

Multidimensional child poverty measurement in Sierra Leone and Lao PDR: Contrasting individual- and household-based approaches

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MULTIDIMENSIONAL CHILD POVERTY MEASUREMENT IN SIERRA LEONE AND LAO PDR: CONTRASTING INDIVIDUAL- AND HOUSEHOLD-BASED APPROACHES

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ABSTRACT

This research brief compares the properties of individual- and household-based multidimensional child poverty approaches. Specifically, it contrasts UNICEF's Multiple Overlapping Deprivation Analysis (MODA) with the Global Multidimensional Poverty Index (MPI) developed by the Oxford Poverty and Human Development Initiative. MODA focuses on children and is rooted in the child rights approach, while MPI has been developed for households and follows Sen's (1985) capabilities approach. We demonstrate their similarities and differences using two recent Multiple Indicator Cluster Surveys: Sierra Leone and Lao People's Democratic Republic (PDR). The analysis suggests that MODA tends to produce higher multidimensional child poverty headcount rates than MPI, both because of the differences in the survey items used to construct the indicators of deprivation and because of how the indicators are aggregated and weighted.

KEY WORDS

Multidimensional child poverty, MODA, MPI, MICS, Lao PDR, Sierra Leone, Sustainable Development Goals.

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1. INTRODUCTION

Despite the efforts made in the last three decades to reduce poverty, children currently make up one half of the population living in extreme monetary poverty (UNICEF, 2017). However, this may understate the true extent of the problem if a large proportion of children living in non-poor households are deprived of the minimum basic needs and services. In response to this universal challenge, governments of the world agreed to include in the Sustainable Development Goals (SDGs) a new explicit focus on reducing child poverty by 2030, committing to eradicate extreme poverty for all people everywhere (Target 1.1) and “to reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions” (Target 1.2). A recent internal survey conducted by UNICEF (2017) to identify each country’s child poverty measurement status showed that 66 out of 160 countries reported not having any official child poverty measurement. Among those measuring poverty, almost one half do not do so routinely. Monetary measures are prevalent among those using a combination of monetary and multidimensional (MD) measures. Countries expected to begin measuring multidimensional child poverty are now facing new challenges regarding the choice of the most suitable approach. This brief contributes to addressing this issue by analysing similarities and differences between two methodologies frequently adopted in low- and middle-income countries: the Multiple Overlapping Deprivation Analysis (MODA) developed by UNICEF (de Neubourg, 2013) and the Global Multidimensional Poverty Index (MPI) produced by the Oxford Poverty and Human Development Initiative (OPHI) and UNDP (Alkire and Santos, 2010). Although both MODA and MPI have been adapted to national contexts in different regions of the world, this brief focuses on their international versions.

To help make differences between MODA and MPI more transparent to policymakers in the countries that are planning to implement or have already implemented them, we build our analysis around four main questions:

- Q1. How do the MODA and MPI approaches compare in their conceptual, operational and presentational properties?
- Q2. What are the differences in the overall estimates of MD child poverty?
- Q3. In how far are the differences between the two measures due to weighting/aggregation methods?
- Q4. How sensitive are they to changes in a single indicator?

We use comparable data for Sierra Leone and Lao PDR from the most recent round of the Multiple Indicator Cluster Surveys (MICS). Both countries collected the MICS in 2017.

2. MODA VERSUS MPI: SIMILARITIES AND DIFFERENCES

Q1. How do the MODA and MPI approaches compare in their conceptual, operational and presentational properties?



















MODA and MPI share key features. Both methods focus on individuals suffering from multiple deprivations simultaneously – necessitating the use of a single survey – and both aggregate deprivations in an index using the ‘dual cut-off’ approach. Moreover, both produce estimates of the proportion of people experiencing multiple deprivations, the intensity of their deprivation,² and the

² i.e., the number of deprivations experienced by multidimensionally deprived children.

adjusted headcount ratio as measures of deprivation (Alkire and Foster, 2011; Alkire et al., 2015). By breaking down the index into subgroups or dimensions, both methodologies allow an understanding of the extent to which each dimension contributes to the overall deprivation level.

MODA and MPI also differ in several aspects (Figure 1). First, MODA uses the child rights approach as the basis for selecting indicators and dimensions of deprivation, whereas MPI draws on Sen's capability approach (Sen, 1985). The capabilities approach views poverty as "deprivation of a person's opportunities to achieve those things she has reason to value" (Sen, 2009), but not all children may have the power to use their set of capabilities. This is the starting point of the rights-based approach: MODA defines child poverty as "the non-fulfilment of children's rights to survival, development, protection and participation" at different stages of children's lives" (de Milliano and Plavgo, 2014).

