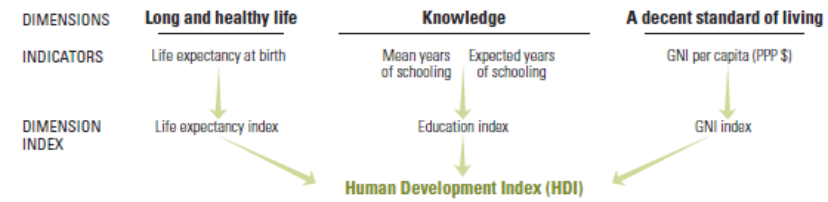
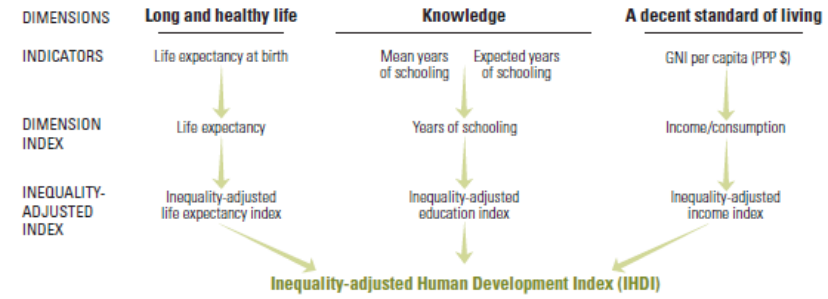
Technical notes

Calculating the human development indices—graphical presentation

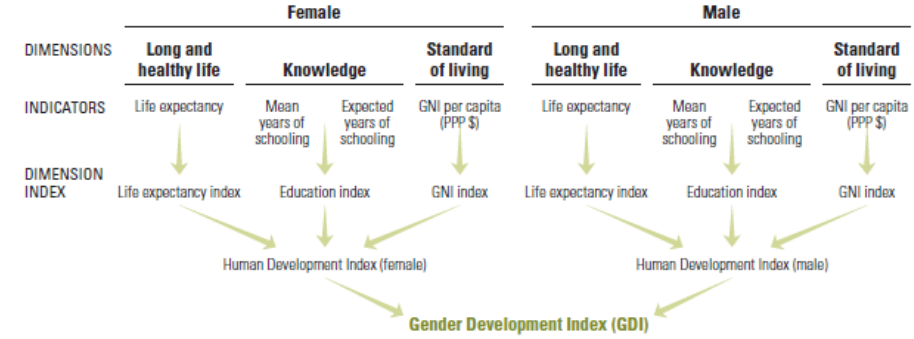
Human Development Index (HDI)



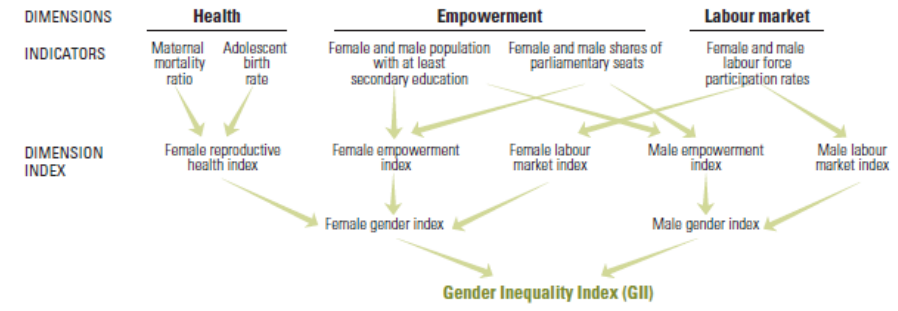
Inequality-adjusted Human Development Index (IHDI)



Gender Development Index (GDI)



Gender Inequality Index (GII)



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 (2017)
- Expected years of schooling: UNESCO Institute for Statistics (2018), United Nations Children's Fund (UNICEF) Multiple Indicator Cluster Surveys, and ICF Macro Demographic and Health Surveys and UNICEF's Multiple Indicator Cluster Surveys.
- Mean years of schooling: Barro and Lee (2016), UNESCO Institute for Statistics (2018), Human Development Report Office updates based on UNESCO Institute for Statistics (2018), UNICEF Multiple Indicator Cluster Surveys and ICF Macro Demographic and Health Surveys.
- GNI per capita: IMF (2018), UN Statistical Division (2018) and World Bank (2018).

