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The Global Multidimensional Poverty Index: Harmonised Level Estimates and their Changes over Time

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Abstract
This paper describes the database *The Global Multidimensional Poverty Index (MPI): Harmonised Level Estimates and their Changes over Time*. The global MPI is an international poverty measure based on ten deprivation indicators in three dimensions: health, education, and living standards. The database contains estimates for the multidimensional poverty index itself (the adjusted headcount ratio), related partial indices such as the headcount ratio, the intensity, indicator-specific indices, and several auxiliary statistics as well as changes over time for most quantities. For this database all deprivation indicators have been harmonised over time. Our database covers estimates for 84 countries and 814 subnational regions for up to four points of observation. The estimates are based on 211 individual survey datasets, mostly the Demographic Health Survey (DHS) and the Multiple Indicator Cluster Survey (MICS). Combining information of different dimensions of human well-being, the global MPI inherently invites interdisciplinary research.

Keywords: multidimensional poverty; global MPI; poverty dynamics

JEL classification: I32, O52

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Background and Summary

Despite substantial progress over the last decades, poverty is one of the most pressing problems of our time. It is widely agreed that both poverty and wellbeing *are* multidimensional concepts. For instance, the human development index (HDI) first published in 1990 draws on health, education and income information. The Millennium Development Goals (MDG) and their successors the Sustainable Developmnet Goals (SDG) include targets such as zero hunger, universal education and access to clean water and sanitation. At the same time research extended conventional poverty measurement[1,2] to multidimensional settings.[3–6] Measures of multidimensional poverty allow to identify overlapping deprivation at the individual level and are, therefore, fundamentally different from both composite indices such as the HDI and (unidimensional) monetary poverty measures. In his last book, Sir Tony Atkinson sets forth the paradigm of triangulating across (i) monetary and multidimensional poverty measures and (ii) international and national measures to better understand poverty dynamics and their drivers.[7]

In this paper we document data of the Global Multidimensional Poverty Index (MPI)—more specifically, its harmonised level estimates and related changes over time which are essential to understand and reinforce poverty reductions. The global MPI was developed Sabina Alkire and Maria Emma Santos, two scholars of the Oxford Poverty and Human Development Initiative (OPHI),[8,9] in collaboration with the Human Development Report Office (HDRO) at UNDP as an internationally comparable measure of acute poverty. The global MPI comprises ten indicators organised in three dimensions (health, education and living standards). Technically, the global MPI relies on the Alkire-Foster method[6] and conceptually it is based on the capability approach.[10–13] While indicator decisions have been informed by MDGs, they were also data constrained. In 2018, five out of the ten indicators have been revised to better align with the SDGs.[14–16] The global MPI is estimated using comprehensive household survey data, which is largely provided by the Demographic and Health Surveys (DHS) Program and the Multiple Indicator Cluster Surveys programme (MICS).

Since 2010, the global MPI is annually computed and published based on the most recent dataset for each country. Related changes over time, which involve indicator harmonisation, have so far only been infrequently published, often for only a few countries[17,18] or for two time periods[19] or individual countries.[20,21] Since 2021, however, harmonised level estimates and their changes over time are annually computed with the objective to provide estimates comparable across countries and time. Additionally, further datasets have been added where possible and all estimates are now available in a single database, which is documented by this paper. Although first published in 2021, this paper is the first description of the database; and in our presentation we focus on the recently released 2023 database. The databases may be distinctively different between each year as additional survey datasets are harmonised for countries where updated surveys are available. The inclusion of additionally harmonised surveys for a country may show differences in the countries' changes over time estimates that is included in the current database compared to the previous database due to indicator harmonisation decisions. The latest release of this database relies on 211 individual survey datasets from 84 countries for 2–4 points of time and provides estimates for 814 subnational regions from 77 countries. The database also provides estimates for urban and rural areas as well as age-groups. All estimates are accompanied by standard errors and confidence intervals reflecting sampling errors, which may not be taken for granted in poverty statistics.[22]

The estimates are organised in two well-structured files, one for levels and one for changes, to provide easy, transparent and user-friendly access. The aim of these files and their documentation is to facilitate the re-use of our estimates in downstream analyses. Such analyses may focus global multidimensional poverty itself. While the global MPI has been analysed from various angles,[17,23,24] obtaining the required specialist knowledge for such analyses is now much easier. Another line of research may explore global poverty within the paradigm laid out by Tony Atkinson, i.e. jointly from monetary and multidimensional angles or together with national poverty estimates. Finally, multidimensional poverty measurement inherently goes beyond disciplinary borders, involving research in health and education among others. Indeed, recent research suggests a novel analysis of deprivation interlinkages which is potentially relevant for both researchers and policymakers in different fields.[25]

Methods

The global MPI relies on the Alkire-Foster method. The method requires selecting dimensions and indicators, applying deprivation cut-offs for each indicator, setting relative indicator weights and defining a cross-dimensionsal poverty cutoff to identify those who are multidimensionally poor. Estimates are obtained from representative household survey data. We discuss each element in turn and detail relevant decisions and policies along the way.

The Alkire Foster method

To facilitate explanations of the estimates distributed within this database, this sections first presents the Alkire-Foster method,[6] which underlies the global MPI computations. A more comprehensive textbook presentation is also available.[26]

Consider for $t = 1,\ldots,T$ time periods the populations of $i = 1,\ldots,N_t$ individuals with $j = 1,\ldots,D$ achievements in different dimensions of wellbeing. These achievements are denoted as $y_{ijt} \in \mathbb{R}^+$. An individual is deprived in j if the respective

achievement falls short of the deprivation threshold z_j, or formally, $d_{ijt} = \mathbb{I}(y_{ijt} < z_j)$ with $\mathbb{I}(\cdot)$ being the indicator function. Let $w_j \in (0,1)$ with $\sum_j w_j = 1$ denote the set of normative weights for all deprivation indicators. The deprivation score of individual i at time t is $c_{it} = \sum_j w_j d_{ij}$ with $c_{it} \in [0,1]$ and reflects the degree of overlapping deprivation experienced by person i.

