How changes in coverage affect equity in maternal and child health interventions in 35 Countdown to 2015 countries: an analysis of national surveys

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Summary

Background **Achievement of global health goals will require assessment of progress not only nationally but also for population subgroups. We aimed to assess how the magnitude of socioeconomic inequalities in health changes in relation to different rates of national progress in coverage of interventions for the health of mothers and children.**

Methods **We assessed coverage in low-income and middle-income countries for which two Demographic Health Surveys or Multiple Indicator Cluster Surveys were available. We calculated changes in overall coverage of skilled birth attendants, measles vaccination, and a composite coverage index, and examined coverage of a newly introduced intervention, use of insecticide-treated bednets by children. We stratified coverage data according to asset-based wealth quintiles, and calculated relative and absolute indices of inequality. We adjusted correlation analyses for time between surveys and baseline coverage levels.**

Findings **We included 35 countries with surveys done an average of 9·1 years apart. Pro-rich inequalities were very prevalent. We noted increased coverage of skilled birth attendants, measles vaccination, and the composite index in most countries from the first to the second survey, while inequalities were reduced. Rapid changes in overall coverage were associated with improved equity. These findings were not due to a capping effect associated with limited scope for improvement in rich households. For use of insecticide-treated bednets, coverage was high for the richest households, but countries making rapid progress did almost as well in reaching the poorest groups. National increases in coverage were primarily driven by how rapidly coverage increased in the poorest quintiles.**

Interpretation **Equity should be accounted for when planning the scaling up of interventions and assessing national progress.**

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Introduction

In order to achieve the Millennium Development Goals by 2015, low-income and middle-income countries have been scaling up coverage of interventions that are effective against maternal and child deaths. Success has been variable. Although some countries have shown rapid improvements, other countries present modest if any advances.[1] At the same time that countries are striving for progress nationally, subnational socioeconomic inequalities are gaining visibility. The present focus on overall progress in coverage and health status might contribute to increasing inequalities[2,3] and reviews of the Millennium Development Goal framework and monitoring consistently criticise the lack of attention to inequalities.[4] Newly introduced interventions will also potentially reach mothers and children in high-income groups before they are adopted by the rest of the population because rich families tend to be better informed about the advantages of new technologies and have greater access in geographical and economic terms than do poor families. This factor might contribute to increasing inequalities in child health, at least in the short term.[5]

Despite such concerns, we are unaware of any systematic attempt to document what happens to socioeconomic inequalities as coverage of maternal and child health interventions changes. However, the increased availability of repeated national surveys in low-income and middle-income countries has made such analyses possible.

The Countdown to 2015 collaboration monitors 75 countries that account for more than 95% of all global deaths of mothers and children. We investigated the relation between coverage change and socioeconomic inequalities in Countdown countries that had undertaken at least two national surveys since 1990.

Methods

Data sources and procedures

We listed all Demographic Health Surveys and Multiple Indicator Cluster Surveys undertaken in Countdown countries since 1990 that included data for household assets. We identified countries that had done two or more surveys at least 5 years apart. We compared two surveys from each country. If a country had done three or more surveys, we prioritised surveys of the same type or the earliest and most recent surveys if surveys were all of the same type. We based all analyses on publicly available data from national surveys. Ethical clearance was the responsibility of the institutions that commissioned, funded, or did the surveys.

We selected two coverage indicators that represent different points on the continuum of care and require different delivery platforms: skilled birth attendance (SBA) and measles vaccination (MSL). We also included a recently introduced intervention: use of insecticide-treated bednets by children (ITN) in countries with endemic malaria. ITN coverage was not measured in early surveys because it is a new intervention that is unlikely to have been present before 2000.

