

Health inequality monitoring: with a special focus on low- and middle-income countries

Lecture 5: Complex measures of health inequality



**World Health
Organization**

How can health inequalities be measured?

- Recall: **Simple measures** make pairwise comparisons of health between two subgroups
- **Complex measures** use of data from all subgroups to assess inequality.
 - For example, complex measures could provide a description of inequality across all wealth quintiles, or among all regions in a country

Complex measures of inequality

- Produce a single number that is an expression of the amount of inequality existing across all subgroups of a population
- There are two major types of complex measures:
 - those that measure inequality across a series of subgroups with a natural ordering
 - those that measure inequality across a series of subgroups, but do not require a natural ordering

Unweighted and weighted data

- *Weighted data* take into account the population size of each subgroup
 - Feature of complex measures
- *Unweighted data* treat each subgroup as equally sized
 - Feature of simple, pairwise measures and sometimes complex measures

Complex measures of inequality in ordered groups

- **Slope index of inequality**
 - Assesses absolute inequality
- **Concentration index**
 - Assesses relative inequality
- Weighted for population size
- Show the gradient of health across multiple subgroups with natural ordering

Slope index of inequality

- For education or wealth, slope index of inequality is the **absolute difference** in predicted values of a health indicator between those with the highest level of education or wealth and those with the lowest level of education or wealth
 - Takes into consideration the entire distribution of education or wealth using an appropriate regression model

Slope index of inequality

- To calculate the slope index of inequality:
 - 1) A weighted sample of the whole population is ranked from the most disadvantaged subgroup (at rank 0) to the most advantaged (at rank 1) according to, for example, education or wealth
 - 2) The population of each wealth or education category is considered in terms of its range in the cumulative population distribution, and the midpoint of this range
 - 3) The health indicator of interest is regressed against this midpoint value for wealth or education subgroups using an appropriate model
 - 4) The predicted values of the health indicator are calculated for the two extremes (rank 1 and rank 0)
 - 5) The difference between the predicted values at rank 1 and rank 0 (covering the entire distribution) generates the slope index of inequality value

Applied example: slope index of inequality

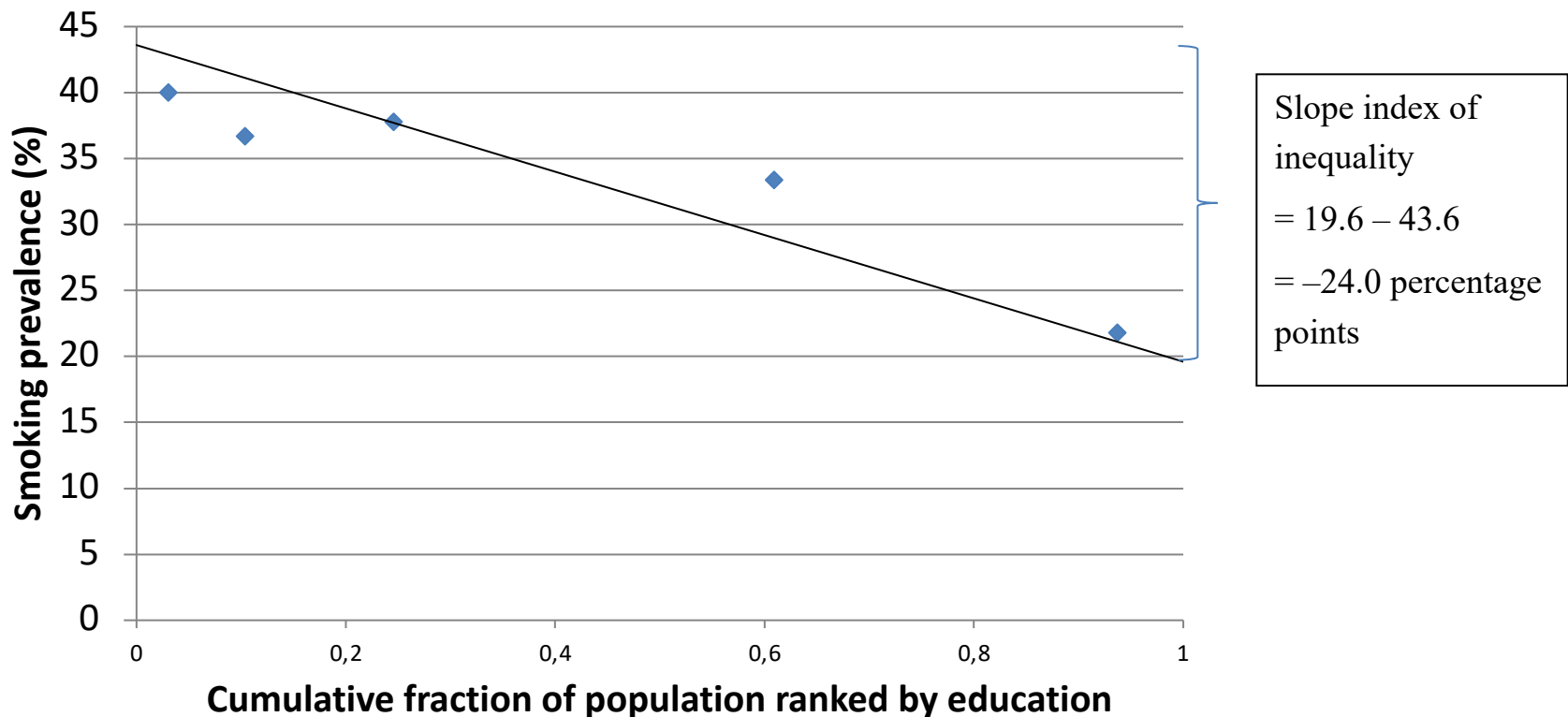
Table 1 Arriving at midpoint values of cumulative range based on education subgroups, for a population of men living in 27 middle-income countries and associated smoking prevalence, World Health Survey 2002–2004