Persons with a critically high deprivation score are considered poor. Formally, $\text{poor}_{it} = \mathbb{I}(c_{it} \geq k)$ where k with $k \in (0,1]$ is the poverty cutoff. Let $Q_t = \{i | poor_{it} = 1\}$ be the set of all poor people in period t and q_t their number. The proportion of the population that is poor, the headcount ratio or incidence of poverty, may be obtained as $H_t = q_t/N_t$. The poverty intensity, which reports the average deprivation among the poor is $A_t = \frac{1}{q_t}\sum_{i \in Q_t} c_{it}$. The adjusted headcount ratio, denoted as MPI or M is $M_t = H_t \times A_t$. Moreover, the deprivation-specific uncensored headcount ratios report the proportion of people who are deprived in a particular indicator j and may be written as $h_{jt} = \frac{1}{N_t}\sum_i d_{ijt}$. Censored headcount ratios instead report the proportion of people who are both poor and deprived in indicator j and may be written as $\underline{h}_{jt} = \frac{1}{N_t}\sum_{i \in Q_t} d_{ijt}$.

The adjusted headcount ratio satisfies several useful properties[6] including *dimensional breakdown*, which allows to compute the adjusted headcount ratio also as $M_t = \sum_j w_j \underline{h}_{jt}$. The contributions of indicators may be reported in absolute terms as $w_j \underline{h}_{jt}$ in units of M or in relative terms as $w_j \underline{h}_{jt}/M_t \times 100$, i.e. as a percentage of M. Besides decomposing M into its indicator contributions, a disaggregation by subpopulations is also often instructive. More specifically, if the population can be divided into $l =, 1 \ldots, L$ mutually exclusively groups of sizes N_{lt}, the above mentioned (sub-) indices may also be expressed as population weighted averages, e.g., $H_t = \sum_l \frac{N_{lt}}{N_t} H_{lt}$.

Finally, one may compute changes over time for each of the previously introduced (sub)index either in absolute terms (e.g., $\Delta M_t = M_t - M_{t-1}$) or in relative terms (e.g., $\delta M_t = \Delta M_t / M_{t-1}$). To compare changes over different observation periods it is often useful to rely on annualised changes. Annualised absolute changes may be computed as $\overline{\Delta} M_t = \frac{\Delta M_t}{\Delta t}$ where Δt is the difference in years between final and initial period; annualised relative changes as $\overline{\delta} M = \left[\left(\frac{M_t}{M_{t-1}}\right)^{\frac{1}{\Delta t}} - 1\right] \times 100$.

Deprivation indicators, weights and cutoffs

The global MPI relies on ten deprivations indicators which capture shortfalls in the three dimensions: health (*Nutrition* and *Child mortality*), education (*Years of schooling* and *School attendance*) and living standards (*Cooking fuel*, *Sanitation*, *Drinking Water*, *Electricity*, *Housing* and *Assets*). Table 1 provides further details on each of the deprivation indicators. While indicator decisions have been informed by the MDGs, they were also data constrained. Previous research found insufficient data to result in missing dimensions of poverty—well before the first estimation of the global MPI in 2010.[27] Considerations during the 2018 revision for a better alignment of the deprivation indicators with the SDGs revealed that such data constraints persist for a substantial share of the countries.[14] As a consequence only five indicators have eventually been revised, although 33 alternative or new indicators were originally considered. Besides these revisions, we also updated in 2020 the construction of the drinking water indicator, following the reclassification of safe drinking water sources of Joint Monitoring Programme for Water Supply Sanitation and Hygiene.[28]

Technically, deprivation indicators are constructed at the household level using both household and individual-level information (cf. table 1). Some deprivation indicators, such as those for living standards, use only household level data. Health and education indicator, however, make use of individual-level information. For instance, if a school-aged child is not attending school, we consider the entire household deprived in school attendance. Likewise, if at least one household member completed six years of schooling, all household members are considered non-deprived in the respective deprivation indicator.

Some households, however, lack the so-called eligible population, i.e. individuals for which the achievement has been measured. In these cases, the entire household is identified as non-deprived in a particular indicator. For example, if households do not have eligible members for an anthropometric measurement (e.g., children under five years), the entire household is identified as non-deprived in nutrition. Similarly, the child mortality indicator is constructed using birth history data that is usually collected from women in the reproductive age group (15–49 years). If a household lacks women in the reproductive age group, then all members of this households are identified as non-deprived in the child mortality indicator. Finally, throughout the construction of the all deprivation indicators, we only rely on usual household members and thus exclude data from non-usual household members. This approach ensures comparability between survey datasets (some datasets only provide information for usual household members) and, moreover, reduces fluctuations in deprivations due to occasional visitors.

In addition to the deprivation indicators themselves, table 1 also shows the respective weights, which follow from an equal-nested weighting structure, i.e. (i) all dimensions are weighted equally with one third and (ii) all deprivation indicators are weighted equally within each dimension. Similar to deprivations, poverty is also established at the household level, i.e. the unit of identification is the household. The poverty cutoff of the global MPI is set to $k = 33\%$, implying that a household is considered poor if it suffers from 33% or more of the maximum possible weighted deprivations.