To provide a broader picture of coverage on the continuum of care (reproductive, maternal, newborn, and child health), we also calculated a composite coverage index (CCI).[6,7] This index is a weighted average of eight coverage indicators, and is calculated with the following formula:

$$\mathrm{CCI} = 0\cdot25 \times (\mathrm{FPS} + 0\cdot5 \times [\mathrm{SBA} + \mathrm{ANCS}] + 0\cdot25 \times [2\mathrm{DPT3} + \mathrm{MSL} + \mathrm{BCG}] + 0\cdot5 \times [\mathrm{ORT} + \mathrm{CPNM}])$$

in which FPS is family planning need satisfied, ANCS is one or more antenatal care visits with a skilled provider, DPT3 is three doses of diphtheria, pertussis, and tetanus vaccine, BCG is BCG vaccination, ORT is oral rehydration therapy with continued feeding for children with diarrhoea, and CPNM is care-seeking for pneumonia. ITN are not included in this index because such use is restricted to countries with malaria. All indicators used were calculated from the original survey data with the standard Countdown definitions[1] and uniform recall periods. For countries missing data for FPS, we imputed data for every wealth quintile with methods described elsewhere.[7]

We used household level wealth index scores to stratify mothers and children according to socioeconomic position, as calculated by the original Demographic Health Survey or Multiple Indicator Cluster Survey.[8] We ranked individuals according to the score of the household in which they lived. We constructed wealth quintiles on the basis of these scores, with quintile 1 representing the poorest 20% of households and quintile 5 representing the richest 20%. We calculated two summary indices of inequality from coverage levels in the five quintiles, an absolute measure termed the slope index of inequality and a relative measure termed the concentration index. Absolute measures of inequality will remain unchanged when all groups compared present the same difference from the first timepoint to the second timepoint, whereas relative measures will remain unchanged when all groups present the same ratio. We estimated the slope index of inequality through logistic regression to avoid prediction of values that fell outside the interval 0–100%. This index expresses the absolute difference, in percentage points, between individuals at the top and bottom of the wealth scale.[9] Positive values show that coverage is higher in rich individuals than it is in poor individuals. The concentration index[10] ranges from –1 to 1, with zero representing perfect equality; positive values suggest that rich individuals have greater coverage than do poor individuals. Increases in the concentration or slope index with time suggest a rising pro-rich inequality. For ITNs, the indices were only calculated for the most recent surveys because the intervention was introduced after 2000.

See Online for appendix

We tested two approaches to account for variability between countries in the time intervals noted between the two surveys. The first approach was to calculate compound annual rates of change, which is appropriate for coverage levels because these are always positive. However, for countries in which some concentration index or slope index of inequality values were negative or zero, compound annual change could not be calculated. For this reason, we opted to adjust for time interval as a covariate in the analyses.

Statistical analysis

To assess differences between surveys, we used ANOVA and partial correlation coefficients, which are similar to Pearson correlation analyses but allow adjustment for covariates (time between surveys and baseline levels). p values for partial correlations relate to the probability of the correlation being equal to zero. Stata 11.2 was used for all the analyses, accounting for the survey design, including sampling weights and clustering.

Role of the funding source

The sponsor of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

We identified 35 countries that had undertaken two or more surveys 5–13 years apart. 23 (66%) of these countries were in sub-Saharan Africa, eight (23%) were in Asia, three (9%) were in Latin America and the Caribbean, and one (3%) was in North Africa. The full list of countries, surveys, and main variables used is shown in the appendix (pp 1–2). Data for family planning needs satisfied (FPS) were not available for five countries in the first survey and one in the second survey, and therefore we imputed composite coverage index data for these countries. The average time interval between national surveys was 9·1 and the median time was 10 years (range 5–13 years): the median year for first survey was 1997 (range 1994–2004, IQR 1996–98) and the median year for second survey was 2006 (2003–10, 2005–08). 35 countries had data for SBA and CCI, 34 countries had data for MSL, and all 21 countries with endemic malaria had data for ITN. Overall, coverage of SBA, MSL, and CCI increased in the 35 countries (table 1), but six countries had decreases in coverage of SBA, eight countries had decreases in coverage of MSL, and three countries had decreases in the CCI (appendix pp 1–2).

