Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries

Aluísio J D Barros, Carine Ronsmans, Henrik Axelson, Edilberto Loaiza, Andréa D Bertoldi, Giovanny V A França, Jennifer Bryce, J Ties Boerma, Cesar G Victora

Summary

Background **Countdown to 2015 tracks progress towards achievement of Millennium Development Goals (MDGs) 4 and 5, with particular emphasis on within-country inequalities. We assessed how inequalities in maternal, newborn, and child health interventions vary by intervention and country.**

Methods **We reanalysed data for 12 maternal, newborn, and child health interventions from national surveys done in 54 Countdown countries between Jan 1, 2000, and Dec 31, 2008. We calculated coverage indicators for interventions according to standard definitions, and stratified them by wealth quintiles on the basis of asset indices. We assessed inequalities with two summary indices for absolute inequality and two for relative inequality.**

Findings **Skilled birth attendant coverage was the least equitable intervention, according to all four summary indices, followed by four or more antenatal care visits. The most equitable intervention was early initation of breastfeeding. Chad, Nigeria, Somalia, Ethiopia, Laos, and Niger were the most inequitable countries for the interventions examined, followed by Madagascar, Pakistan, and India. The most equitable countries were Uzbekistan and Kyrgyzstan. Community-based interventions were more equally distributed than those delivered in health facilities. For all interventions, variability in coverage between countries was larger for the poorest than for the richest individuals.**

Interpretation **We noted substantial variations in coverage levels between interventions and countries. The most inequitable interventions should receive attention to ensure that all social groups are reached. Interventions delivered in health facilities need specific strategies to enable the countries' poorest individuals to be reached. The most inequitable countries need additional efforts to reduce the gap between the poorest individuals and those who are more affluent.**

Funding **Bill & Melinda Gates Foundation, Norad, The World Bank.**

Countdown to 2015
Maternal, Newborn & Child Survival

Lancet 2012; 379: 1225–33

See **Comment** page 1178

Postgraduate Program in Epidemiology, Federal University of Pelotas, Pelotas, Brazil (A J D Barros PhD, A D Bertoldi PhD, G V A França MSc, Prof C G Victora PhD); **London School of Hygiene and Tropical Medicine, London, UK** (Prof C Ronsmans DrPH); **Department of Economics, Lund University, Lund, Sweden** (H Axelson MSc); **Partnership for Maternal, Newborn, and Child Health** (H Axelson) **and Department of Measurement and Health Information Systems, WHO, Geneva, Switzerland** (J T Boerma MD); **UNFPA, New York, NY, USA** (E Loaiza PhD); **and Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA** (J Bryce EdD)

Correspondence to:
Dr Aluisio J D Barros, Postgraduate Program in Epidemiology, Federal University of Pelotas, Pelotas 96020-220, Brazil
abarros.epi@gmail.com

Introduction

Countdown to 2015 for maternal, newborn, and child survival was conceived in 2003[1] to track country and global progress towards achievement of Millennium Development Goals (MDGs) 4 (reduce child mortality) and 5 (improve maternal health).[2] Countdown monitors population-based estimates of coverage for effective interventions in 75 countries with high rates or numbers of maternal or child deaths. Data for coverage indicators are obtained from nationally-representative household surveys.[3] Since its inception, Countdown has emphasised the need to address inequities in maternal and child health as a key strategy to improve health and survival.[4] Stratified analyses of key coverage indicators by sex, wealth, maternal education, urban or rural residence, and region of the country have been an essential part of Countdown reports,[3,5,6] country profiles, and publications.[2,7–9]

We report analyses of nationally-representative surveys available for 54 of the 75 Countdown countries. We aimed to identify which of 12 key maternal, newborn, and child health interventions are most inequitably distributed within these countries and which were least likely to be equitable in the delivery of these interventions. Furthermore, we assessed whether inter-country variability in coverage is greater for poor than for richer individuals.

Methods

Data sources

We used data from Demographic Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) done in countries monitored by Countdown to 2015. We selected the latest survey available for each country (as of October, 2010) that included assessments of household wealth and calculations of a standard wealth index, with exclusion of the countries with no survey or with a survey done before 2000. Therefore, we included 54 countries in the analyses, of which 11 had surveys that were done between 2000 and 2004, 33 in 2005 or 2006, and ten in 2007 or 2008. Of the remaining 21 Countdown countries, 15 had not done either survey, four had done a survey before 2000, and two had no data for household assets.

