a Glance 2019*. Paris. www.oecd-ilibrary.org/education/education-at-a-glance-2019_f8d7880d-en. Accessed 15 July 2020.

Oeppen, J., and J.W. Vaupel. 2002. “Broken Limits to Life Expectancy.” *Science* 296: 1029–1031.

Riley, J.C. 2005. *Poverty and Life Expectancy*. Cambridge, UK: Cambridge University Press.

Seth, S. 2009. “Inequality, Interactions, and Human Development.” Journal of Human Development and Capabilities 10(3): 375–396.

UNDESA (United Nations Department of Economic and Social Affairs). 2019. *World Population Prospects: The 2019 Revision*. *Rev 1.* New York. https://population.un.org/wpp/. Accessed 30 April 2020.

UNESCO (United Nations Educational, Scientific and Cultural Organization) Institute for Statistics. 2020. Data Centre. http://data.uis.unesco.org. Accessed 21 July 2020.

UNICEF (United Nations Children’s Fund). Various years. Multiple Indicator Cluster Surveys. New York. http://mics.unicef.org/. Accessed 15 July 2020.

United Nations Statistics Division. 2020. National Accounts Main Aggregate Database. http://unstats.un.org/unsd/snaama. Accessed 15 July 2020.

World Health Organization (WHO), United Nations Children’s Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank Group and United Nations Population Division. 2019. *Trends in Maternal Mortality: 2000 to 2017: Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division.* Geneva: World Health Organization. www.who.int/reproductivehealth/publications/maternal-mortality-2000-2017/. Accessed 4 August 2020.

World Bank. 2020. World Development Indicators database. Washington, DC. http://data.worldbank.org. Accessed 21 July 2020.