Dimension of Poverty	Indicator	Deprived if living in a household where...	SDG area	Weight
Health	Nutrition	Any eligible person is *undernourished*.[1]	SDG 2	$\frac{1}{6}$
	Child mortality	A child *under 18* has *died* in the household in the five-year period preceding the survey.[2]	SDG 3	$\frac{1}{6}$
Education	Years of schooling	*No* eligible household member has completed *six years* of *schooling*.[3]	SDG 4	$\frac{1}{6}$
	School attendance	Any school-aged child[3] is *not attending* school *up to* the age at which he/she would complete *class 8*.[4]	SDG 4	$\frac{1}{6}$
Living Standards	Cooking fuel	A household cooks using *solid fuel*, such as dung, agricultural crop, shrubs, wood, charcoal or coal.[5]	SDG 7	$\frac{1}{18}$
	Sanitation	The household has *unimproved* or *no* sanitation *facility* or it is improved but *shared* with other households.[6]	SDG 6	$\frac{1}{18}$
	Drinking water	The household's source of *drinking water* is *not safe* or safe drinking water is a *30-minute walk* or *longer walk* from home, roundtrip.[7]	SDG 6	$\frac{1}{18}$
	Electricity	The household has *no electricity*.[8]	SDG 7	$\frac{1}{18}$
	Housing	The household has *inadequate* housing materials in *any* of the three components: *floor*, *roof*, or *walls*.[9]	SDG 11	$\frac{1}{18}$
	Assets	The household does *not own more than one* of these *assets*: radio, TV, telephone, computer, animal cart, bicycle, motorbike, or refrigerator, and does not own a car or truck.	SDG 1	$\frac{1}{18}$

Notes: the global MPI is related to the following SDGs: No Poverty (SDG 1), Zero Hunger (SDG 2), Health & Well-being (SDG 3), Quality Education (SDG 4), Clean Water & Sanitation (SDG 6), Affordable & Clean Energy (SDG 7), Sustainable Cities & Communities (SDG 11).

[1] Children under 5 years (60 months and younger) are considered undernourished if their z-score of either height-for-age (stunting) or weight-for-age (underweight) is below minus two standard deviations from the median of the reference population. Children 5–19 years (61–228 months) are identified as deprived if their age-specific BMI cutoff is below minus two standard deviations. Adults older than 19 to 70 years (229–840 months) are considered undernourished if their Body Mass Index (BMI) is below 18.5 kg/m^2.

[2] The child mortality indicator of the global MPI is based on birth history data provided by mothers aged 15–49. In most surveys, men have provided information on occurrence of child mortality as well but this lacks the date of birth and death of the child. Hence, the indicator is constructed solely from mothers. However, if the data from the mother is missing, and if the male in the household reported no child mortality, then we identify no occurrence of child mortality in the household.

[3] If all individuals in the household are in an age group where they should have formally completed 6 or more years of schooling, but none have this achievement, then the household is deprived. However, if any individuals aged 10 years and older reported 6 years or more of schooling, the household is not deprived.

[4] Data source for the age children start compulsory primary school: DHS or MICS survey reports; or http://data.uis.unesco.org/

[5] If survey report uses other definitions of solid fuel, we follow the survey report.

[6] A household is considered non-deprived in sanitation if it has some type of flush toilet or latrine, or ventilated improved pit or composting toilet, provided that they are not shared. If the survey report uses other definitions of improved sanitation, we follow the survey report.

[7] A household is considered non-deprived in drinking water if the water source is any of the following types: piped water, public tap, borehole or pump, protected well, protected spring, or rainwater. It must also be within a 30-minute walk, round trip. If the survey report uses other definitions of improved drinking water, we follow the survey report.

[8] A small number of countries do not collect data on electricity because of 100% coverage. In such cases, we identify all households in the country as non-deprived in electricity.

[9] Deprived if floor is made of natural materials (mud/clay/earth, sand or dung) or if dwelling has no roof or walls or if either the roof or walls are constructed using natural or rudimentary materials such as such as carton, plastic/ polythene sheeting, bamboo with mud/stone with mud, loosely packed stones, uncovered adobe, raw/reused wood, plywood, cardboard, unburnt brick or canvas/tent. The definition of natural and rudimentary materials follows the classification used in country-specific DHS or MICS questionnaires.

Table 1. Global MPI indicator definitions and weights.

Microdata sources

The global MPI is computed using multi-topic household surveys, primarily with the data collection supported by DHS and MICS. For few countries, data from national household surveys that are comparable to DHS and MICS is used. Household surveys are required to fulfill several criteria for being included in the global MPI estimations. First, the household surveys must be representative at least at the national level. Second, access to the microdata and the related documentation (e.g., questionnaires and survey report) are essential and usually available upon e-registration.

In some cases a single missing survey item would result in the exclusion of the entire country despite all of the remaining items being available. To navigate this trade-off between comparability and country coverage, we require, thirdly, that at least one of the health indicators (child mortality or nutrition) and at least one of the education indicators (years of school and school attendance) has to be computed with the survey. In such cases of missing deprivation indicators, indicator weights of the affected dimension are increased such that the dimensional weights remain unchanged. Estimates based on data with missing deprivation indicators are flagged throughout. This approach allows researchers to decide on a case-by-case basis whether a particular analysis is meaningful. Finally, household surveys published by DHS and MICS are prioritised, to achieve highly comparable estimates. Household surveys by national agencies or statistical offices are only considered in the absence of DHS or MICS surveys. Table 2 provides an overview of the underlying micro data. For each country the table shows the covered period of observation, the number of surveys used, the type of survey, the number of available subnational regions and whether the country lacks a particular indicator.

Indicator harmonisation over time

In survey data it is common to observe that questions and items slightly vary over time. In our data we observe in particular changes in the (i) eligible population (e.g., the age groups for which nutrition data is collected) and (ii) survey item availability (e.g., data on computer availability is not collected in all surveys). In order to harmonise deprivation indicators over time, we restrict the eligible population and the available survey items as needed to the common domain. Below we briefly explain the most common changes in deprivation indicators due to harmonisation over time. For further details on which indicator was harmonised in which way for every country, see the respective methodological note of each release.[29–31]

First, the harmonised nutrition indicator often relies only on the anthropometric information of children under 5, since related information for adults is not collected in all years. Similarly, we would ignore the nutritional information of adult males, if the surveys only provided nutritional information for adult women and children in all years. The harmonised child mortality indicator may ignore birth history information about the age of the child and the year of its death (cf. table 1), if at least one survey lacks this information. Consequently, the harmonised child mortality indicator then considers any child who has died in the household independent of when the death occurred. The drinking water indicator relies on information of both source and round trip time to obtain the water, while the sanitation indicator uses both type of toilet and whether it is shared with other households. If information about the round trip time or whether the toilet is shared is not collected, the respective harmonised indicators rely only on the source of drinking water and the type of toilet, respectively. A household is usually considered deprived in housing if either of floor, roof or walls is constructed using poor materials. If any of the materials are missing in one of the surveys (e.g., wall materials), the harmonised deprivation indicator would rely on the remaining comparable materials (i.e. floor and roof in this case). Finally, the assets indicator relies on the ownership of a car or truck and eight smaller asset items, such as television or bicycle (cf. table 1 for details). While earlier surveys may not collect information about mobile phones or computer, more recent surveys may lack data on landline telephones or animal carts. The harmonised assets indicator includes only ownership of items that are consistently available across all survey periods and relevant for the global MPI.