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 (Oeppen and Vaupel, 2002; Riley, 2005; Maddison, 2010). 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 – 84.1 years in Hong Kong, China (Special Administrative Region), 83.9 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 four countries (Brunei Darussalam, 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: Egypt

Indicator	Value
Life expectancy at birth (years)	71.7
Mean years of schooling (years)	7.2
Expected years of schooling (years)	13.1
Gross national income per capita (PPP, 2011$)	$10,355

Note: Values are rounded.

Health index = $\frac{71.661-20}{85-20} = 0.7948$

Mean years of schooling index = $\frac{7.218-0}{15-0} = 0.4812$

Expected years of schooling index = $\frac{13.0898-0}{18-0} = 0.7272$

Education index = $\frac{0.4812+0.7272}{2} = 0.6042$

Income index = $\frac{\ln(10{,}355)-\ln(100)}{\ln(75{,}000)-\ln(100)} = 0.7009$

Human Development Index = $(0.7948 \cdot 0.6042 \cdot 0.7009)^{1/3} = 0.696$

Methodology used to express income

The World Bank's 2018 World Development Indicators database contains estimates of GNI per capita in 2011 purchasing power parity (PPP) constant terms for many countries. For countries missing this indicator (entirely or partly), the Human Development Report Office calculates it by converting GNI per capita 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 (2011). Second, a time series of GNI per capita in 2011 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 2011 PPP$ for 2017 reported by World Bank, the International Monetary Fund (IMF) projected GDP real growth rates are applied to the most recent GNI values in constant PPP terms. The IMF-projected growth rates are calculated based on local currency terms and constant prices rather than in PPP terms. This avoids mixing the effects of the PPP conversion with those of real growth of the economy.

Official PPP conversion rates are produced by the International Comparison Program (ICP), whose surveys periodically collect thousands of prices of matched goods and services in many countries. The last round of this exercise refers to 2011 and has covered 199 countries.

Estimating missing values

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

In this Report expected years of schooling have been estimated for Bahamas, Dominica, Equatorial Guinea, Haiti, Libya, Papua New Guinea, Tonga, Trinidad and Tobago, and Vanuatu. Mean years of schooling have been estimated for Eritrea, Grenada, and Saint Kitts and Nevis.

Country groupings

The Human development Report 2014 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 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 2017 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

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 (2017). This distribution is presented over age intervals (0–1, 1–5, 5–10, ... , 85+), 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, the United Nations Children's Fund's Multiple Indicators Cluster Survey, ICF Macro's Demographic and Health Survey, Socio-economic database for Latin America and the Caribbean (SEDLAS) 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 in 2017 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 μ is the arithmetic mean of the distribution. This can be written as:

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

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. Income per capita outliers—extremely high incomes as well as negative and zero incomes—were dealt with by truncating the top 0.5 percentile of the distribution to reduce the influence of extremely high incomes and by replacing the negative and zero incomes with the minimum value of the bottom 0.5 percentile of the distribution of positive 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:

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

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

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

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:

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

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: Madagascar

	Indicator	Dimension index	Inequality measure (A)[a]	Inequality-adjusted index (I^*)
Life expectancy (years)	66.3	0.7125	0.213	(1–0.213) · 0.7125 = 0.5607
Mean years of schooling (years)	6.1	0.4097	0.350	
Expected years of schooling (years)	10.6	0.5872		
Education index		0.4985	0.350	(1–0.350) · 0.4985 = 0.3240
Gross national income per capita (PPP, 2011$)	$1358	0.3940	0.204	(1–0.204) · 0.394 = 0.3136
Human Development Index: $(0.7125 \cdot 0.4986 \cdot 0.3940)^{1/3} = 0.5191$			**Inequality-adjusted Human Development Index:** $(0.5607 \cdot 0.3240 \cdot 0.3136)^{\frac{1}{3}} = 0.3848$	
Loss due to inequality (%): $100\left(1 - \frac{0.385}{0.519}\right) = 25.9$			**Coefficient of human inequality (%)** $\frac{100(0.213 + 0.350 + 0.204)}{3} = 25.6$	

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 aged 25 years and older; and command over economic resources, measured by female and male estimated earned income.