Figure 1 shows mean coverage levels by wealth quintile in the first and second surveys. We noted pro-rich patterns for all four indicators. Baseline coverage of SBA, MSL, and CCI differed, with MSL showing the highest levels. Absolute inequalities seem to decrease with time (ie, greater increases for poor individuals than for rich individuals) for SBA, MSL and CCI. Table 1 shows statistical analyses of change in equity with time.

Concentration and slope indices in the first and second surveys were positive for SBA and CCI in all countries assessed (appendix pp 1–2), and were positive for MSL in 33 countries and for ITN in 20 of 21 countries assessed. Pro-rich inequalities were very prevalent.

Relative inequality, according to concentration index, was reduced for SBA, MSL, and CCI (table 1). Absolute inequality, according to slope index, was reduced for MSL and CCI but was stable for SBA (table 1).

Because of the relatively high baseline levels of some interventions, improvements in coverage might have been restricted, particularly for the richest quintiles. To assess this possibility, we calculated partial correlation coefficients that were adjusted for the number of years between surveys. Mean baseline SBA coverage was 45·3%, and a correlation analysis across countries showed no association between initial coverage and change over time expressed as percentage points (r=–0·059, p=0·74). Mean baseline CCI coverage was 52·3% and the correlation with change over time was –0·310 (p=0·07). For MSL, the mean baseline value was 63·3% with an inverse correlation with change over time (r=–0·526, p=0·002). On the basis of these findings, we decided to take baseline levels into account in further analyses.

Table 2 shows correlations between changes in coverage over time and changes in the concentration and slope indices. Two models are shown for each indicator, the first adjusted for time between surveys, and the second also adjusted for baseline coverage. Unadjusted correlation coefficients are not shown, but these were slightly smaller than those adjusted for time, suggesting that failure to adjust for time between surveys would underestimate the strength of correlations (appendix p 3). Coefficients adjusted for baseline coverage should be interpreted with caution because baseline values are part of the formula for change over time, which might result in false associations. However, coefficients adjusted for baseline coverage were very similar to partial coefficients adjusted for time only (table 2). Additional prespecified analyses included stratification by baseline coverage levels (see appendix p 4). These analyses supported the finding that baseline levels do not affect the reported associations.

	Countries	Mean	95% CI	Minimum	Maximum
Time between the two surveys (years)	35	9·1	..	5·0	13·0
Coverage (% points)					
Skilled birth attendant	35	7·6	3·7 to 11·5	–17·2	42·8
Measles vaccination	34	9·5	5·1 to 13·8	–20·7	35·4
Composite coverage index	35	8·0	5·2 to 10·7	–6·8	30·8
Concentration index (×100)					
Skilled birth attendant	35	–3·2	–6·1 to –0·3	–21·0	21·9
Measles vaccination	34	–4·8	–6·4 to –3·1	–14·1	5·0
Composite coverage index	35	–3·3	–4·7 to –1·9	–13·2	7·8
Slope index (% points)					
Skilled birth attendant	35	–0·1	–4·1 to 3·9	–23·2	26·0
Measles vaccination	34	–10·2	–15·1 to –5·3	–36·6	27·1
Composite coverage index	35	–6·1	–8·8 to –3·4	–26·4	6·6

Data from Demographic Health Surveys or Multiple Indicator Cluster Surveys (values in the most recent survey minus values in earlier survey).

Table 1: **Absolute changes in coverage and inequality indices between first and second surveys**

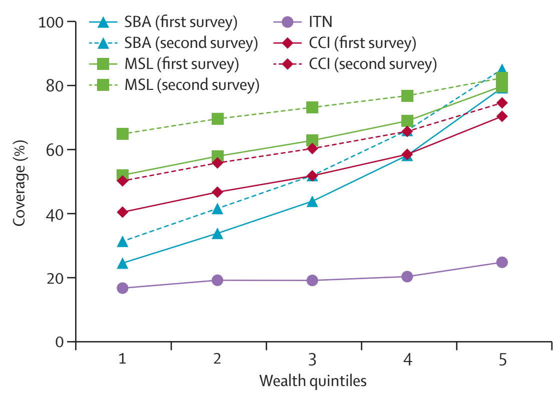

Figure 1: **Unweighted mean coverage levels by wealth quintile in the first and second surveys**
SBA=skilled birth attendants. MSL=measles vaccination. ITN=use of insecticide-treated bednets. CCI=composite coverage index.