Education level	Proportional distribution of population	Cumulative range of population	Midpoint of cumulative range of population (x axis)	Smoking prevalence (%) (y axis)
No formal schooling	0.0610	0–0.0610	0.0305	40.0
Less than primary school	0.0856	0.0610–0.1466	0.1038	36.7
Primary school completed	0.1980	0.1466–0.3446	0.2456	37.8
Secondary/high school completed	0.5287	0.3446–0.8734	0.6090	33.4
College completed or above	0.1266	0.8734–1.0000	0.9367	21.8

Source: Data derived from Hosseinpoor AR et al. Socioeconomic inequalities in risk factors for noncommunicable diseases in low-income and middle-income countries: results from the World Health Survey. *BMC Public Health*, 2012, 12:912.

Applied example: slope index of inequality

Figure 1 Slope index of inequality: absolute inequality in smoking prevalence in a population of men living in 27 middle-income countries, World Health Survey 2002–2004



Source: Data derived from Hosseinpoor AR et al. Socioeconomic inequalities in risk factors for noncommunicable diseases in low-income and middle-income countries: results from the World Health Survey. *BMC Public Health*, 2012, 12:912.

Concentration index

- Concentration index is a **relative measure** of inequality that indicates the extent to which a health indicator is concentrated among the disadvantaged or the advantaged
- Given that a population is ranked by increasing socioeconomic status:
 - Concentration index has a negative value when the health indicator is concentrated among the disadvantaged
 - Concentration index has a positive value when the health indicator is concentrated among the advantaged
- When there is no inequality the concentration index equals 0
- ± 1 is the theoretical maximum of concentration index