Selection of indicators

We selected a subset of intervention coverage indicators that together represent all stages of the continuum of care

See Online for appendix

for maternal and child health. We aimed to include interventions with high and low coverage, and those delivered via health services, the community, and mass education campaigns (table 1, appendix). Most coverage indicators are dependent on short recall periods and were studied for all children younger than 5 years. For antenatal care, skilled birth attendant, and early of breastfeeding, MICS provided information for children born in the 2 years before the survey and DHS for those born up to 3 years before the survey, even when the survey had data for the 5 years before the survey.

As an overall indicator of intervention coverage we used a weighted mean of the coverage of eight interventions (appendix) selected from four specialties (family planning, maternity care, child immunisation, and case management). Boerma and colleagues[9] proposed this indicator to provide a summary measure of coverage that could be used to assess and report equity in the context of multicountry and time-trend analyses. We refer to this index as the composite coverage index, calculated as:

$$CCI = \frac{1}{4}\left(FPS + \frac{SBA + ANCS}{2} + \frac{2DPT3 + MSL + BCG}{4} + \frac{ORT + CPNM}{2}\right)$$

where FPS is family planning needs satisfied, SBA is skilled birth attendant, ANCS is antenatal care with skilled provider, DPT3 is three doses of Diphtheria, Pertussis, and Tetanus (DPT) vaccine, MSL is measles immunisation, ORT is oral rehydration therapy for children with diarrhoea, and CPNM is care seeking for pneumonia. We assessed the composite coverage index to convey an overall measure for the 12 interventions studied. We included the proportion of children aged 12–23 months who received a dose of BCG vaccine in the index, but did not assess this intervention separately. We calculated all indicators from the original survey data, according to the standard definitions used by Countdown[3] (appendix). For all calculations we took into account the survey design, including sampling weights and clustering. To verify the accuracy of the calculations we checked global results for each indicator and country against published results.

Equity analyses

For the equity analyses, we used the wealth index scores for each household as calculated by the original DHS or MICS survey team.[10] These scores are presented in quintiles, with quintile 1 (Q1) representing the poorest 20% of households in the survey sample and quintile 5 (Q5) representing the richest. We calculated two absolute indicators of inequality (the difference between Q5 and Q1, and the slope index of inequality) and two relative inequality indicators (the ratio of Q5 to Q1, and the concentration index). Because these indicators are proportions, we estimated the slope index of inequality[11] with logistic regression rather than with the traditional linear regression approach to avoid predicting values in the regression model that were outside the interval between 0 and 1. The slope index uses the coverage values in the five quintiles to estimate the absolute difference in percentage points between individuals at the top and bottom of the wealth scale. We calculated the concentration index in its relative formulation, with no corrections.[12] The concentration index is expressed in a scale ranging from –100 to 100; a value of 0 represents perfect equality, whereas positive values indicate that rich individuals have greater coverage than do poor individuals.[12]

Seven countries had no data for family planning needs satisfied. For these countries, we imputed this indicator for each wealth quintile to allow calculation of the composite coverage index. In the five countries with data for contraceptive prevalence, we used Boerma and colleagues'[9] approach in which family planning needs satisfied is estimated from a linear regression model with contraceptive prevalence as the predictor (correlation between family planning needs satisfied and contraceptive prevalence was 0·97). In the other two countries, we imputed family planning needs satisfied from a linear regression model with seven indicators that were available for all countries as predictors (oral rehydration therapy, care seeking for pneumonia, skilled birth attendant, antenatal care with skilled provider, DPT immunisation, measles vaccination, and BCG vaccination, whose correlations with family planning needs satisfied varied from 0·24 to 0·49). To avoid imputation of proportions outside the 0–1 interval, we applied the logit transformation to all variables before fitting the regression models. We then calculated the composite coverage for each wealth quintile and country with the data originally available, plus the imputed values for family planning needs satisfied.

Statistical analysis

We did all analyses with publicly available data from national surveys. Ethics procedures were the responsibility of the institutions that commissioned, funded, or administered the surveys. We used STATA (version 11.2) for all the analyses, taking into account the sampling design characteristics of each survey.

Role of the funding source

The sponsors 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

Table 1 shows the mean values and IQRs for the measures of inequality in all countries for which data were available. We presented the IQR instead of SDs with means because the numbers were small and distributions skewed. Data for coverage of nine of the 12 interventions were available

for all 54 Countdown countries. Data for use of insecticide-treated bednets for the prevention of malaria were available only for countries with endemic malaria; data for four or more antenatal care visits were available for the 37 countries for which the data source was a DHS.

Table 1 and figure 1 show mean values of intervention coverage and summary equity indices for the 54 countries. For eight of the 12 interventions, mean overall coverage was between 40% and 60% (table 1). Children sleeping under an insecticide-treated bednet was the only indicator with a mean coverage of less than 40%, whereas DPT immunisation, measles vaccination, and antenatal care with a skilled provider had coverage of greater than 60% (appendix p 3).