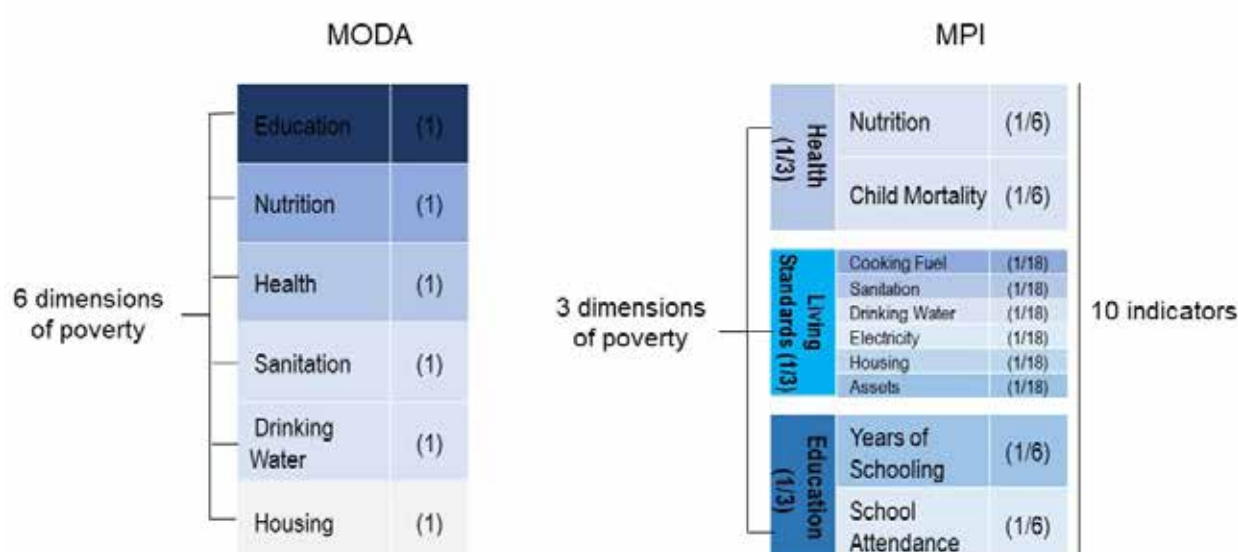
Figure 1: MODA versus MPI: Main features

MODA		MPI
 CHILDREN'S RIGHTS	UNDERLYING ASSUMPTIONS	 CAPABILITY APPROACH
 YES	LIFE COURSE APPROACH	 NO
 YES, UNION APPROACH	AGGREGATION OF INDICATORS INTO DIMENSIONS	 YES, 3 DIMENSIONS IN 1 INDEX
1-2	# INDICATORS PER DIMENSION	2-6
 YES, AT CHILD LEVEL	OVERLAPS	 YES, AT HH LEVEL
 YES  NO  YES	SENSITIVITY TO CHANGE IN INDICATORS	 YES  NO  YES
 DCI [0,n]  DCI [0,n] DEPRIVATION COUNT INDEX	MD POVERTY THRESHOLD	 I [0,1]  I [0,1] MPI INDEX
HEADCOUNT INTENSITY INTENSITY ADJUSTED	MD MEASURES	HEADCOUNT INTENSITY INTENSITY ADJUSTED

Source: Authors' elaboration

Second, the indicators and dimensions of poverty tend to differ. MODA is usually based on five to eight dimensions (i.e. nutrition, health, early child development/education, housing, information access, water and sanitation, protection from violence and freedom from child labour)³. The Global MPI comprises three dimensions (health, education and living standards)⁴ as sketched in Figure 2. Each dimension is proxied by one or two indicators (MODA) or two to six indicators (MPI) depending on the context of analysis and data availability (Ferrone and Chzhen, 2016; Hjelm et al., 2016). It must be noted that the term ‘dimension’ means somewhat different things in the MODA and MPI approaches. In MODA, each dimension refers to whether a child’s right is fulfilled. In MPI, dimensions are groupings of indicators, while each indicator denotes a minimum level of satisfaction of a basic need.