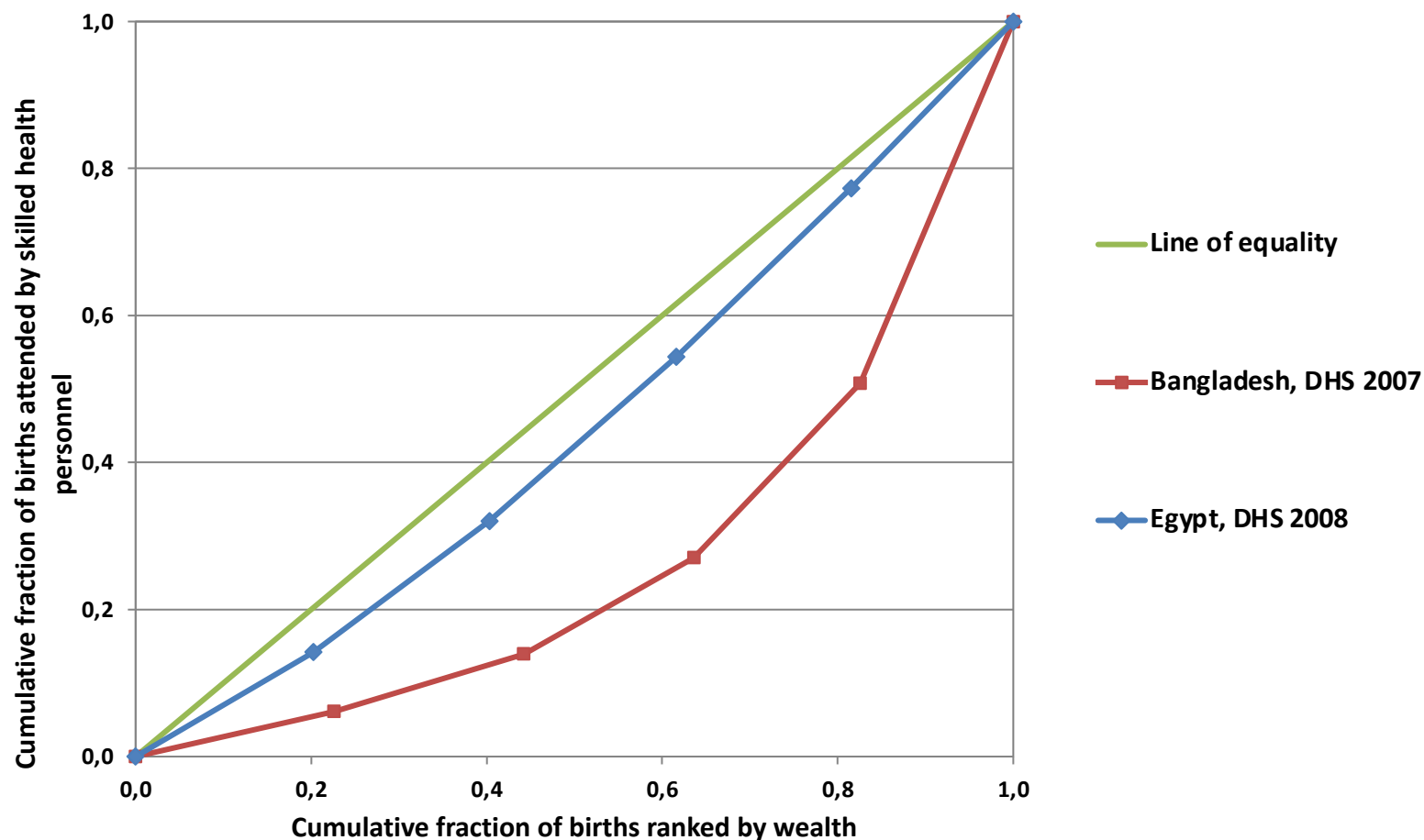
Applied example: concentration index

Table 2 Arriving at cumulative fraction values for births and births attended by skilled health personnel using wealth-disaggregated data from Bangladesh and Egypt, DHS 2007 and 2008

Country	Household wealth	Number of births (in weighted sample)	Proportion of births	Cumulative fraction of births	Number of births attended by skilled health personnel (in weighted sample)	Proportion of births attended by skilled health personnel	Cumulative fraction of births attended by skilled health personnel
Bangladesh, DHS 2007	Quintile 1 (poorest)	1367	0.226	0.226	66	0.061	0.061
	Quintile 2	1312	0.217	0.442	85	0.078	0.139
	Quintile 3	1173	0.194	0.636	143	0.131	0.270
	Quintile 4	1149	0.190	0.826	258	0.237	0.508
	Quintile 5 (richest)	1056	0.174	1.000	535	0.492	1.000
Egypt, DHS 2008	Quintile 1 (poorest)	2145	0.203	0.203	1183	0.142	0.142
	Quintile 2	2125	0.201	0.403	1490	0.178	0.320
	Quintile 3	2251	0.213	0.616	1865	0.223	0.543
	Quintile 4	2113	0.200	0.815	1917	0.230	0.773
	Quintile 5 (richest)	1956	0.185	1.000	1896	0.227	1.000