Data sources

- Life expectancy at birth: UNDESA (2017).
- Expected years of schooling: UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF's Multiple Indicator Cluster Surveys and OECD (2017).
- Mean years of schooling for adults ages 25 and older: UNESCO Institute for Statistics (2018), Barro and Lee (2016), ICF Macro Demographic and Health Surveys, UNICEF's Multiple Indicator Cluster Surveys and OECD (2017).
- Estimated earned income: Human Development Report Office estimates based on female and male shares of the economically active population, the ratio of female to male wage in all sectors and gross national income in 2011 purchasing power parity (PPP) terms, and female and male shares of population from ILO (2018), UNDESA (2017), World Bank (2018) and IMF (2018).

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 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 and EA_m are respective female and male share of the economically active population.

The male share of the wage bill is calculated as:

$$S_m = 1 - S_f.$$

Estimated female earned income per capita ($GNI_{pc,f}$) is obtained from GNI per capita (GNI_{pc}), 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 a scale of 0 to 1 using the same goalposts as for the HDI, except life expectancy at birth, which is adjusted for the average of five years biological advantage that women have over men.

Goalposts for the Gender Development Index in this Report

Indicator	Minimum	Maximum
Expected years of schooling (years)	0	18
Mean years of schooling (years)	0	15
Estimated earned income (2011 PPP$)	100	75,000
Life expectancy at birth (years)		
Female	22.5	87.5
Male	17.5	82.5

Note: For 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: Japan

Indicator	Female value	Male vale
Life expectancy at birth (years)	87.1	80.7

Expected years of schooling (years)	15.17	15.29
Mean years of schooling (years)	12.87	12.53
Wage ratio (female/male)	0.7297	
Gross national income per capita (2011 PPP $)	38986.15	
Shares of economically active population	0.4322	0.5678
Share of population	0.51166	0.48834

Female wage bill:
S_f = (0.7297·0.4322)/[(0.7297·0.4322)+0.5678] = 0.35709
Estimated female earned income per capita:
$GNI_{pc,f}$ = 38986.15·0.35709/0.51166 = 27208.6
Male wage bill:
S_m = 1-0.35709= 0.64291
Estimated male earned income per capita:
$GNI_{pc,m}$= 38986.15·0.64291/0.48834 = 51326.1
Female health index = (87.1-22.5)/(87.5-22.5) = 0.9938
Male health index = (80.7-17.5)/(82.5-17.5) = 0.9723
Female education index = [(15.17/18) + (12.87/15)]/2 = 0.8504
Male education index = [(15.29/18) + (12.53/15)]/2 = 0.8424
Estimated female earned income index: [ln(27208.6)-ln(100)]/[ln(75000)-ln(100)] = 0.8468
Estimated male earned income index: [ln(51326.1)-ln(100)]/[(ln(75000)-ln(100)] = 0.9427
Female HDI = $(0.9938 \cdot 0.8504 \cdot 0.8468)^{1/3}$ = 0.894
Male HDI = $(0.9723 \cdot 0.8424 \cdot 0.9427)^{1/3}$ = 0.917

GDI = 0.894/0.917= 0.975

Note: Values are rounded.

GDI groups

The GDI groups are based on the absolute deviation of GDI from gender parity, $100 \cdot |GDI-1|$. Countries with absolute deviation from gender parity equal or less than 2.5 percent are considered as high equality in HDI achievements between women and men and classified into group 1. Countries with absolute deviation from gender parity between 2.5 percent and 5 percent are considered as countries with medium-high equality in HDI achievements between women and men and classified into group 2. Countries with absolute deviation from gender parity between 5 percent and 7.5 percent are considered as countries with medium equality in HDI achievements between women and men and classified into group 3. Countries with absolute deviation from gender parity between 7.5 percent and 10 percent are considered as countries with medium-low equality in HDI achievements between women and men and classified into group 4. Countries with absolute deviation from gender parity greater than 10 percent are considered as countries with low equality in HDI achievements between women and men and classified into 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 between 0, where women and men fare equally, and 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*): UN Maternal Mortality Estimation Group (2017).
- Adolescent birth rate (ABR): UNDESA (2017).
- Share of parliamentary seats held by each sex (*PR*): IPU (2018).
- Attainment at secondary and higher education levels (*SE*): UNESCO Institute for Statistics (2018) and Barro and Lee (2016).
- Labour force participation rate (*LFPR*): ILO (2018).