The appendix shows the mean levels of intervention coverage against those of the concentration index

	Number of countries	Overall coverage (%)	Q1 coverage (%)	Q5 coverage (%)	Difference (Q5–Q1; % points)	Slope index of inequality (% points)	Ratio (Q5:Q1)	Concentration index (×100)
Family planning needs satisfied	47	53·6% (33·0–72·0)	41·4% (21·6–60·5)	67·0% (53·3–78·7)	25·6 (13·6–35·0)	30·9 (16·9–42·8)	2·1 (1·2–2·5)	13·6 (4·7–19·8)
Antenatal care with a skilled provider	54	77·9% (71·4–93·2)	65·0% (49·6–83·9)	93·0% (92·2–97·9)	28·0 (12·7–42·6)	33·6 (13·6–50·0)	1·9 (1·2–1·9)	9·3 (2·6–12·0)
Antenatal care (≥4 visits)	37	49·5% (35·6–66·7)	35·9% (15·6–52·1)	70·5% (61·8–81·3)	34·6 (20·8–46·6)	38·7 (24·9–52·1)	3·3 (1·5–3·6)	17·2 (7·5–27·0)
Skilled birth attendant	54	53·6% (39·6–67·4)	32·3% (17·8–43·5)	84·4% (76·8–95·9)	52·2 (39·2–66·1)	58·5 (48·6–73·3)	4·6 (2·1–4·5)	24·3 (13·8–29·6)
Early start of breastfeeding	54	46·4% (35·4–58·9)	45·3% (30·3–57·2)	47·8% (39·7–60·1)	2·6 (–5·1 to 11·8)	3·3 (–3·7 to 12·2)	1·1 (0·9–1·3)	1·5 (–1·7 to 4·7)
Insecticide-treated bednet for children*	30	15·4% (4·1–26·5)	12·6% (2·5–19·7)	19·4% (5·3–30·5)	6·7 (0·0–12·4)	7·8 (–0·1 to 15·7)	3·2 (0·9–4·1)	12·9 (–1·8 to 26·3)
DPT immunisation	54	65·9% (53·5–80·9)	55·4% (35·0–75·2)	78·8% (71·8–91·2)	23·4 (9·8–37·1)	27·5 (11·3–42·1)	1·9 (1·1–2·1)	8·6 (2·0–14·4)
Measles vaccine	54	70·1% (59·9–84·9)	61·3% (48·2–79·8)	81·3% (74·9–90·4)	20·0 (9·1–29·9)	23·7 (10·4–34·7)	1·5 (1·1–1·7)	6·8 (2·3–10·4)
Fully immunised	54	52·2% (37·2–68·4)	43·4% (24·4–62·0)	63·3% (49·7–78·5)	19·9 (8·1–30·5)	23·1 (10·5–32·9)	2·3 (1·1–2·4)	9·8 (2·8–17·0)
Vitamin A	51	51·9% (34·5–68·5)	47·7% (33·7–65·1)	56·7% (37·2–76·0)	9·0 (1·6–19·6)	11·3 (1·9–20·3)	1·4 (1·0–1·4)	4·4 (0·3–8·0)
Oral rehydration therapy	54	40·1% (32·7–46·7)	35·6% (27·2–42·1)	47·3% (37·8–57·3)	11·7 (6·1–17·3)	12·3 (7·2–19·0)	1·4 (1·2–1·5)	5·5 (2·5–8·4)
Care seeking for pneumonia	54	48·0% (37·8–60·6)	41·0% (27·8–52·4)	60·1% (49·4–73·5)	19·1 (12·7–28·1)	22·3 (11·6–34·7)	1·8 (1·3–1·9)	9·8 (4·1–12·9)
Composite coverage index	54	58·5% (50·2–67·4)	47·4% (38·0–56·9)	72·7 (67·0–80·4)	25·3 (19·1–29·9)	30·7 (22·3–36·2)	1·8 (1·3–1·9)	9·5 (5·6–11·9)

Data are mean (IQR). Q1 is the 20% poorest wealth quintile; Q5 is the 20% richest quintile. Q=quintile. *Appendix p 1 specifies age ranges of children.