Missing values

Missing values are a common issue in survey datasets. For the global MPI estimates we address missing values in several ways. First, in some cases we construct a particular deprivation indicator despite missing responses following the approach to provide a lower bound estimate for those deprivations. Specifically, we consider the household to be non-deprived if we have at least partial information suggesting that a household may not be deprived and in particular when this presumption is supported by further complementary information. For example, in the absence of child mortality information from any eligible women, if a men in the same household reported no child mortality, then the entire household is considered as non-deprived in child mortality. Similarly, if a household used improved source of drinking water but the time to the water source is missing, then the household is identified as non-deprived by the source. For the sanitation indicator, if a household has access to an improved toilet facility but information on shared facility is missing, then the household is identified as non-deprived by type of facility. Note that this approach results in an lower-bound estimation for a particular deprivation.

Second, in our estimations we can only consider households for which we can construct all deprivation indicators. So observations with missing deprivation indicators are dropped (case-wise deletion). Since excessive sample drop bias our estimates, we first report the proportion missing values individually for every deprivation indicator and, moreover, also the retained sample which we can ultimately use in our estimation after accounting for missing values in all deprivation indicators.

Country code	First year	Last year	# years	Survey Names	# regions	Missing Indicator
Afghanistan	2010	2016	2	DHS MICS	8	Nutrition
Albania	2008	2018	2	DHS	12	
Algeria	2012	2019	2	MICS	7	
Armenia	2010	2016	2	DHS	–	
Bangladesh	2014	2019	2	DHS MICS	7	
Belize	2011	2016	2	MICS	7	
Benin	2014	2018	2	DHS MICS	12	
Bolivia	2003	2016	3	DHS EDSA	9	
Bosnia and Herzegovina	2006	2012	2	MICS	–	Child mortality
Burkina Faso	2006	2010	2	DHS MICS	–	
Burundi	2010	2017	2	DHS	5	
Cambodia	2010	2022	3	DHS	19	
Cameroon	2011	2018	3	DHS MICS	12	
Central African Republic	2000	2019	3	MICS	8	
Chad	2010	2019	3	DHS MICS	20	
China	2010	2014	2	CFPS	3	Housing
Colombia	2010	2016	2	DHS	16	Nutrition
Congo	2005	2015	2	DHS MICS	4	
Congo, Democratic Republic of the	2007	2018	3	DHS MICS	11	
Côte d'Ivoire	2011	2016	2	DHS MICS	11	
Dominican Republic	2007	2019	3	DHS MICS	10	Nutrition
Ecuador	2013	2018	2	ECV ENSANUT	24	
Egypt	2008	2014	2	DHS	23	Cooking fuel
eSwatini	2010	2014	2	MICS	4	
Ethiopia	2011	2019	3	DHS	11	
Gabon	2000	2012	2	DHS	5	
Gambia	2005	2020	4	DHS MICS	8	
Ghana	2011	2018	3	DHS MICS	10	
Guinea	2012	2018	3	DHS MICS	8	
Guinea-Bissau	2014	2019	2	MICS	9	
Guyana	2009	2020	3	DHS MICS	2	
Haiti	2012	2017	2	DHS	10	
Honduras	2005	2019	3	DHS MICS	16	Electricity
India	2005	2021	3	DHS	29	
Indonesia	2012	2017	2	DHS	33	Nutrition
Iraq	2011	2018	2	MICS	18	
Jordan	2012	2018	2	DHS	12	
Kazakhstan	2010	2015	2	MICS	16	
Kenya	2008	2014	2	DHS	8	
Kyrgyzstan	2005	2018	3	MICS	8	
Lao PDR	2011	2017	2	MICS	17	
Lesotho	2009	2018	3	DHS MICS	4	Cooking fuel
Liberia	2007	2020	3	DHS	5	
Madagascar	2008	2021	3	DHS MICS	22	
Malawi	2010	2020	3	DHS MICS	27	
Mali	2006	2018	3	DHS MICS	9	
Mauritania	2011	2021	3	DHS MICS	12	
Mexico	2012	2021	4	ENSANUT	4	Child mortality
Moldova	2005	2012	2	DHS MICS	4	
Mongolia	2010	2018	3	MICS	5	
Montenegro	2013	2018	2	MICS	3	
Morocco	2011	2018	2	PAPFAM	–	
Mozambique	2003	2011	2	DHS	11	
Namibia	2006	2013	2	DHS	13	
Nepal	2011	2019	3	DHS MICS	7	
Nicaragua	2001	2012	2	DHS	17	
Niger	2006	2012	2	DHS	8	
Nigeria	2013	2021	4	DHS MICS	37	Nutrition
North Macedonia	2005	2019	3	MICS	8	Child mortality
Pakistan	2012	2018	2	DHS	6	
Palestine, State of	2010	2020	3	MICS	2	
Peru	2012	2021	4	DHS ENDES	25	
Philippines	2013	2017	2	DHS	17	Nutrition & School attendance
Rwanda	2010	2020	3	DHS	5	
Sao Tome and Principe	2008	2019	3	DHS MICS	4	
Senegal	2005	2019	3	DHS	11	
Serbia	2010	2019	3	MICS	4	
Sierra Leone	2013	2019	3	DHS MICS	4	
Sudan	2010	2014	2	MICS	–	
Suriname	2006	2018	3	MICS	5	Child mortality
Tajikistan	2012	2017	2	DHS	5	
Tanzania	2010	2016	2	DHS	8	
Thailand	2012	2019	3	MICS	6	
Timor-Leste	2009	2016	2	DHS	13	
Togo	2010	2017	3	DHS MICS	6	
Trinidad and Tobago	2006	2011	2	MICS	5	Nutrition
Tunisia	2011	2018	2	MICS	7	
Turkmenistan	2006	2019	3	MICS	6	Cooking fuel
Uganda	2011	2016	2	DHS	4	
Ukraine	2007	2012	2	DHS MICS	5	Nutrition
Viet Nam	2013	2021	2	MICS	6	Nutrition
Yemen	2006	2013	2	DHS MICS	–	Nutrition
Zambia	2007	2018	3	DHS	9	
Zimbabwe	2010	2019	3	DHS MICS	10	