Figure 2: Comparison of indicators: MODA versus Global MPI



Note: Weights in parenthesis. MODA dimensions are representative of Sierra Leone and Lao PDR contexts. They are subject to change relative to the country, study and data availability. Authors elaboration

Third, the MODA approach is child-centered, as it focuses on child-specific indicators evaluated at the child level wherever possible (e.g. vaccination, medical attendance, infant feeding). On the other hand, MPI measures deprivations at the household level, therefore assuming that all children living in the same household share the same condition (poor/non-poor).

Fourth, MODA follows the life-course approach, using age-specific indicators separately for each stage of life. In contrast, MPI uses age indicators only in the nutrition and education dimensions, but outcomes are still constructed at household level.

Fifth, MODA and MPI treat the indicators differently (Figure 1). If there is more than one indicator per dimension, MODA combines the indicators into dimensions using the “Boolean logic” of the union approach and then counts the number of deprivations. According to the union approach, a child is

3 The inclusion of important issues like ‘protection from violence’ and ‘freedom from child labour’ within MODA largely depend on data availability. Some studies use those dimensions (De Milliano and Plavgo, 2014, among others), some do not (Chzhen et al., 2014; Ferrone and Chzhen, 2016, among others).

4 This brief refers specifically to the Global MPI, not to National MPIs or National Child MPIs.

deprived in one dimension if he/she is deprived in any of the indicators included in that dimension. The indicators are thus subsumed within dimensions. It is the dimensions rather than indicators of deprivation that are summed up for each child. In contrast, MPI counts the number of weighted indicators for each household. Equal weights are assigned to the three dimensions, and equal weights to the indicators nested in each dimension. The larger the number of indicators included within a dimension, the lower the weight assigned to each of them. This means that MODA can be less sensitive than the MPI to changes in just one indicator (unless there is just one indicator per dimension). While this suggests that MODA is more robust to fluctuations in an indicator (e.g. due to measurement error), it produces more conservative estimates of changes in deprivation.

Finally, the MPI uses 33 per cent of the weighted indicator-level deprivations as the multidimensional poverty cut-off, while MODA-based studies usually provide a set of statistics for every possible cut-off (Ferrone and Chzhen, 2016). For example, if MODA includes six dimensions, the study will produce the distribution of children deprived in one to six dimensions as well as the estimates of multidimensional poverty headcount and intensity for every possible cut-off (e.g. one or more, two or more, three or more, four or more, and five or more). Yet in practice, MODA studies tend to select one cut-off (e.g. two or more deprivations) to analyse variations in the probability of being multidimensionally poor by key predictor characteristics.

3. DATA AND METHODS

Data

This analysis draws on two internationally comparable datasets: Sierra Leone Multiple Indicator Cluster Survey 6 (SL-MICS6) and Lao PDR Multiple Indicator Cluster Survey 6 (L-MICS6) (Table 1). MICS is a household survey conducted by developing countries' governments in collaboration with UNICEF. It is well suited for MD child poverty analysis as it collects information on a range of topics including education and child health using standardized methods and tools. This research brief focuses on children aged 0–5 because MICS has particularly rich information for this age group in the 'under-five' module. We also use information from the household module.

Table 1: MICS6 sample sizes, 2017

Country	Year	Households		Children under 5	
		Sampled	Interviewed	Eligible for interview	Mothers/ caretakers interviewed
Sierra Leone	2017	15,605	15,309	11,774	11,764
Lao PDR	2017	23,299	22,287	11,812	11,720

Source: Lao PDR MICS 6; Sierra Leone MICS 6.

A multidimensional approach encompasses a set of dimensions that reflect different aspects that are considered to constitute poverty. Indicators are selected to give a comprehensive representation of the development within the respective domains. In Table 2 we compare the dimensions used to construct MD child poverty with MODA (6 dimensions) and MPI (3 dimensions) approaches for Sierra Leone and Lao PDR. In MODA, the education, health and nutrition dimensions are constructed

at the level of the child under five years old, while water, sanitation and housing are defined at the household level and merged with the child questionnaire in order to keep the child as the main unit of analysis. In both MODA and MPI, indicators and dimensions are expressed in binary form, with '1' denoting deprivation and '0' otherwise based on specific thresholds (Table 2).