Applied example: concentration index

Figure 2 Relative wealth-based inequality in births attended by skilled health personnel in Bangladesh and Egypt, represented using concentration curves, DHS 2007 and 2008



Applied example: concentration index

Table 3 Wealth-based relative inequality in births attended by skilled health personnel in selected countries, DHS 2006–2008

Country	Percentage of births attended by skilled health personnel (proportion of total births*)					Ratio (quintile 5 / quintile 1)	Concentration index
	Quintile 1 (poorest)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (richest)		
Egypt, DHS 2008	55.2 (0.20)	70.1 (0.20)	82.8 (0.21)	90.7 (0.20)	96.9 (0.18)	1.8	0.11
Uganda, DHS 2006	28.7 (0.22)	32.0 (0.23)	35.3 (0.20)	50.0 (0.19)	77.1 (0.16)	2.7	0.21
Philippines, DHS 2008	25.7 (0.27)	55.6 (0.23)	75.8 (0.19)	86.0 (0.18)	94.4 (0.14)	3.7	0.24
Ghana, DHS 2008	24.2 (0.26)	50.0 (0.22)	64.8 (0.19)	81.7 (0.19)	94.6 (0.14)	3.9	0.25
Bangladesh, DHS 2007	4.9 (0.23)	6.5 (0.22)	12.2 (0.19)	22.5 (0.19)	50.6 (0.17)	10.4	0.48

*Note: due to rounding country total births may not equal exactly 1.

Using complex measures to account for population shift

Table 4 Education-based inequality in contraceptive prevalence (modern methods) in the Philippines, DHS 1993 and 2008

Survey year	Simple measures of inequality		Complex measures of inequality	
	Difference (secondary school or higher – none) (percentage points)	Ratio (secondary school or higher / none)	Slope index of inequality (percentage points)	Concentration index
1993	20.8	3.9	15.7	0.08
2008	27.1	4.1	14.3	0.04

Slope index of inequality and concentration index – other applications

- Whereas the examples in this lecture focused on calculations of group-level data, both of these indices can also be calculated from individual-level data
- Relative index of inequality
 - Analogous to slope index of inequality, but calculates relative inequality
- There is also a version of concentration index that expresses absolute inequality
 - Derived by plotting cumulative fraction of the population rank by socioeconomic status against the cumulative *amount* of health indicator

Complex measures of inequality in non-ordered groups

- Absolute mean difference
 - Absolute inequality
- Theil index
 - Relative inequality

Absolute mean difference from the overall mean

- How different is each subgroup, on average, from the population average?
- To calculate the absolute mean difference from the overall mean:
 - Calculate the absolute value of the difference between the mean of a health indicator in each population subgroup and the mean in the total population are calculated
 - Find the sum of these differences
 - Divide this figure by the number of subgroups
- Only positive values can be generated for the mean difference from the mean; because there is no natural ordering of subgroups the measure shows no indication of directionality

Weighted absolute mean difference from the overall mean

- To account for cases where subgroups differ in size, the mean difference from the overall mean calculation can also be done by weighting each difference by the size of the subgroup
- To calculate:
 - Take the difference of each subgroup's mean from the population average and multiply these differences by each subgroup's population size
 - Sum the differences
 - Divide by the total population size