Table 2. Information on underlying microdata samples

In some cases we consider the sample drop as highly problematic and thus refrain from reporting certain estimates. Specifically, we omit subnational estimates if the sample drop exceeds 15% at the national level or 25% at the subnational level.

Estimation

In this section we present selected aspects related to the estimation procedures of the global MPI. First, the entire production of the global MPI including both data cleaning, deprivation indicator construction and estimation are carried out using Stata 17. Moreover, the sampling of most datasets relies on complex survey designs, with stratified two-stage clustered sampling being the most common form. The microdata variables which contain information about the survey design (`psu`, `stratum`, `hhweight`) are coded such that we can rely on Stata's `svyset` command to account for the complex survey design. Accordingly, all estimates rely on the survey weights as provided by the data distributor. Specifically,

```
svyset psu [pw=weight] , strata(strata) singleunit(centered)
```

All deprivation indicators in the cleaned microdata begin with `d_` followed by their abbreviated name and `_01` which identifies the harmonised indicator (e.g., `d_cm_01` for the harmonised child mortality indicator). The estimations rely on the user-written Stata package `mpitb` (version 0.4) which is publicly available at the Statistical Software Component (SSC) Archive and gitlab and documented in a companion paper.[32] The estimation proceeds in a two-step procedure: first we specify the indicators of the MPI of interest before we choose the (sub-)indices to be estimated and the underlying parameters among other things. Most of the estimates for single country as provided in this database can be obtained using the following two commands:

```
mpitb set , d1(d_cm_01 d_nutr_01, n(hl)) d2(d_satt_01 d_educ_01, n(ed)) ///
   d3(d_elct_01 d_sani_01 d_wtr_01 d_hsg_01 d_asst_01 d_ckfl_01 , name(ls)) n(gmpi_hot)

mpitb est , k(33) w(equal) n(gmpi_hot) tv(t) m(all) indm(all) aux(all) ///
    svy lfr(mylevs, replace)  over(region_01 area agec2 agec4) dou ///
    cotm(all) coty(year_cot) coto(inseq nor) cotfr(mycots, replace)
```

The commands as shown above do not account in any particular for item or unit non-responses (e.g., multiple imputation, adjustment of sampling weights, etc). Instead, observations are which exhibit a missing value in a relevant variable, such as deprivation indicators, disaggregation or survey design variable are removed from the estimation sample (casewise deletion). Non-response rates are, however, monitored and reported in this database.

The household surveys used for the estimation of the global MPI are representative at the national or subnational level and usually also for urban and rural areas in a country. For most countries we, therefore, also provide estimates by subgroups to understand whether poverty is increasing or decreasing across age groups, between urban and rural areas, and by gender of household head. Since for most countries the samples are also representative at lower administrative levels (e.g., governorates, provinces, regions, states, or zones), we provide related estimates where possible, too. If required, subnational regions are carefully harmonised to ensure comparability over time; in case where comparability is impossible to attain then regions are excluded from the analysis[31].

Finally, the estimation of annualised change rates requires the difference between two survey periods. For surveys that are fielded between two or more periods, the analysis takes the average of the survey periods for calculating annualised change. Taking the average across the survey periods means we are usually going with a lower bound of possible absolute annual reduction compared to counting the mean or median of the month and year of the interviews to produce the annualised change.[30]

Summary of policies

We close this section with summary of the policies mentioned in the previous subsections. Estimating and publishing data such as the global MPI requires various decisions which go beyond those inherent to multidimensional poverty measurement (e.g., deprivation indicators, their thresholds and weights, etc). Usually decisions whether to include a particular estimate involve trade-offs (e.g., a higher country coverage versus perfectly comparable indicator construction). Related policies describe the rules how these inescapable trade-offs are navigated and how related decisions are made. The documentation of such policies is essential for both the transparency of the computations and the understanding of reach and limits of comparability. Naturally, related policies are not eternally determined and may be subjected to revision at some point. Doing so would, however, require good reason and a comprehensive and balanced assessment. Moreover, compliance with revised policy should be anticipated, too. Major policies underlying the production of this database include

1. The survey data must be representative at least at the national level, easy to access and well-documented.
2. The survey data must permit to construct at least one health indicator and one nutrition indicator. For missing deprivation indicators, indicator weights will be increased such that dimensional weights remain unchanged.

3. The deprivation indicator construction relies only on usual household members (and ignores non-usual household members).
4. Households with no eligible members (e.g., school aged children for the school attendance indicator) are assumed to be non-deprived in this particular indicator.
5. We do not publish subnational estimates for a particular country if (i) the survey does not permit analyses for subnational regions, (ii) a harmonisation of the region variable over time is not straightforward, (iii) the sample drop exceeds 15% at the national and 25% at the subnational level.
6. For harmonised deprivation indicators over time, we restrict (i) the eligible population or (ii) the available survey items to the common domain.