Table 1: **Magnitude of inequalities by intervention in countries with available information**

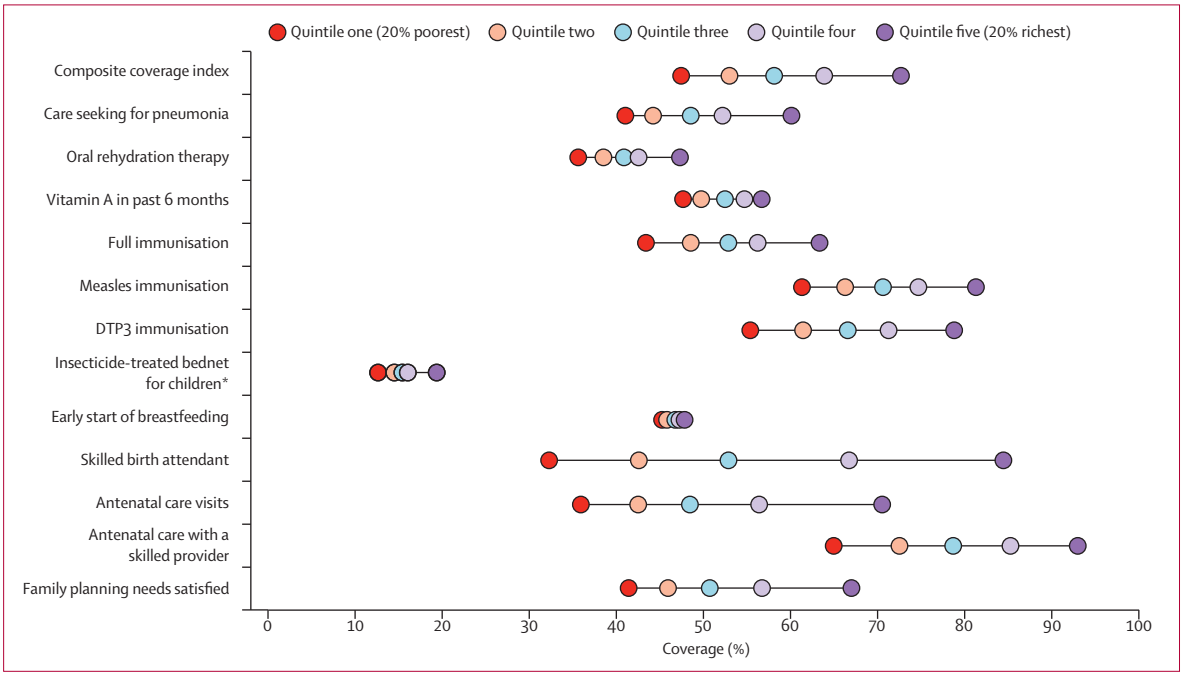

Figure 1: **Mean coverage in each wealth quintile for the studied interventions in 54 Countdown countries**
Coloured dots show the average coverage in each wealth quintile. Q1 is the 20% poorest wealth quintile; Q5 is the 20% richest. The distance between quintiles 1 and 5 represents absolute inequality. *Appendix p 1 specifies age ranges of children.

(relative inequality) and the slope index (absolute inequality). We noted wide variability in inequities for skilled birth attendant and vitamin A coverage despite similar levels of overall coverage (appendix p 3). Coverage of insecticide-treated bednets was the only indicator with substantial variability between the absolute and relative inequality findings.

Coverage of skilled birth attendants was the least equitable of the 12 interventions, according to all four summary indices (table 1). Mean national coverage for the 54 countries was 54%, but the mean coverage in the poorest quintile was only 32%, compared with 84% in the richest quintile (table 1). Antenatal care with a skilled provider had the highest overall coverage of all indicators studied and moderate levels of inequity; whereas, four or more antenatal care visits had much lower coverage and higher inequity (table 1), despite the fact that the indicator does not need a skilled provider. For all four summary indices, four or more antenatal care visits was the second most inequitable indicator, surpassed only by skilled birth attendant (table 1). When the analyses were limited to the 37 countries for which four or more antenatal care visits were available, results for antenatal care with a skilled provider remained unchanged compared with the first set of results (data not shown). Antenatal care with a skilled provider was ranked third of all 12 indicators for absolute inequality (SII and Q5–Q1 difference), but was ranked sixth for relative inequalities (concentration index and Q5:Q1 ratio). Family planning was the third most inequitable intervention. Its overall coverage was similar to that for skilled birth attendant, but its coverage in the wealthiest quintile was modest compared with the other indicators (table 1, figure 1). DPT immunisation and measles vaccination had high coverage and intermediate levels of inequity, which we also noted for full immunisation despite its lower coverage (table 1). Insecticide-treated bednets had a unique combination of very low coverage, high relative inequity, and low absolute inequity (table 1; appendix). The low absolute inequity can be explained by the low mean coverage in the wealthiest quintile; however, very low coverage in the poorest quintile led to high relative inequality, even though