The choice of indicators matters (Table A1 in Appendix for details on each indicator). For example, the deprivation in nutrition is lower for MODA than MPI in both Lao PDR and Sierra Leone. In line with the existing cross-country comparative MODA analyses for lower income countries (e.g. De Neubourg et al., 2012), MODA uses a measure of wasting (weight for height) to identify nutrition-deprived children. MPI draws on the specifications set out in Alkire and Jahan (2018) for the Global MPI Indicators, and considers as deprived those households with at least one child (0–5 years of age) who is stunted (i.e. height for age below two standard deviations from the median of the reference population) or underweight (weight for age below two standard deviations from the median of the reference population). Aggregation and weighting methods are based on the schemes reported above in Figures 1 and 2. MODA uses the union approach to aggregate indicators into dimensions. The cut-offs adopted in this analysis follow the standard MODA and MPI procedures: a child is MD poor if deprived in two or more dimensions (for MODA) or if she lives in a household with the sum of weighted indicator-level deprivations equal to 0.33 or higher (for MPI).

Table 2: Cut-offs, dimensions, indicators, thresholds

MODA			Global MPI		
Cut-off	MD poor if deprived in 2 or more dimensions out of 6		Cut-off	MD poor if Global MPI > 0.33 (out of 1)	
Age	Dimension	Deprived if...	Dimension	Indicator	Deprived if...
0–5	Education/ ECD	- Deprived if child does not play with at least 1 toy (homemade or shop or HH objects) (0–35 months) - Deprived if engaged by adults in less than four stimulating activities (36–59 months)	Education	Years of schooling	- No household member aged 12 years or older has completed six years of schooling
				Child school attendance	- Any school-aged child is not attending school up to the age at which he/she would complete class 8
0–5	Health	- Child >12 months has not received three DPT vaccines* (for Lao PDR, DPT (0–35 months) + Vitamin A Immunization (36–59 months))	Health	Child mortality	- Any child has died in the family in the five-year period preceding the survey
0–5	Nutrition	- The child's weight-for-height is below minus two standard deviations from the median of the reference population)		Nutrition	- At least one Child (0–5 years of age) for whom there is nutritional information is undernourished (either height- for-age or weight-for-age is below minus two standard deviations from the median of the reference population)
	Housing	-Natural floor material (earth or sand) or natural roof material (thatch or palm leaf or raffia) - Overcrowding (more than 4 people per room)	Living standards	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.
	Drinking water	- Unimproved water source or - more than 30 minutes to get water		Safe drinking water	-The household does not have access to improved drinking water (according to SDG guidelines) or safe drinking water is at least a 30-minute walk (roundtrip) from home
	Sanitation	- Household has an unimproved toilet facility		Improved sanitation	-The household's sanitation facility is not improved (according to SDG guidelines) or is improved but shared with other households
	Information	<i>Not included</i>		Housing	-The household has inadequate housing: the floor is of natural materials or the roof or walls are of natural or rudimentary materials
	Cooking fuel	<i>Not included</i>		Cooking fuel	- A household cooks with dung, agricultural crop, shrubs, wood, charcoal or coal
	Assets	<i>Not included</i>		Assets	-The household has no electricity (no interconnected grid, no off-grid)

Note: MODA indicators and dimensions are constructed following de Neubourg et al. (2012, 2013), whereas the MPI Indicators and dimensions draw upon OPHI/UNDP global MPI (Alkire and Santos, 2010). Indicators and dimensions are consistent across countries.

*Children with missing information for DPT vaccination have been flagged as deprived in the health dimension if they have: never received any vaccination; never received any other vaccination during campaigns; never been given Pentavalent vaccination; or been given less than three doses of Pentavalent.

Methods

In section 2 we highlighted the five key differences between the two approaches. This section summarizes the methods used to answer research questions 2–4.

Q2: What are the differences (between MODA and MPI) in the overall estimates of MD child poverty?