Release content and repository

The global MPI is released on an annual basis. As new survey datasets become available, related estimates are added to the database. Older survey datasets are added where resources and indicator harmonisation permit to do so. Consequently, newer releases of the database may also contain new estimates for more distant periods. To ensure transparent and replicable downstream analyses of the global MPI data, every release is separately archived and documented by its own methodological note where related decisions are recorded. Moreover, releases are versioned with the estimates published in 2021 being version 1 and the most recent estimates published in 2023 version 3. Each release can also be identified by its own DOI. Table 3 provides an overview of the available releases, their coverage in terms of countries, subnational regions, and micro datasets. The table also shows the respective methodological note, which details any country-specific decisions. The data and the methodological notes are available from the OPHI website and the Oxford Research Archive (ORA).

Table 3. Available databases

Release year	# Countries	# Countries with subnational regions	Micro datasets	Database version	Methodological note
2023	84	77 (814 regions)	211	3	57
2022	84	76 (810 regions)	205	2	54
2021	84	77 (793 regions)	196	1	51

Result files

The data of the global MPI is distributed in two separate files: one for the level estimates and one for the change estimates. Both files are available in different formats including Stata's format (dta) and comma-separated values (csv). The structure of both files follows from the key design principle that (i) each row (observation in Stata) refers to a single estimate and (ii) each estimate has a nucleus (comprising the point estimate, its standard error, etc.) and meta information which allows to identify the content of an estimate (e.g., the estimated measure, the country, etc.). Table 4 shows some data entries for illustration purposes. Specifically, the table shows six point estimates (`b`) with their standard errors (`se`), whereas the remaining variables provide further details about the estimates (they show headcount ratio and intensity for India at the national level in three different years for preferred poverty cutoff and weighting structure).

Table 4. Example data entries

ccty	year	survey	measure	b	se	k	wgt	loa
IND	2005-2006	DHS	A	51.33	0.19	33	equal	nat
IND	2005-2006	DHS	H	55.07	0.43	33	equal	nat
IND	2015-2016	DHS	A	43.96	0.06	33	equal	nat
IND	2015-2016	DHS	H	27.68	0.16	33	equal	nat
IND	2019-2021	DHS	A	41.98	0.06	33	equal	nat
IND	2019-2021	DHS	H	16.39	0.12	33	equal	nat

Table 5 provides further detail about the available variables in the results files. Most variables never have missing values as they describe the content of a particular entry, including, the country codes `ccty` and `ccnum`, name and year of survey `survey` and `year`, the level of analysis `loa`, or the estimated measure `measure`. The level of analyses distributed in the database include national and regional (i.e. subnational) estimates, by area (urban and rural) and by age group. Table 5 also flags

Variable	Level file	Change file	Missing allowed	Description
cty	•	•		ISO-country code
ccnum	•	•		numeric country code
survey	•	•		name of survey (e.g., DHS)
year	•	•		year of survey
ctype	•	•		0 = level, 1 = absolute change, 2 = relative change
loa	•	•		level of analysis, is one of nation, region, area, or agegroup
measure	•	•		measure estimated
b	•	•		Point estimate
se	•	•	○	Standard error
ll	•	•	○	Lower bound of confidence interval
ul	•	•	○	Upper bound of confidence interval
tval	•	•	○	t-value for the null of the coefficient being zero
subg	•	•	•	numeric group identifier within loa (if applicable)
k	•	•	•	poverty cutoff (if applicable)
wgts	•	•	•	weighting scheme (if applicable)
indicator	•	•	•	name of indicator (if applicable)
misind	•	•	•	name of missing indicator (if applicable)
t0	–	•		first period of change ($t = 1,2,\ldots,T$)
t1	–	•		second period of change
year0	–	•		year of first period of change
year1	–	•		year of second period of change
ann	–	•		dummy for annualized change; missing for levels

Table 5. Main variables of the results files. • indicates whether variable exists in level and change file, respectively and whether values may be missing; ○ indicates that variables may be missing for selected measures.

those variables which may not apply to all estimates and thus have missing values. For instance, the subgroup identifier subg is only needed for disaggregations and consequently missing for national level estimates. Likewise, the variable indicator is missing for measures which are not indicator-specific and the variables k and wgts which contain the values of underlying parameters (poverty cutoff and weighting scheme) are missing for population share estimates, for instance.

Table 5 also points to the main difference between level and change files. The estimate of a change essentially features the same variables as the estimate of a level. Additionally, a change estimate is also characterised by (i) beginning and end period and (ii) whether it is annualised or raw. Consequently, the change file contains two variables t0 and t1 which contain the value of the country-specific time integer for beginning and end period and two variables year0 and year1 which contains the years of the respective surveys underlying each change estimate. Finally, the variable ann indicates whether changes are raw or annualised.

In addition to the variables shown in table 5 the database also includes convenience variables which facilitate downstream analysis including easier-to-read labels. All these variable carry the suffix _lab in their name. For instance, cty_lab contains the full country name instead of the ISO country code and ind_lab contains full names of deprivation indicators instead of cryptic abbreviations. Particular useful for downstream analysis are also the variables region_lab, area_lab agec2_lab and agec4_lab, which are only defined for the indicated level of analysis and contain an easy-to-read label for the respective subgroup such as subnational regions; examples following below. Further labelling variables include misind_lab, dim_lab and measure_lab.

Table 6 provides an overview of the available measures in the results files. First, the database provides estimates for the key measures of the Alkire-Foster framework, including the MPI (the adjusted headcount ratio) itself, several partial indices (e.g., the heacount ratio, the intensity and censored headcount ratios), but also uncensored headcount ratios and population shares. Besides the quantities of the Alkire-Foster framework, the database also provides some auxiliary measures. For instance, N contains the numbers of observations of the estimation sample. The variables mv_w and mv_uw both provide information on missing values and retained samples, either using or ignoring survey weights. Where indicator is not missing, mv_w and mv_uw contain the proportion of missing values for that particular indicator. If indicator is missing mv_w and mv_uw report the retained samples. Finally, the database also contains the severity (sev) and vulnerability vuln measures. Severity reports the proportion of people who are severe poor, which means they suffer from 50% or more from the maximum possible

deprivations. Put differently, severity is the headcount ratio for poverty cutoff $k = 50\%$. Vulnerability shows the proportion of people with a deprivation score of 20% or more, but less than 33% (so people who are close to being poor).