Steps to calculate the Gender Inequality Index

There are five steps to calculating the GII.

Step 1: Treating zeroes 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:

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

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 groups 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 $\overline{Health} = \left(\sqrt{\frac{10}{MMR} \cdot \frac{1}{AFR}} + 1\right)/2$, $\overline{Empowerment} = \left(\sqrt{PR_F \cdot SE_F} + \sqrt{PR_M \cdot SE_M}\right)/2$, 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: Sri Lanka

	Health		Empowerment		Labour market
	Maternal mortality ratio (per 100,000, live births)	**Adolescent fertility rate (per 1,000 women aged 15-19**	**Parliamentary representation (% of seats)**	**Attainment at secondary and higher education (%)**	**Labour market participation rate (%)**
Female	30	14.1	5.8	82.6	35.1
Male	na	na	94.2	83.1	74.1
(F+M)/2	$\frac{\sqrt{\left(\frac{10}{30}\right)\cdot\left(\frac{1}{14.1}\right)}+1}{2}=0.5769$		$\frac{\sqrt{0.058\cdot 0.826}+\sqrt{0.942\cdot 0.831}}{2}=0.5518$		$(0.351+0.741)/2 = 0.546$

Note: na is not applicable.

Using the above formulas, it is straightforward to obtain:

G_F: $\sqrt[3]{\sqrt{\frac{10}{30}\cdot\frac{1}{14.1}}\cdot\sqrt{0.058\cdot 0.826}\cdot 0.351}=0.2277$

G_M: $\sqrt[3]{1\cdot\sqrt{0.942\cdot 0.831}\cdot 0.741}=0.8687$

$HARM\ (G_F, G_M)$: $\left[\frac{1}{2}\left(\frac{1}{0.2277}+\frac{1}{0.8687}\right)\right]^{-1}=0.3608$

$G_{\overline{F},\overline{M}}$: $\sqrt[3]{0.5769\cdot 0.5518\cdot 0.546}=0.5581$

GII : **1–(0.3608/0.5581) = 0.354**

Technical note 5. Multidimensional Poverty Index

This technical note will be added in due course.

Technical note 6. Human development dashboards 1-5

This year five colour-coded tables were produced: Dashboard 1 on quality of human development, dashboard 2 on life-course gender gap, dashboard 3 on women's empowerment, dashboard 4 on environmental sustainability and dashboard 5 on socioeconomic sustainability.

The dashboards visualize grouping of countries by each indicator, thus partially, contrary to a complete grouping by a composite measure, which combines all listed indicators after making them commensurable. A good example of a complete grouping is the grouping of countries into four human development groups by the Human Development Index (HDI). The complete grouping by a composite index depends on the way the component indicators are combined into the index. On the other hand, the partial grouping does not require any assumption on normalization, weighting or the functional form of the composite index. A partial grouping may depend on the predefined values considered as thresholds needed for grouping, such as what is considered a good performance or as a target to be achieved.

In these dashboards, countries are grouped partially by their performance in each indicator into three groups of approximately equal size (terciles), thus, there is the top third, the middle third and the bottom third. The intention is not to suggest the thresholds or target values for indicators but rather to allow a crude assessment of country's performance relative to others. Three-colour coding visualizes a partial grouping of countries by indicator. It can be seen as a simple visualization tool as it helps the users to immediately picture the country's performance. A country that is in the top group performs better than at least two thirds of countries (i.e., it is among the top third performers); a country that is in the middle group performs better than at least one third but worse than at least one third (i.e., it is among the medium third performers); and a country that is in the bottom third performs worse than at least two thirds of countries (i.e., it is among the bottom third performers). A distinct colour is attached to each of three groups of countries. The colour-coding scale graduates from darkest to lightest. The darker shade of purple represents the top third group; the moderately shaded purple represents the middle third; and the lighter shade of purple represents the bottom third of countries. Partial grouping of countries applies to all listed indicators. When indicators are expressed as female to male ratio, countries with values in the vicinity of one are coloured as top performers in that indicator. Large gaps in favor of men are treated equally as those in favor of women. For some skewed distributions the groups differ in sizes.