	Skilled birth attendant	Measles immunisation	Composite coverage index
Chad	7	2	1
Nigeria	8	1	2
Somalia	9	3	3
Ethiopia	1	6	4
Laos	2	11	5
Yemen	12	16	6
Madagascar	17	4	7
Mali	6	38	8
Central African Republic	28	18	9
Pakistan	16	7	10
Liberia	29	12	11
Niger	3	8	12
Mauritania	22	42	13
Guinea	11	20	14
Côte d'Ivoire	26	23	15
Cameroon	23	34	16
Guinea Bissau	19	28	17
Haiti	5	30	18
India	20	5	19
Togo	13	22	20
Senegal	15	39	21
Benin	44	19	22
Kenya	18	17	23
Mozambique	24	15	24
Nepal	10	27	25
Democratic Republic of the Congo	47	13	26
Bolivia	30	31	27
Ghana	25	43	28
(Continues in next column)			

	Skilled birth attendant	Measles immunisation	Composite coverage index
(Continued from previous column)			
Gabon	49	10	29
Cambodia	14	32	30
Sierra Leone	36	37	31
Lesotho	35	49	32
Congo (Brazzaville)	48	14	33
Philippines	27	29	34
Morocco	31	33	35
Tanzania	33	21	36
Zimbabwe	38	24	37
Uganda	34	41	38
Burkina Faso	53	36	39
Azerbaijan	51	9	40
Bangladesh	4	35	41
Rwanda	37	48	42
Indonesia	41	26	43
Zambia	21	46	44
Gambia	32	53	45
Vietnam	45	25	46
Peru	40	44	47
Tajikistan	50	40	48
Burundi	39	51	49
Egypt	46	50	50
Swaziland	42	45	51
Malawi	43	47	52
Kyrgyzstan	52	54	53
Uzbekistan	54	52	54

Lower ranks indicate higher inequality.

Table 2: **Country ranking according to the concentration index of selected indicators for 54 Countdown countries**

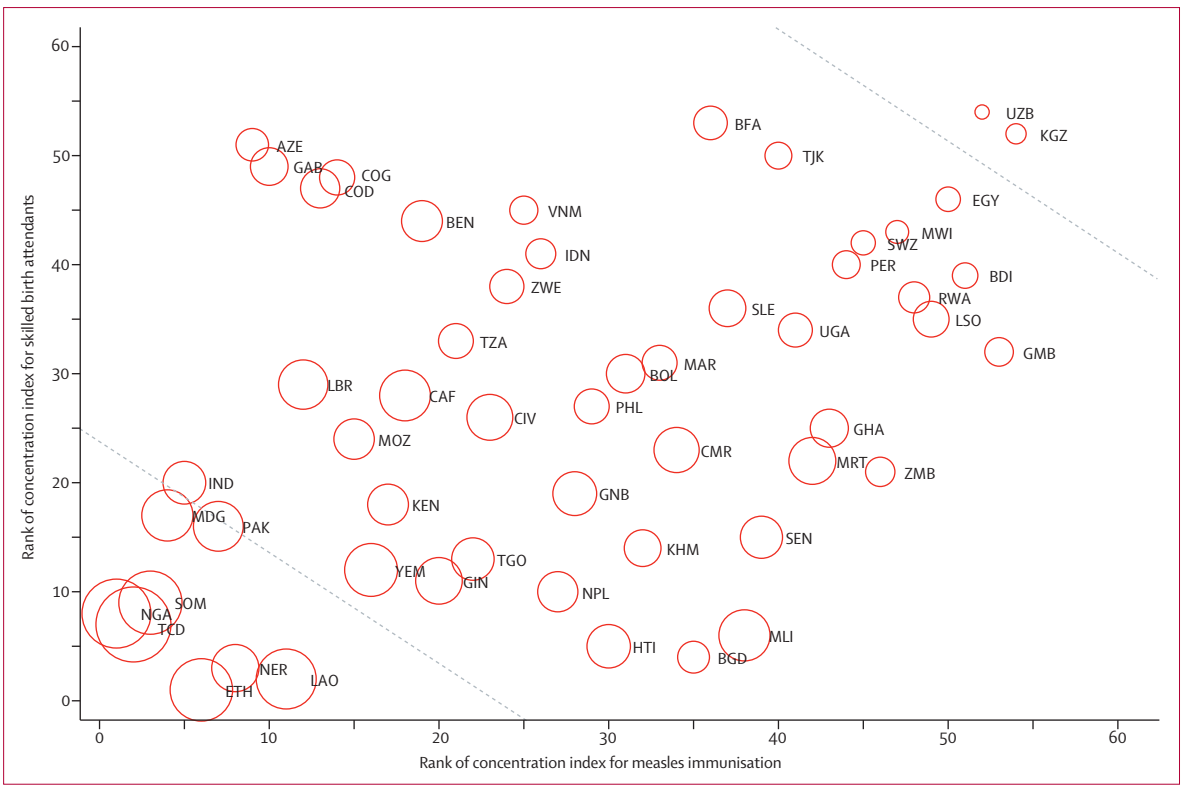

Figure 2: **Scatterplot of country ranks of inequality for skilled birth attendance and measles immunisation**
Circle radii are proportional to the concentration index of the composite coverage index for the 54 countries; large circles indicating more inequality. Country codes are International Organization for Standardization country codes (appendix).