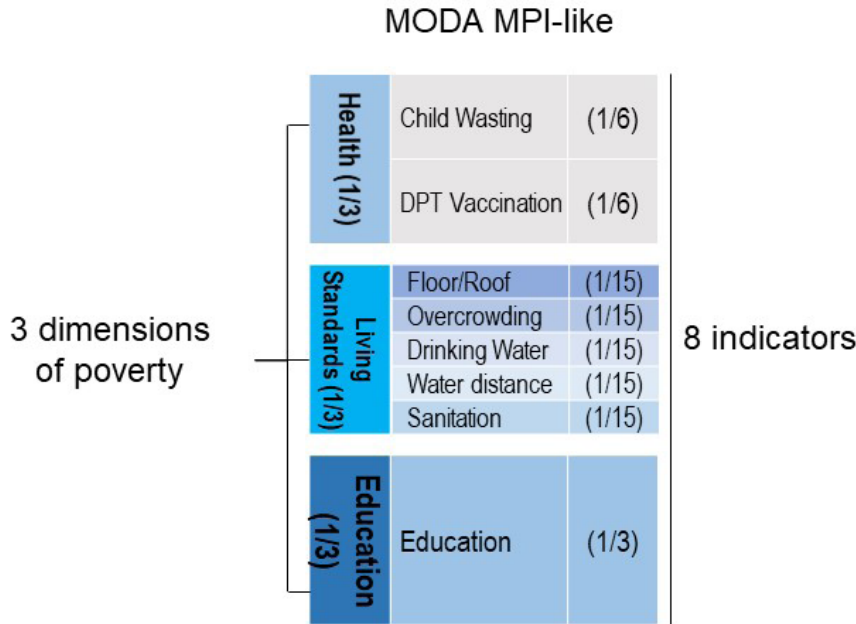
To ascertain how the choice of MODA or MPI may influence the final count of deprived children, we need to compare the overall MD poverty estimates resulting from using the two methodologies. The differences are likely to be driven by the choice of different indicators, the methods of aggregating these and the different weighting schemes adopted.

In Appendix A we provide an extensive presentation on how MODA and MPI headcount ratios are constructed without explicitly focusing on the identification, censoring and aggregation steps. Briefly, in MODA the multidimensional deprivation headcount ratio shows the proportion of children experiencing several deprivations at the same time. The indicators are aggregated into dimensions with the union approach and then the total number of deprivations is computed for each child. A child is defined as multidimensionally deprived if the number of dimensions in which he/she is deprived exceeds a cut-off threshold. The sum of the multidimensionally deprived children divided by the total number of children returns the headcount estimate. Similarly, the MPI headcount ratio shows the proportion of the population that lives in households with multiple deprivations. Each person is assigned a deprivation score between zero and one, denoting the weighted sum of the number of his/her deprivations. An individual is defined as multidimensionally poor if his/her deprivation score is equal to or greater than a poverty cut-off of 0.33.

Q3: To what extent are the discrepancies between MODA and MPI due to different weighting/aggregation methodologies?

To understand in how far the differences between the two approaches may be due to the indicator weighting/aggregation methods, we re-run the analysis by calculating the number of the MODA-poor using the MPI weighting and aggregation scheme (MODA Poor (MPI-like)) to form an index ranging from zero to one, with a cut-off at 33 per cent. The MODA indicators are aggregated to form three dimensions as in the MPI approach, therefore each of them is assigned a weight of one third (Figure 3). We then compare the headcount rates between MODA and the re-weighted MODA (MPI-like).

Figure 3: MPI-like MODA



Nutrition and health dimensions are combined under the “Health” dimension; sanitation, drinking water and housing under “Living Standards”; and education under “Education”. The MODA weighting approach gives an equal weight to deprivations related to material conditions of the household, while MPI assigns them a relatively lower weight because they are all part of the “Living Standards” dimension. This exercise is also useful for clarifying how the definition of ‘dimension’ changes under the MODA and MPI approaches (many MPI indicators are identified as separate dimensions in the MODA approach). To single out the weighting/aggregation effect, we proceed by reweighting the MODA indicators using the MPI scheme as follows.

$$p_{ic} = \sum_{i=1}^n D_{ix} * w_x > C \tag{8}$$

With $x=1,2,3...X$ representing the selected MODA indicators. The headcount ratio according to the MPI-like MODA is therefore given by the specification in (9)

$$MODA (MPI - like) (HC_C) = \sum_{i=1}^n p_{ic} * \frac{1}{tch} \tag{9}$$

Q4: How sensitive are MODA and MPI to changes in a single indicator?