HDI groups, regions, special interest groups and the world are coloured and placed into groups based on the values of aggregates for indicators.

Dashboard 1: Quality of human development, contains a selection of 13 indicators associated with the quality of health, education and standard of living. Three indicators on quality of health are: lost health expectancy, number of physicians, and number of hospital beds. Six indicators on quality of education are: pupil-teacher ratio in primary schools, primary school teachers trained to teach, the proportion of schools with access to the Internet and the Programme for International Student Assessment (PISA) scores in mathematics, reading and science. Four indicators on quality of standard of living are: the proportion of employment that is in vulnerable employment, the proportion of rural population with

access to electricity, the proportion of population using improved drinking-water sources and the proportion of population using improved sanitation facilities.

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

Table 6.1 contains ranges of values that define tercile groups and the number of countries in groups for each indicator in dashboard 1.

Table 6.1. 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, % of life expectancy at birth	≤11.5	66	11.5 – 12.0	49	>12.0	68	12
Physicians, per 100,000 people	≥25.0	58	5.5 – 25.0	60	<5.5	57	20
Hospital beds, per 100,000 people	≥35	63	15 - 35	67	<15	58	7
Pupil-teacher ratio, primary school, pupils per teacher	≤15	59	15 - 25	53	>25	55	27
Primary school teachers trained to teach, % of primary school teachers	≥95	47	75 - 95	31	<75	39	78
Proportion of schools with access to the Internet, % of primary and secondary schools	≥90	38	50 - 90	17	<50	29	111
Programme for International Student Assessment (PISA) score, mathematics	≥495	20	425 - 495	25	<425	22	128
Programme for International Student Assessment (PISA) score, reading	≥495	24	435 - 495	20	<435	23	128
Programme for International Student Assessment (PISA) score, science	≥495	25	435 - 495	21	<435	21	128
Vulnerable employment, % of total employment	≥20.0	60	20.0 - 45.0	57	>45.0	63	15
Rural population with access to electricity, % of rural population	=100.0	98	75.0-100.0	32	<75.0	61	4
Population using improved drinking-water sources, % of total population	≥98.0	67	85.0 - 98.0	65	<85.0	61	2
Population using improved sanitation facilities, % of total population	≥95.0	70	65.0 - 95.0	62	<65.0	61	2

Dashboard 2: Life-course gender gap, contains a selection of 12 key indicators that display gender gaps in choices and opportunities over the life course – childhood and youth (5 indicators): sex ratio at birth, gross enrolment ratio in pre-primary, primary and secondary school level, and youth unemployment rate; adulthood (6 indicators): population with at least some secondary education, total unemployment rate, female share of employment in nonagriculture, share of seats in parliament held by women, and time spent on unpaid domestic chores and care work; and older age (one indicator): old-age pension recipients. The indicators refer to health, education, labour market and work, political representation, time use and social protection. Most indicators (9) are presented as a ratio of female to male values, and three are presented only for women. Countries are grouped partially by their performance in each

indicator into three groups of approximately equal size (terciles) with the exception of sex ratio at birth—countries are grouped into two groups: the natural group (countries with a value between 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, suggesting possible future social and economic problems and may indicate gender bias.

The aggregates are published for 10 indicators. Aggregates are not available for two indicators related to time spent on unpaid domestic chores and care work.

Table 6.2 contains ranges of values that define tercile groups and the number of countries in groups for each indicator in dashboard 2.