For SBA, CCI and MSL, countries with faster increases in coverage tended to also reduce inequalities, particularly relative inequalities as assessed by the concentration index.

We noted inverse correlations between inequality measures and coverage change irrespective of time between surveys and baseline coverage levels (table 2). Figure 2 shows change in each of the inequality indices plotted against change the coverage of CCI. We noted much the same patterns in prespecified analyses for SBA and MSL (appendix pp 6–9).

Adjustment for time between surveys and baseline levels did not affect the conclusion that rapid changes in coverage were associated with reduced inequalities (table 2). Correlation analyses, adjusted for time between surveys, were also done for the other six coverage indicators included in the CCI (table 2, appendix). All correlations between change in coverage and change in the concentration index were negative,

	Concentration index			Slope index of inequality		
	Partial correlation	Regression coefficient (95% CI)	p value	Partial correlation	Regression coefficient (95% CI)	p value
Skilled birth attendant*	–0·887	–0·666 (–0·791 to –0·542)	<0·0001	–0·440	–0·453 (–0·785 to –0·120)	0·0092
Skilled birth attendant†	–0·886	–0·665 (–0·792 to –0·538)	<0·0001	–0·512	–0·490 (–0·791 to –0·188)	0·0023
Measles vaccination*	–0·731	–0·276 (–0·371 to –0·182)	<0·0001	–0·521	–0·585 (–0·936 to –0·234)	0·0019
Measles vaccination†	–0·601	–0·202 (0·302 to –0·102)	0·0003	–0·405	–0·492 (–0·907 to –0·078)	0·0215
Composite coverage index*	–0·674	–0·345 (–0·482 to –0·209)	<0·0001	–0·691	–0·539 (–0·842 to –0·235)	0·0010
Composite coverage index†	–0·691	–0·365 (–0·515 to –0·214)	<0·0001	–0·631	–0·662 (–0·983 to –0·341)	0·0002

*Adjusted for time between surveys. †Adjusted for time between surveys and baseline coverage of skilled birth attendants, measles vaccination, and the composite coverage index.

Table 2: **Partial correlations and linear regression coefficients between change in concentration and slope indices and in coverage over time, controlling for time between surveys and baseline coverage of three indicators**