Reference points

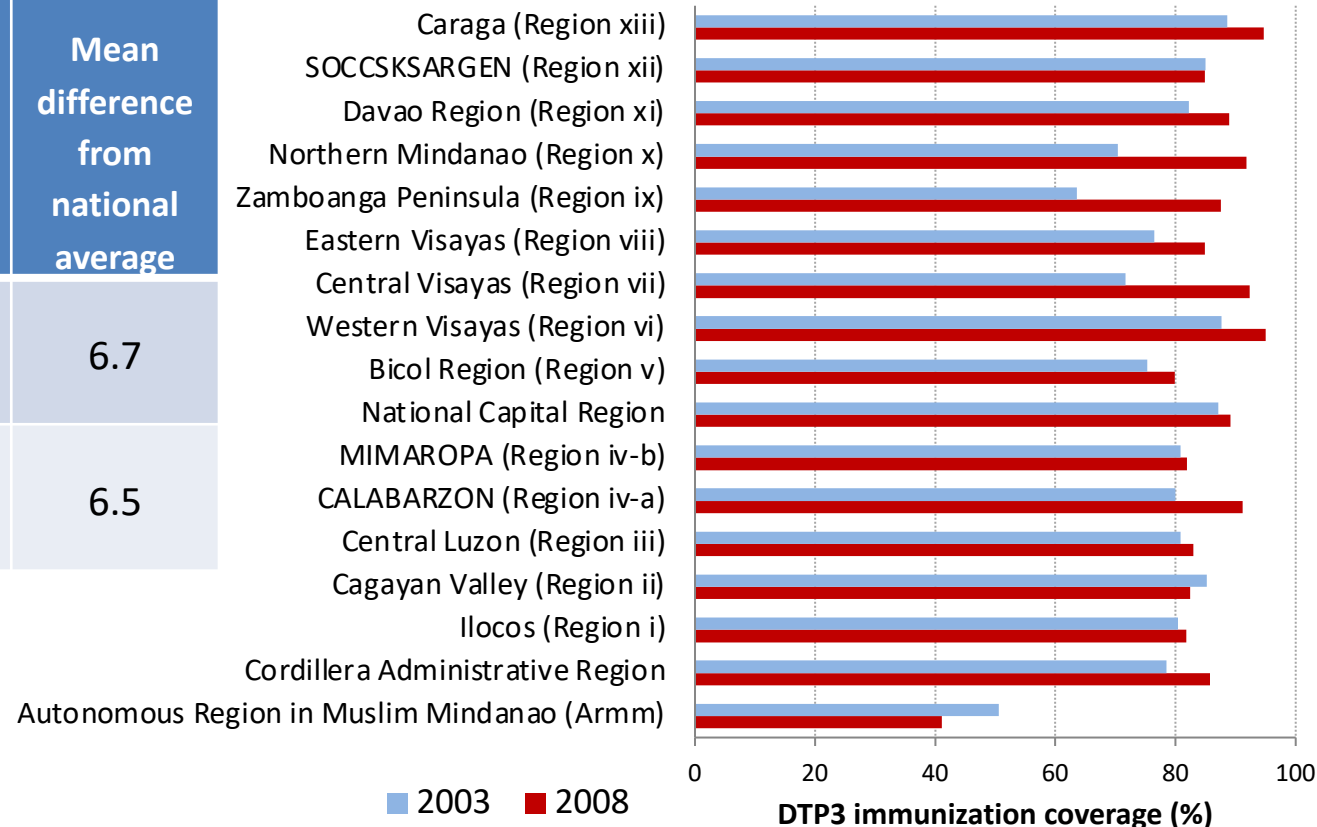
- For mean difference from the mean measures, the reference for the comparison of each population subgroup does not have to be the overall population mean value
- Alternative reference points include:
 - Best-performing subgroup (shortfall inequality)
 - Target level of health

Applied example: mean difference from the overall mean

Table 5 Region-based inequality in DTP3 immunization coverage among 1-year-olds in the Philippines, DHS 2003 and 2008

Survey year	Difference (high – low) (percentage points)	Mean difference from the best region	Mean difference from national average
2003	38.1	10.7	6.7
2008	53.9	10.5	6.5

Figure 3 Region-based inequality in DTP3 immunization coverage among 1-year-olds in the Philippines, DHS 2003 and 2008



Other measures similar to mean difference from the overall mean

- **Standard deviation, variance and index of disparity** are other measures that can be applied to assess health inequality in non-ordered subgroups

Theil index

- Measure of relative inequality in cases where there is no natural ordering among population subgroups
- Calculated using the formula:

$$T = \sum_{i=1}^N p_i r_i \ln(r_i)$$

- For subgroup i , p_i is the proportion of the population, and r_i is the ratio of the health indicator prevalence in the subgroup i to the overall health indicator prevalence in the population
- Interpreting Theil index values:
 - When there is no inequality, Theil index is 0
 - Greater values for the Theil index indicate higher levels of relative inequality with no maximum
 - Theil index will always be a positive value

Applied example: Theil index

Table 6 Arriving at Theil index values for antenatal care (at least four visits), using region-disaggregated data from Egypt, DHS 1995 and 2008