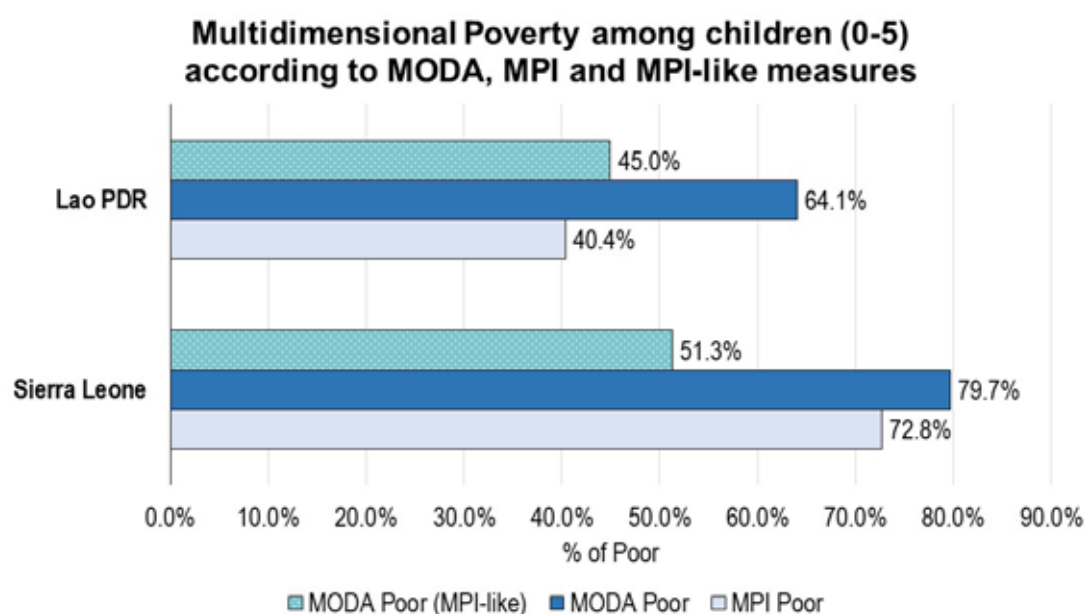
To analyse the effect of a short-term change in deprivation status for a single indicator on the MODA/ MPI poverty headcounts, we conduct static simulation analysis. A good indicator to use for simulation purposes would be one that is common to both MODA and MPI methodologies. The housing-related indicator (i.e. the floor is of natural materials or the roof or walls are of natural or rudimentary materials) works well in our case as it is present in both indexes. Note that in MODA, it is combined with an indicator of overcrowding into the housing dimension using the union approach. We simulate changes in the floor/roof/wall indicator for a randomly selected sample (without replacement) of housing-deprived children. A random 20 per cent of the child sample goes from deprived to non-deprived in the roof/floor/walls, and the resulting MD poverty estimates will be compared with the original ones.

4. RESULTS

In this section we report the findings for Q2, Q3 and Q4: first comparing the baseline MODA and MPI MD child poverty estimates, then analysing the effect of reweighting the MODA indicators using the MPI method and, finally, comparing the sensitivity of MODA and MPI to changes in deprivation on just one indicator.

Figure 4 shows the MD poverty headcount rates for children under the age of five in Sierra Leone and Lao PDR using MODA and MPI. The rates of multidimensional child poverty are higher in Sierra Leone on both measures, although the difference is smaller for MODA (80 per cent in Sierra Leone compared with 64 per cent in Lao PDR) than for the MPI (73 per cent versus 40 per cent, respectively). In both countries, the MODA-poor rates are higher than the MPI-poor rates. The difference between the MODA and MPI rates is greater in Lao PDR in both absolute and relative terms. This is not necessarily surprising since the Global MPI is based on the minimum internationally agreed standards of basic needs. A wealthier country can be expected to have a lower share of children living in MPI-poor households, but this is not necessarily the case for MODA. Lao's GDP per capita exceeds that of Sierra Leone nearly fivefold (US\$2,457 versus US\$499). Indeed, Table A1 in the Annex shows that the MPI indicator-level deprivation rates are all higher in Sierra Leone than in Lao PDR, but some of the MODA indicators that are not present in MPI show higher deprivations in Lao PDR than in Sierra Leone (e.g. lack of vaccination)⁵.

Figure 4: MODA versus MPI comparison of MD poverty headcount estimates in Sierra Leone and Lao PDR



Source: Authors' elaboration on MICS6 data for Sierra Leone and Lao PDR.

Note: The MODA poor (MPI-like) index is built by weighting dimensions using MPI weights and an MD-poor cut-off of 0.33

⁵ This is consistent with higher DPT3 immunization coverage in Sierra Leone than Lao PDR in 2017 (see https://www.who.int/immunization/monitoring_surveillance/data/en/).

Differences in the way that indicators are weighted and aggregated into dimensions account for at least some of the difference between MODA and MPI in the headcount rates. Figure 4 shows a marked decrease in the rate of MODA-poor children in both countries when MODA is rebuilt using the MPI approach. In Sierra Leone, the share of MD poor children reduces by about 28 percentage points (about 55 per cent in relative terms), while in Lao PDR the rate goes down by 19 percentage points (about 37 per cent in relative terms) (Figure 4).⁶ This corroborates the results in the existing literature, which concluded that the union approach leads to higher MD poverty rates estimates (Hjelm et al., 2016; Evans and Abdurzakov, 2018).