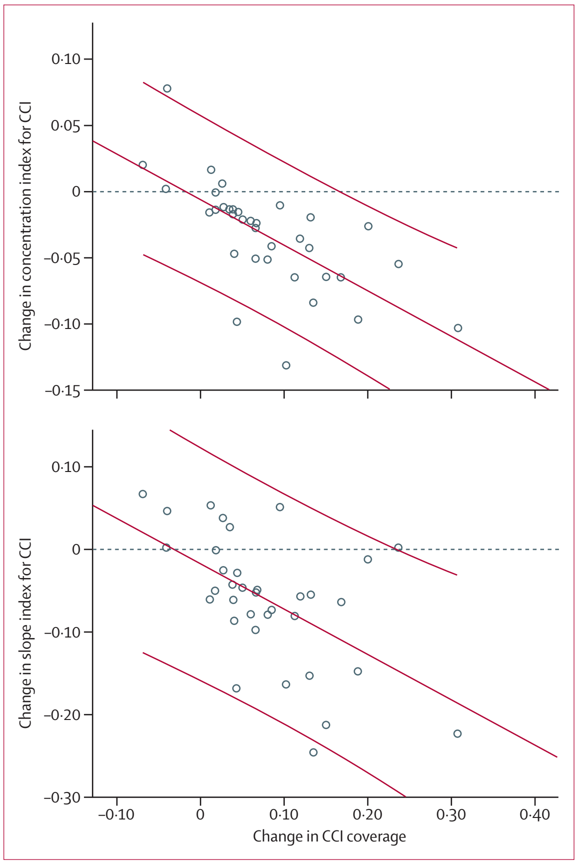

Figure 2: **Scatter diagrams of change in concentration (A) and slope (B) indices of inequality according to change in the coverage level for the CCI**
Lines show fitted linear trends (95% CIs). CCI=composite coverage index.

and all but one were significant (oral rehydration therapy p=0·06). For the slope index, four of six indicators had significant inverse correlations, but those for oral rehydration and care for pneumonia were close to zero and non-significant. Because these two indicators are based on children who were ill in the 2 weeks before the survey, their denominators are much smaller than those reported for the other indicators, especially in high-income quintiles in which fewer disease episodes are reported. The additional analyses support our main findings.

Figure 3 shows changes in coverage of SBA, CCI, and MSL by wealth quintile. Countries with rapid overall increases in coverage had the greatest absolute improvements in the poorest quintiles. Each line represents one third of the countries, from those with the most rapid increase in coverage to those with little or no increase. Countries with moderate overall increases also had greatest improvements in the poorest quintiles for CCI and MSL, but increases in SBA were the much the same for all quintiles. Countries with slow or no increases in overall coverage showed stagnation or even declines in most wealth quintiles. Compared with SBA, MSL coverage had large increases in the lowest quintiles (quintile 1, quintile 2, and to a lesser extent quintile 3). Changes in coverage of SBA, MSL, and CCI by wealth quintile differed significantly dependent on tercile of change in overall coverage ($p_{interaction}=0·0126$ for SBA, $p_{interaction}<0·0001$ for MSL, and $p_{interaction}=0·0016$ for CCI).

In 21 countries with data available from the most recent survey for ITN, mean coverage was 19·8% (95% CI 11·7–27·9, range 1·3–61·4). The concentration index (mean 13·7, 95% CI 5·7–21·7) and slope index (8·4, 3·3–13·5) suggested significant pro-rich distributions. Figure 3 shows changes in coverage of ITN, divided into terciles of overall coverage ($p_{interaction}=0·15$). By contrast with SBA, CCI, and MSL, countries that achieved rapid progress overall managed to increase coverage of ITN in all quintiles by about the same extent, although slightly higher levels were noted in the richest quintile. Countries with moderate overall improvements had pro-rich patterns. Countries with slow rates of overall increase had little progress in all wealth quintiles.

Baseline coverage levels in the richest quintile were not associated with magnitude of increase in overall coverage (table 3), suggesting that the aforementioned results were not attributable to a capping effect. Table 3 also shows that there was substantial room for improvement in richest quintile for all three indicators in most countries because coverage levels were around 80% for this quintile (nine countries had