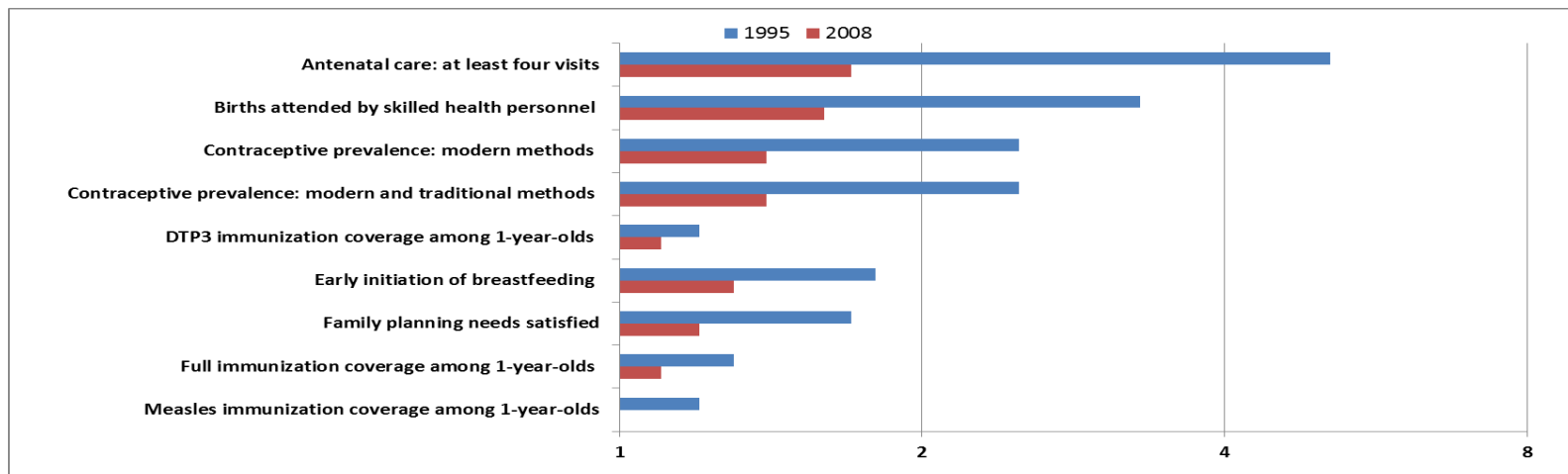
Region	Coverage of antenatal care: at least four visits (%)	Proportion of the population (p_i)	Ratio of coverage in region i to national coverage (r_i)	Natural log of ratio of coverage in region i to national coverage ($\ln(r_i)$)	Theil index components ($p_i r_i \ln(r_i)$), multiplied by 1000	Theil index, multiplied by 1000
DHS 1995						
Frontier governorates	32.6	0.01	1.07	0.07	0.71	176.78
Lower Egypt: rural	21.5	0.29	0.71	−0.35	−71.71	
Lower Egypt: urban	53.3	0.10	1.75	0.56	100.53	
Upper Egypt: rural	10.8	0.29	0.36	−1.04	−107.55	
Upper Egypt: urban	41.2	0.11	1.35	0.30	45.79	
Urban governorates	55.4	0.19	1.82	0.60	209.01	
<i>National coverage</i>	30.4					
DHS 2008						
Frontier governorates	65.8	0.01	0.99	−0.01	−0.15	17.78
Lower Egypt: rural	63.9	0.34	0.96	−0.04	−13.23	
Lower Egypt: urban	78.5	0.10	1.18	0.16	19.57	
Upper Egypt: rural	50.3	0.27	0.76	−0.28	−57.30	
Upper Egypt: urban	75.6	0.11	1.14	0.13	15.65	
Urban governorates	85.6	0.16	1.29	0.25	53.25	
<i>National coverage</i>	66.5					

Source: Disaggregated data provided by: International Center for Health Equity, Federal University of Pelotas, Brazil.