coverage in the richest quintile was also low. Early initiation of breastfeeding was by far the most equitable indicator (table 1). It was the only intervention that, in a few countries, had higher coverage in poor individuals than in rich, as shown by negative values of the concentration and slope indices (table 1). Oral rehydration therapy and vitamin A were fairly equitable, with moderate coverage (table 1).

Because we derived the composite coverage index from several of the indicators, its equity is within the range of values shown in table 1 and figure 1. To assess which countries are least equitable, we compared concentration indices for selected coverage indicators. We used coverage with skilled birth attendant because it is dependent on strong health systems, and because it is the most inequitable of all indicators studied. We used measles immunisation coverage as an example of a moderately equitable indicator, perhaps because it is often delivered through mass campaigns and needs one dose. We also assessed the composite coverage index because it conveys an overall measure for the 12 interventions studied.

Country ranks in inequalities (from high to low) varied according to the coverage measure used (table 2). Spearman rank correlation coefficients between the three indicators were all positive (data not shown), which indicates that greater inequality in one indicator was

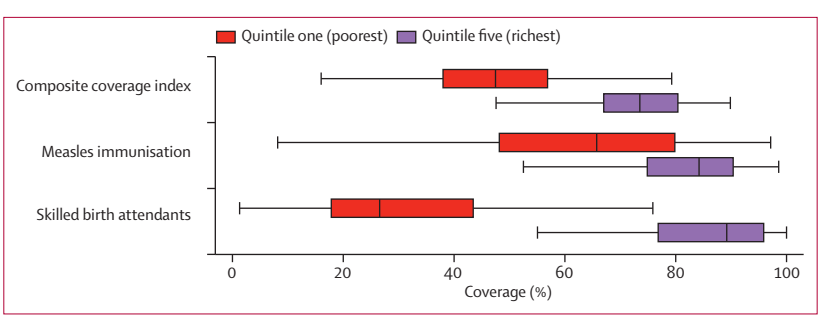

Figure 3: **Box-plots showing intercountry variability in the coverage of selected interventions in the poorest and richest quintiles**
Boxplots do not show extreme or outside values that are detached from the data distribution shown by the whisker lines.

associated with greater inequality in all others. The lowest correlation was 0·42 (skilled birth attendant *vs* measles vaccination), followed by 0·72 (composite coverage index *vs* measles vaccination), and 0·75 (composite coverage index *vs* skilled birth attendant). Nevertheless, we noted some consistent patterns when we used the information about the three indicators simultaneously. Chad, Nigeria, Somalia, Ethiopia, Laos, and Niger were clearly the countries with the largest inequalities, closely followed by Madagascar, Pakistan, and India (figure 2). We noted the smallest inequalities for Uzbekistan and Kyrgyzstan

(figure 2). Country rankings were very similar when we used the slope index of inequality instead of the concentration index, except for countries with very low coverage in the poorest individuals (eg, Somalia, Niger, Chad, and Ethiopia), which were more equal according to the slope index than the concentration index (data not shown). We investigated whether intervention coverage showed greater variability in mothers and children from the poorest quintile than in those from the wealthiest quintile each of the 54 countries. In figure 3, box plots show between-country variability in coverage for skilled birth attendant, measles vaccine, and composite coverage index in Q1 and Q5. As expected, median values for variability between countries in coverage for skilled birth attendant, measles vaccine, and composite coverage index were higher for the richest (Q5) than for the poorest (Q1) quintile, but the variability in Q5 was substantially lower than that in Q1 (figure 3).This finding is shown by the wider IQRs in Q1 compared with Q5, and by the wider amplitudes of the whisker lines. Findings for measles vaccine are the most remarkable, with Q1 amplitude covering almost all variation in Q5, which implies that measles coverage for Q1 in some countries is far higher than for Q5 in others (appendix shows findings for individual countries). After ranking of countries according to Q5 coverage, those with similar levels of Q5 coverage often had very different levels of Q1 coverage (appendix).