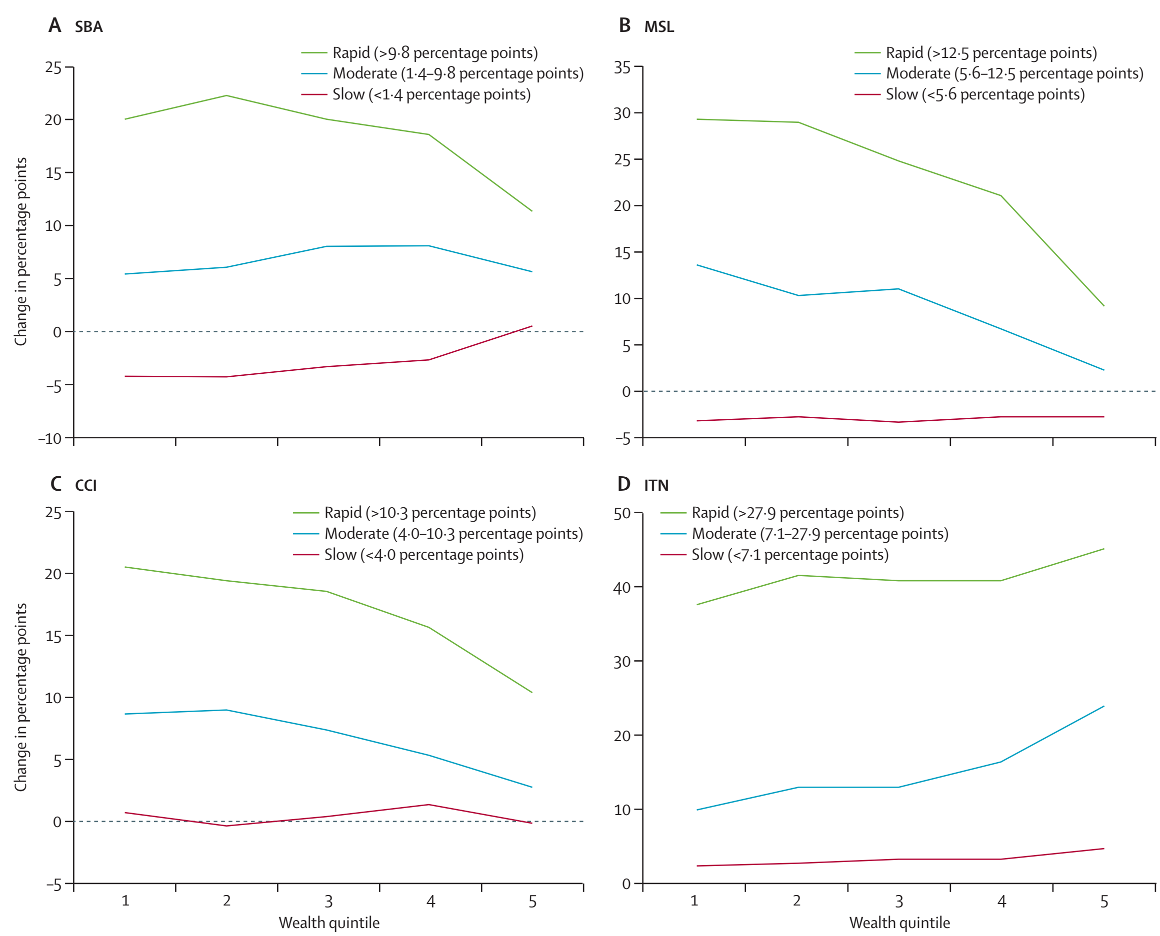

Figure 3: **Coverage of skilled birth attendants (A), measles vaccination (B), composite coverage index (C), and use of insecticide-treated bednets (D), by tercile of increase in overall coverage**
Quintile 1 is the poorest and quintile 5 is the richest.

	Skilled birth attendant coverage	Measles vaccine coverage	Composite coverage index
Slow or no increase	77·4%	82·1%	72·5%
Moderate increase	82·1%	77·8%	68·3%
Rapid increase	78·4%	79·0%	71·0%
p value	0·82	0·73	0·61

Table 3: **Baseline coverage levels in the richest quintile, according to groups of coverage increase over time**

SBA baseline coverage of more than 90% in the richest quintile compared with six countries for MSL and none for the CCI).