Measure	Description	Indicator-specific	Comment
`M0`	MPI (adjusted headcount ratio)		$H \times A$
`H`	headcount ratio		proportion of population which is poor
`A`	intensity		average deprivation among the poor
`hd`	uncensored deprivation rate	•	proportion of people deprived in indicator
`hdk`	censored deprivation rate	•	proportion of people being poor and deprived in indicator
`actb`	absolute contribution	•	Absolute contribution of indicator to MPI
`pctb`	percentage contribution	•	Relative contribution of indicator to MPI
`popsh`	population share		population share of particular subgroup (if applicable)
`N`	number of observations		number of observations in estimation sample
`mv_uw`	missing values (unweighted)	•	proportion of missing values for indicator / overall retained sample (unweighted)
`mv_w`	missing values (weighted)	•	proportion of missing values for indicator / overall retained sample (weighted)
`sev`	severity		proportion of the population which is severely poor
`vuln`	vulnerability		proportion of the population which is vulnerable

Table 6. Measures available in the database

The results files of this database are comprehensive in the sense that they contain all data which is used in other outlets of OPHI such as the conventionally produced spreadsheets (in particular Table 6 'Trends Over Time') or the respective findings in the country briefings.

Technical Validation

In this section we present selected quality checks for the estimates of this database which are implemented at different stages. A first set of quality check is undertaken for selected deprivation indicators whose construction are similar to those produced in the survey reports published by the DHS program and MICS programme and their national collaborators, which are renowned provider of high-quality survey data. Their survey reports incorporate cross-tabulations for a wealth of indicators,[33,34] which facilitates the quality checks for all living standard indicators of the global MPI. In particular, we compare between our estimates and the survey report, the proportion of (1) households with electricity; (2) household members with improved sanitation, (3) household members with improved access to safe drinking water; (4) households with rudimentary and finished floor materials; (5) households with finished construction materials for the walls and roof; (6) households using clean fuels and technologies for cooking; (7) households that own television, radio, telephone, refrigerator, bicycle, motorbike, computer, animal cart, and car or truck. In addition, we also compare selected demographic figures, including the proportion of (1) urban and rural population; (2) population living in each subnational region that are sampled; (3) households successfully interviewed; (4) children under five successfully measured; (5) women in the reproductive age group (15–49 years) successfully interviewed; and (6) men successfully interviewed (for surveys that implemented male questionnaire). A continuous communication is maintained with teams in DHS, MICS and other data providers to resolve any mismatches between our tabulations and those provided in survey reports.

Additionally, we also carefully monitor and report missing values in all of our deprivation indicator as already discussed above. Specifically, we report the share of missing values for individual deprivation indicators as well as the ultimately retained sample. This documentation of missing values allow researchers critical assessment of the issue for their particular purpose. Finally, in our estimation and productions routines, we also rely on certifications scripts, which perform quality checks against the microdata to detect potential mistakes or issue (e.g., whether all deprivation indicators are 0–1 coded).

Usage Notes

Result files

Five brief remarks on the usage of the result files. First, as the data is provided in csv format all statistical software packages are able to process these files. Specialised packages like Stata or R, which can easily manage larger datasets are, however,

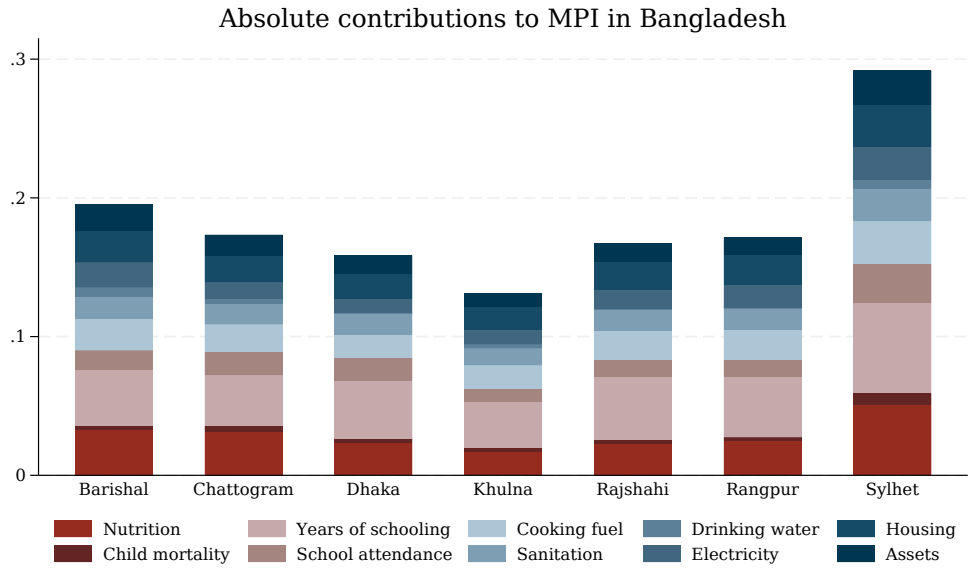

Figure 1. Absolute indicator contributions in Bangladesh in 2014. For the underlying Stata command, please see the main text.

preferable. After all, together level and change estimates for the 2023 release of this database amount to more than 350,000 observation across the result files. Second, in order to facilitate merging additional data both result files include (i) ISO country code (alpha-3 and numeric) and (ii) the year of the survey as stated by data provider, which allows users to adopt the most appropriate approach in their use case (e.g., how to choose years from surveys spanning several years). Unfortunately, a universal ISO code for subnational regions is unavailable.