With some exceptions (eg, skilled birth attendant in Burkina Faso and measles in Tajikistan), we noted monotonic increases in coverage with wealth quintiles (appendix pp 4–6). Inequalities in skilled birth attendant coverage were much greater than were disparities in measles immunisation (appendix pp 4–6). Inequalities in the composite coverage index were between these two indicators (appendix pp 4–6), which was expected because it represents an average of indicators of maternal and child health.

Discussion

We have described inequalities in intervention coverage. These inequalities seem to be unfair and avoidable, and therefore represent inequities.[13] Our first objective was to compare how different coverage indicators perform in terms of equity. Our findings show that interventions with similar levels of overall coverage often have very different degrees of inequality. The most inequitable indicator was skilled birth attendant, followed by four or more antenatal care visits, whereas the most equitable was early initiation of breastfeeding. These analyses confirm previous findings that, unlike in high-income countries, in many low-income countries, breastfeeding is more prevalent in poor than in rich individuals.[3,14–16] Notably, despite low overall coverage, inequalities are small.

Interventions that are usually delivered in fixed health facilities, particularly those that need constant access to secondary-level or tertiary-level care, tend to be the most inequitably distributed in the population.[3,17] Furthermore, the organisation and location of health facilities affects equity[18] (eg, skilled birth attendant and four or more antenatal care visits). Interventions that are often delivered at community level (eg, vaccinations or vitamin A supplementation) tend to be much more equitable than are those delivered in health facilities. Cost might also be a factor. Some interventions are usually provided free of charge, such as vaccinations and vitamin A, but others might need out-of-pocket spending by families, either for services or because families need to travel to a health facility. For example, in Uzbekistan, Kyrgyztstan, and Brazil,[19] where maternity hospitals are accessible and free of charge, coverage for skilled birth attendant is almost universal. Cultural perceptions might affect care-seeking patterns and the choice of whether to adopt specific interventions, such as contraceptives or breastfeeding, despite counselling or information campaigns.

Countries with similar levels of overall coverage often had very different results for equity. Systematic analyses of the reasons for success in equitable countries are important to understand their achievements and to transfer their experiences to other countries with greater inequities. Several promising approaches have been identified to improve equity, including deployment of services and health workers in the areas most in need, task shifting, reductions in financial barriers to access to services, and conditional cash transfers (panel).[18,22–24]

The choice of indicator is important when inequalities are assessed—eg, antenatal care with a skilled provider and four or more antenatal care visits had different levels of coverage and magnitude of inequalities. Aggregated coverage measures, such as the composite coverage index, might mask the different patterns of coverage and inequality noted for single-intervention coverage indicators. However, these indicators are less affected by sampling variability and allow for a more simple comparison of countries than would be possible if several indicators were used. The indicators used should be appropriate for the questions being addressed; aggregate measures could be useful for some purposes, such as global monitoring, but are less helpful in guiding policy and programme decisions at country level than are single indicators.

We compared the magnitude of inequalities across the 54 countries at the time of the latest survey. Our findings show a clear pattern with five highly inequitable counties in the northern half of sub-Saharan Africa: Nigeria, Niger, Chad, Ethiopia, and Somalia. Additionally, Madagascar, Laos, India, and Pakistan were similarly inequitable. The most equitable countries were Uzbekistan, Kyrgyzstan, Egypt, Malawi, Swaziland, and Tajikistan. Because country rankings varied according to each coverage indicator used, and to whether we used relative or absolute measures of inequality, these results should be interpreted with caution.

Variability between countries was substantially greater in individuals in the poorest quintile than in those in the

richest, which suggests that irrespective of how poor a country is, those in the richest quintile have the means to ensure fairly high coverage levels to mothers and children. Many individuals in the richest quintile of most countries live in urban areas, which could partly explain why they have increased access to the interventions. How much of these differences are attributable to area of residence or region is an issue that we will assess in future publications. Our findings add to those of previous analyses of survey data from Countdown countries.[9] Comparisons of survey results from several countries might be affected by methodological differences—eg, although both MICS and DHS are standardised across countries, DHS achieve a higher level of standardisation. Furthermore, some discrepancies exist between the two sets of surveys—eg, variables related to pregnancy and delivery are reported for children born in the past 2 years for MICS, and the past 3 years for DHS. We used the most recent survey for which the dataset was publicly available by October 2010, but questions about the quality of some surveys remain. For example, socioeconomic variation in skilled birth attendant coverage in Burkina Faso was unexpectedly small in the 2006 MICS (slope index of inequality equal to 2·3 percent points; appendix), but the same index was much wider in the 2003 DHS (equal to 63·2 percent points).