Discussion

Inequalities in the health of mothers and children in low-income and middle-income countries were infrequent from the global medical literature before 2000 (panel).[2,12,13] The assumption was that all mothers and children in low-income and middle-income countries were equally poor, and that there was no need to account for subnational inequalities when strategies were designed for scaling up of health interventions. Practical difficulties in the stratification of health status by socioeconomic position contributed to this lack of visibility. Adoption of asset indices in large-scale household surveys after 2000 was a notable advance.[8,14]

The situation changed rapidly. In the past couple of years, issues related to accountability have been brought to the forefront of global maternal and child health,[15] including the notion that progress should be measured not only by overall rates of change, but also by how well the poorest and most deprived subgroups of the population are reached. Countries making rapid overall progress concomitantly with reducing inequalities, such as Brazil,[16] Thailand,[17] and China,[18] are examples of what can be achieved in short timeframes. Conversely, in some countries inequities have increased (appendix); for example, SBA coverage fell by 2 percentage points overall in Zimbabwe, with a decline of 12 points in the poorest quintile but an increase of 4 points was noted in the

Panel: **Research in context**

Systematic review

We have recently updated[7] a systematic review[11] of studies published since Jan 1, 1990, that included a PubMed search with several keyword combinations of socioeconomic factors with terms related to child morbidity, mortality, nutrition, use of services, and coverage. The search was restricted to publications about low-income and middle-income countries, or global analyses.

Interpretation

To our knowledge, this report is the first systematic investigation of time trends in inequalities according to changes in coverage levels in all low-income and middle-income countries with available data. We show inverse correlations between coverage change and the degree of inequality. Countries making faster gains in coverage were able to increase coverage among the poorest at a faster rate than for the better-off. Immediate implications of our results include the need to give special emphasis to reach the poorest segments of the population in order to achieve rapid gains in intervention coverage to contribute to lowering the morbidity and mortality of mothers and children.

richest quintile. Continued focus on overall coverage might therefore mask important socioeconomic differences in provision of coverage.

To our knowledge, this is the first attempt at a systematic analysis of how overall change in intervention coverage is related to coverage in different subgroups. We selected three coverage indicators. SBA depends on functional facility-based health services, which need to be available around the clock, and for which user fees are charged in most low-income and middle-income countries. SBA is one of the most inequitable coverage indicators according to previous Countdown analyses.[7] MSL is often delivered through campaigns or outreach as a one-off dose with no cost to families, and was selected as an example of an equitable intervention.[7] SBA and MSL have been promoted for many years so that relatively high coverage has been achieved, at least in the richest quintile. Our third indicator, ITN, is also often delivered at community level through campaigns, voucher schemes, or social marketing, and was chosen as an example of a recently introduced intervention for which coverage is increasing rapidly in several countries. Even though many countries use campaigns to promote vaccines and ITN, the patterns of inequality in the most recent surveys are different for these two interventions. The correlation between the two measures of slope index of inequality (r=–0·118) and the relative index of inequality (r=0·188) were weak and non-significant, suggesting differential patterns of adoption by wealth quintiles.

We also used a composite index, the CCI, which is a weighted average of four intervention areas with different delivery strategies and includes eight facility-based and community-based interventions, all of which have been available for at least 20 years.

Our different analytical approaches, relying on relative and absolute inequality measures, showed consistent findings for three indicators that represent long-existing interventions (SBA, MSL and CCI). First, coverage increased in almost all countries and inequalities declined because increases in the poorest wealth quintiles tended to be faster than they were in the richest wealth quintiles (figure 1). The three indicators showed pro-rich patterns in the first survey, but countries making rapid progress were characterised by especially strong gains in coverage in the poorest groups. This conclusion was supported by the partial correlation analyses (table 2), scatter diagrams (figure 2), and the analyses of changes in every wealth quintile according to the speed of overall change (figure 3). Adjustments for time between surveys and baseline levels did not change these conclusions. Increases in MSL coverage were larger than were those for SBA, which was chiefly due to greater improvements in the lowest quintiles (especially quintile 1 and quintile 2; figure 3) and presumably associated with the fact that MSL is often delivered at community level and does not require out-of-pocket payments.

Results for ITNs, which were included in the analyses as an example of an intervention that is still in the early adoption phase, differed from those for SBA, CCI, and MSL. Countries making fastest progress were those that managed to reach all socioeconomic groups to almost the same extent, although they were still slightly pro-rich. This feature might have resulted, for example, from focusing ITN delivery in rural areas where many of the poorest families live. Countries making moderate progress were those where ITNs were mostly adopted by the richest groups. Countries with limited progress in increasing ITN coverage did not have any detectable pattern in coverage, either pro-rich or pro-poor.