Finally, how robust are the two approaches to changes in a single indicator, such as floor/roof materials, that is used in both indexes? Table 3 shows the results of a static simulation of reducing the housing deprivation for a random 20 per cent of children under five. This has a similar effect for both countries in all three measures. In line with our expectations, we register in all simulations a slight decrease in poverty headcount with respect to the original index. However, the registered relative change in magnitudes between the original estimate and the simulation is relatively small (between 1.68 and 3.22 per cent). In both countries, the simulated MODA estimate is slightly higher than the MPI-like MODA one. This small difference is likely due to the different weighting schemes used. MODA assigns equal weights to the household dimensions on the assumption that they all reflect a basic right and have equal importance. MPI gives a relatively lower importance to each “Living Standards” indicator meaning that a change in one “Living Standard” indicator has a relatively low impact on the overall measure.

Table 3: Static simulation results of a change in housing deprivation status

	Sierra Leone		Lao PDR	
	Share (%)	SD (%)	Share (%)	SD (%)
MPI Poor	72.8	44.5	40.4	49.1
Simulated MPI Poor	71.6	45.1	39.1	48.8
MODA Poor	79.7	40.2	64.1	48.0
Simulated MODA Poor	78.1	41.6	62.3	48.5
MODA Poor (MPI-like)	68.5	46.4	45.0	49.9
Simulated MODA (MPI-like) Poor	65.8	47.4	44.2	50.0
Absolute change (pp)				
MPI	-1.20		-1.30	
MODA	-1.90		-1.77	
MODA (MPI-like)	-0.74		-0.79	
Relative Change (%)				
MPI	-1.67		-3.22	
MODA	-2.05		-2.85	
MODA (MPI-like)	-1.47		-1.80	

Source: Authors' elaboration on MICS6 data for Sierra Leone and Lao PDR.

⁶ T-test on equality of means (MODA = MODA (MPI-like)) indicates that there is support for rejecting the null hypothesis that there is no difference between the two groups (Sierra Leone: $t = 15.58$, $p\text{-value} = 0.000$; Laos: $t = 16.85$, $p\text{-value} = 0.000$).

5. CONCLUSION

The analysis highlights similarities and differences in using an individual-based approach (such as MODA) and a household-based one (MPI) to estimate MD poverty rates among children aged 0–5 in two different countries. We observe lower multidimensional child poverty headcounts for MPI than MODA for children under the age of five in both Lao PDR and Sierra Leone. These differences have two sources: 1) differences in the survey items used to construct the indicators and 2) differences in how the indicators are combined into dimensions, how the dimensions are aggregated into an index and how the poverty cut-off is chosen. We find that differences in the definition of indicators account for much of the discrepancy between the MODA and MPI estimates, even when using the same household survey. The way that indicators are weighted and aggregated into dimensions also matters. Rebuilding the MODA index using the MPI approach to weighting and aggregating substantially reduces the share of MD poor children in both Lao PDR and Sierra Leone compared with the original MODA estimate.

This analysis suggests that for the purposes of monitoring progress towards achieving the SDG Target 1.2, countries should carefully evaluate the strengths and weaknesses of alternative approaches, their statistical properties, details on thresholds and cut-offs, unit of analysis and regional or international comparability. The main strength of an individual-based, rights-focused and age-sensitive approach like MODA is that it allows the identification of children who are multidimensionally poor even if they live in a non-poor household. Yet, it also makes it more difficult to produce a whole-of-population MD poverty estimate, since one would have to define comparable deprivation indicators and dimensions for the adult population as well. In contrast, a household-centric measure like MPI produces the share of individuals (by age, sex or another characteristic) living in MD-poor households without distinguishing between potentially different situations of individuals within households.