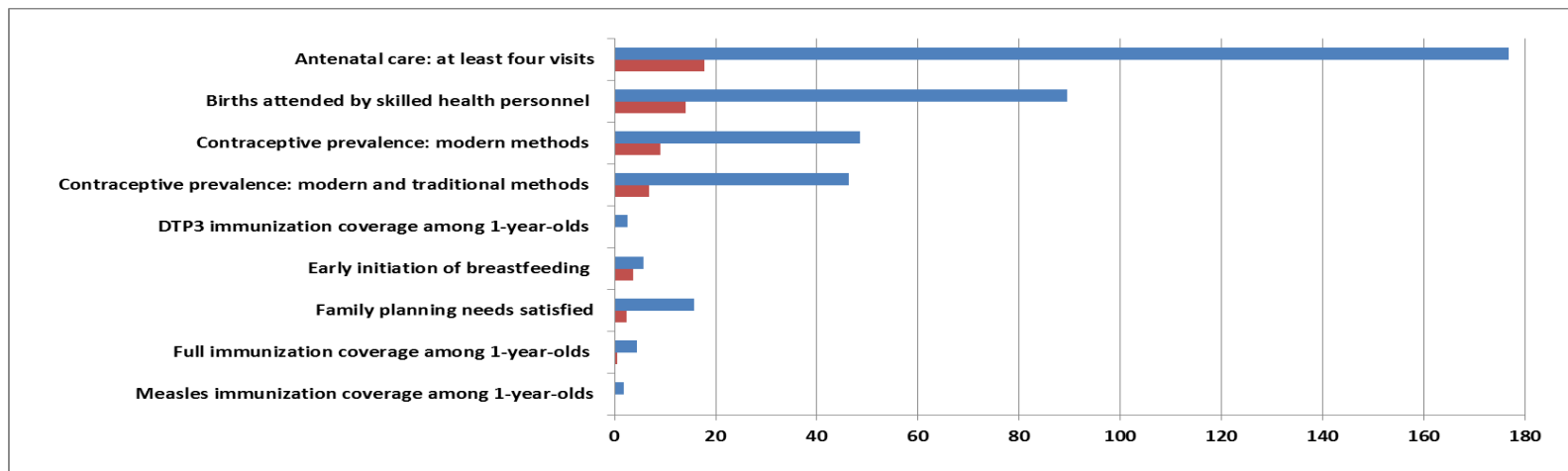
Applied example: Theil index

Figure 4 Region-based relative inequality in selected reproductive, maternal and child health indicators in Egypt shown using (a) ratio and (b) Theil index, DHS 1995 and 2008

(a) Ratio



(b) Theil index



Source: Disaggregated data provided by: International Center for Health Equity, Federal University of Pelotas, Brazil.

Ordered geographical regions

- Geographical regions may sometimes be assigned a “natural” ordering as an equity stratifiers
 - For example, a dataset may record infant deaths and also geographical region BUT individual wealth is unknown
 - If the regional average wealth is known it may be used to rank regions as a proxy to measure wealth-related inequality in infant mortality at the regional level

Population attributable risk

- Measure of absolute inequality
- Shows the improvement possible if all subgroups had the same rate as a reference subgroup
- Can be used for ordered or non-ordered groups
- Can take into account subgroups of different sizes
- Reference subgroup is typically that which has the best outcome or the highest social position

Population attributable risk percentage

- Measure of relative inequality
- To calculate, divide the population attributable risk by the overall rate in the total population
 - The outcome value range is 0-100
- Shows the proportional improvement possible by eliminating inequality between subgroups (to the level of the reference subgroup)
 - A higher value indicates more-pronounced inequality

Population attributable risk and universal health coverage

- The gap in health service coverage represents the proportion of health services that were required but not received: the increase in coverage needed to achieve universal coverage
 - A lower national gap indicates that a country is closer to achieving universal coverage

Applied example: population attributable risk and population attributable risk percentage