Equity was influenced by the magnitude of the change in overall coverage, with countries with the greatest increase in overall coverage achieving the greatest increase among the poorest quintiles. Large overall increases, therefore, were noted when very substantial increases were achieved in the poorest quintiles.

The inverse equity hypothesis was proposed in 2000.[5] It stated that, in the absence of any efforts to promote equity, new health interventions will first be adopted by the wealthy, resulting in a strikingly pro-rich pattern of inequality. As coverage increases and reaches high rates in the wealthy, poorer individuals will make faster gains and inequality would eventually be reduced. The present analyses suggest that several countries have managed to circumvent this expectation, most likely by deliberately adopting scaling up strategies aimed at reaching the poorest. For example, countries with moderate progress in scaling up of ITNs (figure 3; mean coverage increase 0–15·0%) are in line with the hypothesis, showing that this new intervention is being picked up by the rich. However, countries making rapid progress with ITN coverage (mean coverage 41·2%) managed to increase coverage in all wealth groups to roughly the same extent, contradicting what would be expected in the absence of deliberate efforts to promote equity. For an intervention with high baseline coverage levels such as MSL, both groups of countries with rapid improvements (mean increase 55·6–78·9%) and moderate improvements (mean increase 58·9–67·8%) complied with the hypothesis. Conversely, countries with small increases or coverage reductions (mean change 74·9–71·3%) remained static in terms of inequalities.

Detailed analyses of the contextual and programmatic characteristics of countries that effectively managed to reach the poor are outside the scope of the present analyses, but we plan to address them in the future by linking these results to information being collected on which delivery strategies were used in each county.

Our analyses had limitations. Asset-based wealth indices have been criticised because they vary according to the choice of assets and issues of comparability between urban and rural households, and asset measurements are improving with time.[19,20] Nevertheless, several analyses show that they closely match more complex indicators of socioeconomic position.[13,21,22] Another limitation was that wealth is closely associated with place of residence, and therefore varies by region of country and urban or rural location; we did not attempt to disentangle these dimensions in the present set of analyses. In addition, asset-based classifications represent a relative instead of absolute measure of wealth; thus, households at the lowest quintile in the second survey might be comparable with households in the middle quintile in the first survey in terms of absolute wealth, and this factor might contribute to increased coverage. However, this observation does not preclude the comparison of how different countries do in terms of inequalities in different quintiles. Finally, because of higher fertility in low-income groups, there are more children in the poorest household quintile than there are in the richest quintile: an average excess of 33–49% in the 35 countries, dependent on the indicator measured. However, changes in fertility within 10 years are unlikely to have affected our results.

Measurement of survey-based coverage indicators depends on the knowledge and recall of the respondents, which can vary from indicator to indicator; the recall period can be as long as 2 years for SBA and some of the components of the CCI. Nevertheless, these household surveys provide the best available data for this type of analysis and because analyses are based on information from two subsequent surveys, with similar methods in the same countries, the likelihood of the results being affected by bias is low. In addition, because we focused on internal comparisons within 35 countries, changes in questionnaires or other methodological procedures are unlikely to have biased the results. Our analyses confirm the importance of taking equity into account when assessing overall progress in coverage at country level, and to the need for stratified analyses when reporting progress towards the Millennium Development Goals.

Contributors

CGV, AJDB, HA, ZAB, MC, KK, BRK, HN, CR, and JTB are members of the Equity Working Group of the Countdown to 2015: Maternal, Newborn and Child Health initiative. CGV conceived the study and prepared the draft report. AJDB and GAF prepared the databases and did the analyses. All authors participated in discussions about the data sources and planning of analyses and critically revised and approved the report.

Conflicts of interest

We declare that we have no conflicts of interest.

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