Table 6.2. Observed ranges of values and number of countries in each tercile group, by indicator in Dasboard2: Life-cycle gender gap

	Top group		Middle group		Bottom group		Number of 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, >1.07	50	10
Gross enrollment ratio: Pre-primary, female to male ratio	0.99 – 1.01	58	0.97 – 0.99 1.01 – 1.03	50	<0.97 >1.03	57	30
Gross enrollment ratio: Primary, female to male ratio	0.99 – 1.01	81	0.97 – 0.99 1.01 – 1.03	45	<0.97 >1.03	52	17
Gross enrollment ratio: Secondary, female to male ratio	0.98 – 1.02	56	0.92 – 0.98 1.02 – 1.08	60	<0.92 >1.08	50	29
Youth unemployment rate, female to male ratio	0.95 – 1.05	50	0.85 – 0.95 1.05 – 1.15	65	<0.85 >1.15	65	15
Population with at least some secondary education, female to male ratio	0.95 – 1.05	69	0.80 – 0.95 1.05 – 1.20	53	<0.80 >1.20	43	30
Total unemployment rate, female to male ratio	0.90 – 1.10	35	0.75 – 0.90 1.10 – 1.25	58	<0.75 >1.25	87	15
Share of employment in nonagriculture, female, % of total employment in nonagriculture	≥45.0	75	40.0 – 45.0	40	<40.0	65	15
Share of seats in parliament, % held by women	≥25.0	68	15.0 – 25.0	67	<15.0	58	2
Time spent on unpaid domestic chores and care work: women ages 15 and older, % of 24-hour day	≤15.0	17	15.0 – 20.0	41	>20.0	15	122
Time spent on unpaid domestic chores and care work, female to male ratio	≤2.0	23	2.0 – 3.0	25	>3.0	25	122
Old-age pension recipients, female to male ratio	0.99 – 1.00	35	0.80 – 0.99 1.00 – 1.20	8	<0.80 >1.20	20	132

Dashboard 3: Women's empowerment, contains a selection of 13 woman-specific empowerment indicators that allows empowerment to be compared across indicators and countries. Indicators

represent three distinct empowerment dimensions – reproductive health and family planning (6 indicators): Antenatal care, at least one visit; proportions of births attended by skilled health personnel; maternal mortality rate; adolescent birth rate; contraceptive prevalence, any method; unmet need for family planning ; violence against girls and women (3 indicators): child marriage, violence against women ever experienced by intimate partner, violence against women ever experience by nonintimate partner; and socioeconomic empowerment (4 indicators): female share of graduates in science, mathematics, engineering, manufacturing and construction at tertiary level; 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 regional aggregates are published for 12 indicators. Aggregates are not available for indicator on female share of middle and senior management.

Table 6.3 contains ranges of values that define tercile groups and the number of countries in groups for each indicator in dashboard 3.

Table 6.3. Observed ranges of values and number of countries in each tercile group, by indicator in Dashboard 3: Women's empowerment

	Top group		Middle group		Bottom group		Number of countries with missing values
	Range	Number of countries	Range	Number of countries	Range	Number of countries	
Antenatal care coverage, at least one visit, %	≥97.5	47	92.0 – 97.5	46	<92.0	52	50
Proportion of births attended by skilled health personnel, %	≥99.0	64	90.0 – 99.0	39	<90.0	60	32
Maternal mortality ratio, deaths per 100,000 live births	≤25	64	25 – 150	59	>150	59	13
Adolescent birth rate, births per 1,000 women ages 15-19	≤20.0	62	20.0 – 60.0	61	>60.0	62	10
Contraceptive prevalence, any method, % of married or in-union women of reproductive age, 15-49 years	≥60.0	59	40.0 – 60.0	39	<40.0	54	43
Unmet need for family planning, % of married or in-union women of reproductive age, 15-49 years	≤12.5	43	12.5 – 23.0	41	>23.0	42	69
Women married by age 18, % of women ages 20-24 who are married or in union	≤15	42	15 – 27	43	>27	40	70
Violence against women ever experienced: Intimate partner, % of female population ages 15 and older	≤20.0	30	20.0 – 30.0	41	>30.0	36	88
Violence against women ever experienced: Nonintimate partner, % of female population ages 15 and older	≤4.0	23	4.0 – 8.0	16	>8.0	17	139
Female share of graduates in science, mathematics, engineering, manufacturing and construction at tertiary level, %	≥15.0	38	10.0 – 15.0	38	<10.0	30	89
Female share of employment in senior and middle management, %	≥35.0	27	30.0 – 35.0	21	<30.0	33	114