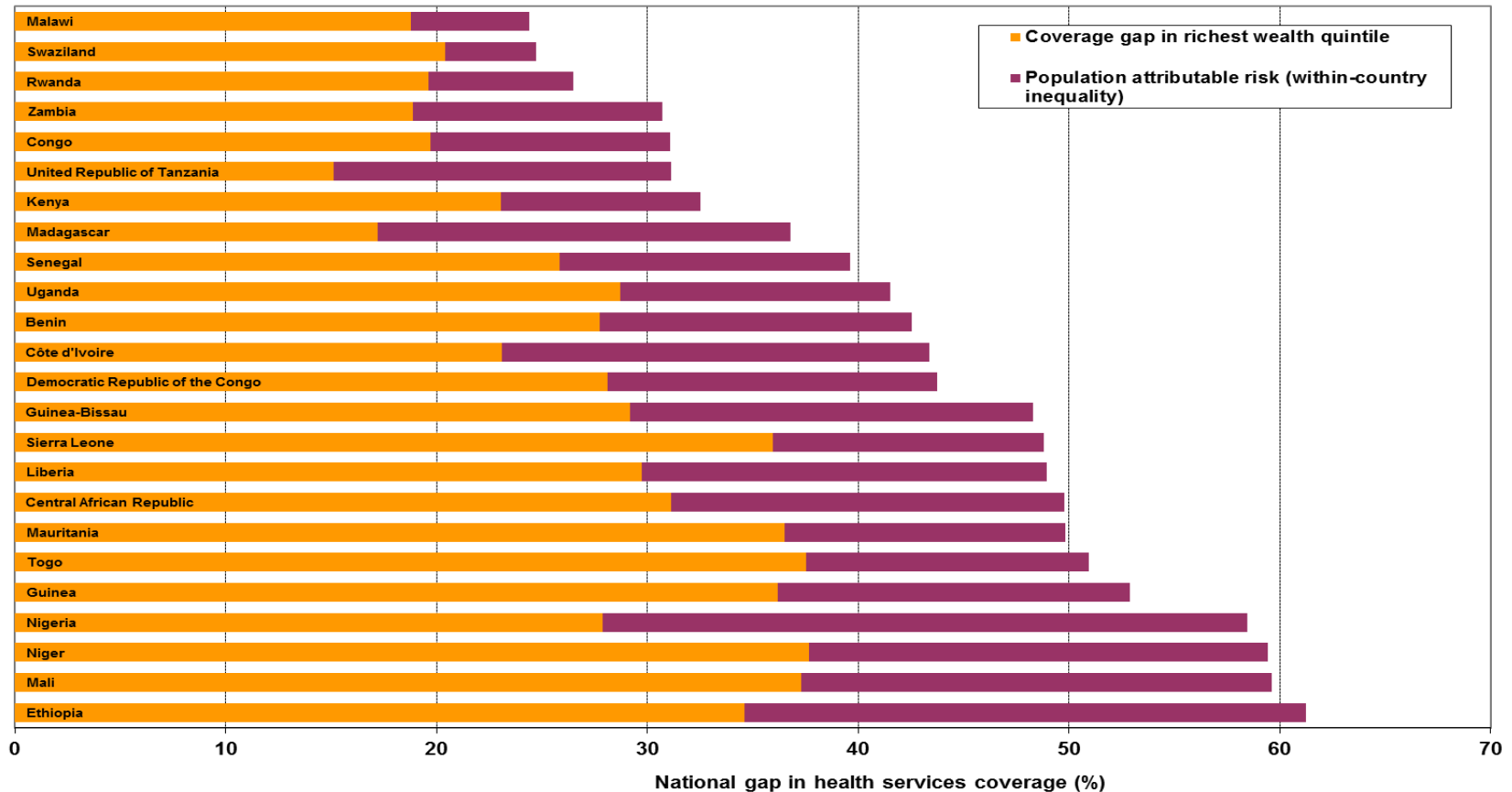
Table 7 Wealth-based inequality in the coverage gap in family planning needs satisfied in selected African countries, DHS 2000–2008

Country	National coverage gap (%)	Coverage gap in richest wealth quintile (%)	Population attributable risk (percentage points)	Population attributable risk percentage
Benin	64	44	20	31
Burkina Faso	68	41	27	40
Cameroon	44	26	18	40
Chad	88	70	18	20
Congo	27	20	7	27

Source: Hosseinpoor AR et al. Towards universal health coverage: the role of within-country wealth-related inequality in 28 countries in sub-Saharan Africa. *Bulletin of the World Health Organization*, 2011, 89(12):881–890.

Applied example: coverage gap and population attributable risk

Figure 5 National average gap in coverage of reproductive, maternal and child health services and within-country wealth-based inequality in coverage gap in 24 low- and middle-income African countries, DHS and MICS 2005–2011



Note: DHS = Demographic and Health Survey; MICS = Multiple Indicator Cluster Survey

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Full text available online:

http://apps.who.int/iris/bitstream/10665/85345/1/9789241548632_eng.pdf

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