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APPENDIX A

Table A1: Share of children (0–5) deprived in each dimension, by country

		Sierra Leone			Lao PDR		
		mean	SD	N	mean	SD	N
MODA							
Nutrition	Child wasting	0.07	0.25	11466	0.09	0.28	11720
Health	DPT vaccination	0.23	0.42	9184	0.42	0.49	11720
Education/ECD	Education	0.49	0.50	11764	0.37	0.48	11720
Water	Drinking water	0.65	0.48	11774	0.31	0.46	11720
	Water distance	0.11	0.32	11774	0.02	0.12	11720
Sanitation	Unimproved toilet	0.63	0.48	11774	0.32	0.47	11720
Housing	Floor/roof	0.61	0.49	11774	0.53	0.49	11720
	Overcrowding	0.06	0.24	11774	0.28	0.45	11720
Global MPI							
Education	Years of schooling	0.46	0.50	11774	0.27	0.45	11252
	School attendance	0.36	0.48	8347	0.19	0.39	6916
Health	Nutrition	0.25	0.44	11774	0.30	0.46	11720
	Child mortality	0.07	0.26	10977	0.03	0.18	11246
Living standards	No improved drinking water	0.65	0.48	11774	0.31	0.46	11720
	Large distance to water	0.11	0.32	11774	0.02	0.12	11720
	Sanitation	0.89	0.31	11774	0.35	0.48	11720
	Floor/roof	0.61	0.49	11774	0.53	0.50	11720
	Assets (<1)	0.79	0.40	11774	0.24	0.43	11720
	Cooking fuel	0.99	0.06	11748	0.95	0.22	11703
	No electricity	0.88	0.33	11729	0.10	0.30	11720

APPENDIX B

MODA and MPI Headcount ratios

In MODA, the multidimensional deprivation headcount ratio ($MODA(HC_C)$) shows the proportion of children experiencing different numbers of deprivations at the same time.

Once indicators are aggregated into dimensions with the union approach we start computing the total number of deprivations each child experiences. Deprivations counting happens for each child i separately to inform about his/her breadth of deprivation, so let $j = 1, 2, \dots, d$ index dimensions⁷ and let $i = 1, 2, \dots, n$ identify the children.

$$ND_i = \sum_{j=1}^d y_j \quad (1)$$

where

ND_i = the total number of dimensions j each child i is deprived in;

y_j = if child i is deprived in the dimension j ;

y_j = if child i is not deprived in dimension j .

Then, the total number of deprivations per child is used to identify those children who are multidimensionally deprived depending on the chosen cut-off point C (two dimensions in this research brief). This means that child i is considered to be multidimensionally deprived if the number of dimensions in which he/she is deprived (ND_i) is equal to or larger than C . This can be defined as follows:

$$D_C = 1 \text{ if } ND_i \geq C \quad (2)$$

$$D_C = 0 \text{ if } ND_i < C$$

with C representing the cut-off point.

Simply put, the deprivation headcount ratio (3) is represented as follows:

$$MODA(HC_C) = \frac{nch_C}{tch} \quad (3)$$

with

$$nch_C = \sum_{i=1}^n D_C \quad (4)$$

Where:

$MODA(H_C)$ represents the multidimensional child deprivation headcount ratio according to cut-off point C ;

nch_C is the number of children affected by at least C deprivations;

⁷ MODA uses the union approach to aggregate indicators into dimensions in order to capture all the children who are deprived in any of the chosen indicators

tch is the total number of children;

y_C is the deprivation status of a child i depending on the cut-off point C .

Similar to MODA, the multidimensional deprivation headcount ratio ($MPI(HC_C)$) of the Global MPI shows the proportion of the population that is multidimensionally poor.

Let $i = 1, 2, \dots, n$ index individuals. Let $a_i = (a_{i1}, a_{i2}, \dots, a_{iD})$ be a vector of achievements for children i in the indicator $j = 1, 2, \dots, J$. Finally, let k be the deprivation threshold of indicator j .

An individual i is said to be deprived (D_{ijk}) in indicator j if the condition in (5.1) holds:

$$D_{ijk} = 1 \text{ if } a_{ij} > k \quad (5.1)$$

$$D_{ijk} = 0 \text{ if } a_{ij} < k \quad (5.2)$$

Now let $w = (w_1, w_2, \dots, w_j)$ be a vector of weights given to each vector of indicators (see Figure 1), such that $w_j \geq 0$ and $\sum_{j=1}^J w_j = 1$.

$$p_{iC} = \sum_{i=1}^n D_{ij} * w_j > C \quad (6)$$

Where p_i is a dichotomous variable being equal to 1 if the child is multidimensionally poor with respect to the selected cross-dimensional cut-off C (0.33, here).

From the individual poverty measure p_i we build the population-wide multidimensional headcount ratio that measures the incidence of multidimensional poverty over the total children:

$$MPI(HC_C) = \sum_{i=1}^n p_{iC} * \frac{1}{tch} \quad (7)$$