Women with account at financial institution or with mobile money-service provider, % of female population ages 15 and older	≥75.0	50	40.0 – 75.0	48	<40.0	58	39
Mandatory paid maternity leave, days	≥105	62	90 – 105	57	<90	59	17

Dashboard 4: Environmental sustainability, contains a selection of 10 indicators that cover environmental sustainability and environmental threats. On environmental sustainability there are 7 level and change indicators related to energy consumption, carbon dioxide emissions, change in forest area and fresh water withdrawals. Three environmental threats indicators are mortality rate attributed to household and ambient air pollution and to unsafe water, sanitation and hygiene service and the International Union for Conservation of Nature and Natural resources' Red List Index that measures aggregate extinction risk across groups of species.

The percentage of total land area under forest is not coloured and aggregates are not available for Red List Index. Thus the regional aggregates are published for 8 indicators.

Table 6.4 contains ranges of values that define tercile groups and the number of countries in groups for each indicator in dashboard 4.

Table 6.4. Observed ranges of values and number of countries in each tercile group, by indicator in Dashboard 4: Environmental 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	
Fossil fuel energy consumption, % of total energy consumption	≤60.0	44	60.0 – 85.0	46	>85.0	48	57
Renewable energy consumption, % of total final energy consumption	≥40.0	63	15.0 – 40.0	56	<15.0	74	2
Carbon dioxide emissions, per capita (tonnes)	≤1.0	62	1.0 – 4.5	67	>4.5	64	2
Carbon dioxide emissions, kg per 2011 PPP $ of GDP	≤0.15	51	0.15 – 0.25	74	>0.25	62	8
Forest area, % of total land area	—	—	—	—	—	—	—
Forest area, change (%)	≥4.0	62	-3.0 – 4.0	56	<-3.0	68	9
Fresh water withdrawals, % of total renewable water sources	≤3.0	36	3.0–14.0	34	>14.0	36	89
Mortality rate attributed to household and ambient air pollution, per 100,000 population	≤45.0	59	45.0 – 115.0	63	>115.0	61	12
Mortality rate attributed to unsafe water, sanitation and hygiene services, per 100,000 population	≤0.5	68	0.5 – 6.0	52	>6.0	63	12
Red List Index, value	≥0.925	56	0.825 – 0.925	73	<0.825	66	0

Dashboard 5: Socioeconomic sustainability, contains a selection of 11 indicators that cover economic and social sustainability. The 6 economic sustainability indicators are: adjusted net savings, total debt service, gross capital formation, skilled labour force, diversity of exports and expenditure on research

and development. The 4 social sustainability indicators are: the ratio of education and health expenditure to military expenditure, change in overall loss in HDI value due to inequality, and changes in gender and income inequality.

The military expenditure is not coloured and aggregates are not available for concentration index and the change in income quintile ratio. Thus the aggregates are published for 9 but coloured for 8 indicators.

Table 6.5 contains ranges of values that define tercile groups and the number of countries in groups for each indicator in dashboard 5.

Table 6.5. 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	≥12.0	57	3.0 – 12.0	45	<3.0	51	42
Total debt service, % of exports of goods, services and primary income	≤6.0	38	6.0 – 16.0	38	>16.0	41	78
Gross capital formation, % of GDP	≥25.0	67	20.0 –25.0	58	<20.0	49	21
Skilled labour force, % of labour force	≥75.0	51	40.0 – 75.0	41	>40.0	49	54
Concentration index (exports), value	≤0.200	61	0.200 – 0.400	72	>0.400	58	4
Research and development expenditure, % of GDP	≥1.0	39	0.3 – 1.0	51	<0.3	36	69
Military expenditure, % of GDP	—	—	—	—	—	—	—
Ratio of education and health expenditure to military expenditure	≥10.0	40	6.0 – 10.0	39	<6.0	38	78
Overall loss in HDI due to inequality, average annual change (%)	≤-2.0	51	-2.0 – -0.5	37	>-0.5	44	63
Gender Inequality Index, average annual change (%)	≤-2.0	47	-2.0 – -1.0	50	>-1.0	47	51
Income quintile ratio, average annual change (%)	≤-1.0	45	-1.0 – 0.0	38	>0.0	41	71

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