Third, a convenient strategy for retrieving the desired estimates is to first choose how to display or plot the nucleus of an estimate, say, point estimate and standard error (variables `b` and `se`) and then selected the content of an estimate based on the meta data, say, the entity of an estimate, the underlying parameters, etc. In Stata selecting the estimates of interest can be conveniently achieved using `if` conditions. For instance, the data shown in table 4 above may be retrieved in Stata using

```
li ccty year survey measure b se k wgt loa ///
   if ccty == "IND" & inlist(measure,"H","A") & loa == "nat"
```

Fourth, as mentioned above the results files also contain several convenience variables which facilitate the downstream analysis and are suffixed by `_lab`. Besides containing detailed labels, the advantage of variables such as `region_lab` is that they are only define for the respective level of analysis (region in this case), which results in shorter and simpler commands for the analysis. For instance, in order to plot a stacked bar chart of the absolute indicator contributions for all subnational regions in Bangladesh for the first period of observation, one may simply issue the following command in Stata; for the related output see figure 1.

```
graph bar b if ccty == "BGD" & t == 1 & measure == "actb", ///
   over(ind_lab) over(region_lab) stack asyvar leg(rows(2) colf) ///
   yti("") ti(Absolute contributions to MPI in Bangladesh)
```

Finally, one may also combine change and level files for certain analyses. For instance, let us say we would like to see absolute reductions of the adjusted headcount ratio (M) conditional on the level of the initial period for all subnational regions of particular country. First, we load the level estimates of the adjusted headcount ratio for all subnational regions and all periods of observation. Then we create a variable `t0=t` which will allow us to merge level estimates of the initial period to a particular change estimate. Now we can load the absolute changes of the adjusted headcount ratio for all subnational regions.

```
use GMPI_HOT_2023_puf.dta if loa == "region" & measure == "M0", clear
gen t0 = t
frame put * , into(mylev)
```

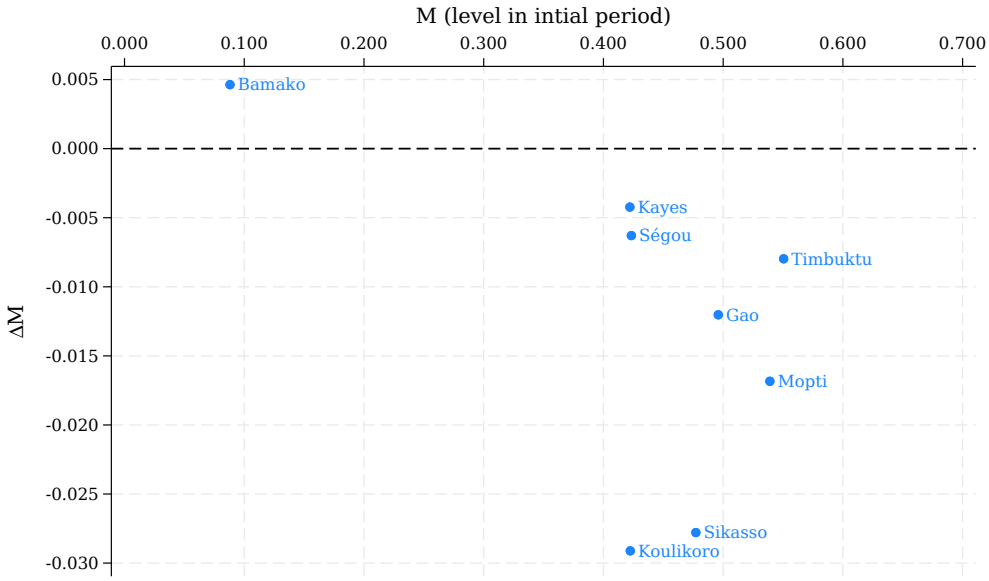

Figure 2. Absolute reductions of the adjusted headcount ratio for subnational regions in Mali in 2015–2018. For the underlying Stata command, please see the main text.

```
use GMPI_COT_2023_puf.dta if loa == "region" & measure == "M0" & ctype == 1, clear
frlink m:1 ccty subg t0 , frame(mylev)
frget lt0 = b , from(mylev)
format b lt0 %9.3f
```

After linking the frames and copying the variable of interest, we can plot our graph using `twoway`.

```
tw (sca b lt0, ml(region_lab)) if loa == "region" & ccty == "MLI" & t0==2, ///
    xsca(alt) xlab(0 (.1) .7) ylab(-0.03 (.005) 0.005) yline(0) ///
    leg(off) xti("M (level in intial period)") yti({&Delta}M)
```

Note that the graphing command above requires only minor modifications to produce the same figure for a different country (e.g., `ccty=="BGD"`), a different initial period and change (e.g., `t0==1`) or a different measure (e.g., `measure=="H"`) which are available in the database. Naturally, there are various ways to improve figure 2 such as plotting only labels for selected regions, draw symbol markers proportional to population shares, an automatic way to compute ranges for labels, etc.

Microdata

The underlying micro datasets of most countries (largely DHS and MICS) are available only for research purposes and can, therefore, not be publicly shared. In order to construct the deprivation indicators underlying the estimates of this database, one has to run one do-file for every survey (211 do files in total, which are all available on the OPHI website). These do-files also rely on other user-written Stata programs (e.g., `who2007`, `mdesc`). Therefore, analyses using the micro data underlying the global MPI are feasible, too.

Code availability

We use Stata (version 17) for both data preparation and estimation. The Stata scripts (do-files) for data cleaning and deprivation indicator construction are available for each release on the OPHI website. The estimation has been carried out with the user-written ado `mpitb` (version 0.4), which is available at the Statistical Software Components (SSC) Archive and gitlab.[32] `mpitb` is distributed under an MIT-license. The key commands for the global MPI estimation of a particular country are presented above.

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Author contributions

U.K. leads the global MPI estimation since 2018 is responsible for the cleaning of the micro datasets, which also includes the generation of the deprivation indicators and related quality checks among other things. She also drafted and revised parts of this manuscript. N.S. runs and refines the estimation routines he previously developed since 2018, which also includes the production of the country briefings. He drafted and revised large parts of this manuscript. Finally, U.K. and N.S. jointly developed the workflow underlying all estimation (including quality checks and deliverable production) through countless discussions where U.K. contributed with project oversight (including project needs, priorities, etc.) and N.S. with structuring and implementing the workflow in Stata.

Competing interests

The authors declare no competing interests.

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