Although the assessment of socioeconomic position on the basis of asset indices might be affected by the choice of assets and poor comparability between urban and rural areas,[25,26] such indices are easy to compute and compare well with more complex indicators of wealth.[27–29] The usefulness of asset indices for discrimination of different subpopulations is evident by their strong association with most coverage indicators. However, wealth quintiles are specific to a given country, and the poorest quintile in a middle-income country might be wealthier than the third or fourth quintile in an extremely poor country. Furthermore, irrespective of the actual magnitude of intracountry differences in wealth between rich and poor individuals, all samples will be represented as five groups with about 20% of all households each. Despite these limitations, use of asset indices allows the systematic comparison of inequalities in health that would not be possible with other measures of socioeconomic position. The coverage indicators that we used in the analyses are based on maternal recall, and further work is being done to assess and improve their validity. In addition to non-differential recall, which could dilute any existing associations, some indicators might be affected by differential reporting by rich and poor mothers, thus leading to bias.

Another potential source of bias is that surveys were done over 8 years and secular changes in inequalities might have occurred. However, the correlation between the year of the survey and the concentration indices for the three main coverage indicators (composite coverage index, skilled birth attendants, and measles vaccine) were all between 0·1 and –0·1. Additionally, we noted no significant associations between the type of survey and these three concentration indices (data not shown). A potential caveat of the composite coverage index is its reliance on arbitrary weights, giving equal weights to four domains (family planning, pregnancy and delivery care, immunisations, and case management of childhood illness). However, when we included these eight separate indicators in a principal components analysis (appendix), the first component shows a correlation coefficient of 0·95 with the composite

Panel: Research in context

Systematic review

Our findings add to international comparisons of intracountry inequalities in child health and nutrition published in the past decade,[4,20,21] and to those from a systematic review on this topic.[23] Studies published between Jan 1, 1990, and Dec 31, 2010, were identified with PubMed 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

Previous publications did not include the most recent surveys done in low-income and middle-income countries, or provide systematic analyses of which countries have the highest inequalities or which interventions are most inequitably distributed.

With new analyses of recently available Demographic and Health Surveys and Multiple Indicator Cluster Surveys, we showed that delivery by a skilled birth attendant and antenatal care visits (more than four) had the greatest socioeconomic inequalities. We identified which countries of those with existing data had the widest inequalities. We related the degree of inequality to the delivery of interventions, thus identifying those traditionally provided by health facilities as the most inequitable compared with those delivered by outreach or mass campaigns. Intercountry variability in intervention coverage is much greater for the poorest wealth quintile in each country than for the richest, which suggests that even in the poorest countries, wealthier individuals have mechanisms for gaining access to lifesaving interventions.

Immediate implications of our results include the need to give special attention, nationally, regionally, and internationally, to the most inequitable interventions. Community-based interventions were generally more equally distributed than were service-based interventions, which indicates that additional efforts are needed to reach the poorest individuals with such interventions. The most inequitable Countdown countries need renewed efforts from the international community.

coverage index, suggested that the arbitrary weights did not affect the resulting index.

We make a clear distinction between absolute and relative inequality, because the choice of indicators might affect the interpretation of findings.[30–32] In several situations, especially when change in inequalities are assessed, absolute and relative indicators might lead to conflicting findings. Furthermore, the indices showing the difference and ratio of coverage levels in Q1 and Q5 are simple measures that are easy to understand. However, the concentration index and the slope index of inequality are more complex, but account for the whole distribution, rather than only the richest and poorest quintiles. We therefore used all four indices, but with emphasis on relative inequality with the concentration index.

Concern about inequalities in maternal and child health in poor countries was conspicuously absent from the global agenda in the past,[4] but has gained increased attention. UNICEF[33] and the Commission on Information and Accountability for Women's and Children's Health now emphasise equity as a priority.[34] At the same time, the increase in the number of available surveys in low-income and middle-income countries[3] allows for international comparisons that were not feasible only a few years ago. Countdown to 2015 is producing continuous analyses of national surveys to monitor inequalities in coverage of cost-effective interventions, and providing regular feedback to policy makers and health managers at country level. Because health services often contribute to aggravation of health inequalities in[35] mainstreaming of equity considerations into health policies and programmes can contribute to the achievement of national and international health goals.

Contributors

All authors participated in discussions about the data sources and planning of analyses, and have critically revised versions of the report. AJB and CGV conceived the study, did the analyses, and prepared the draft report. All authors have seen and approved the revised version of this report.

Conflicts of interest

We declare that we have no conflicts of interest.

Acknowledgments

The study was funded by the Bill & Melinda Gates Foundation, Norad, and the World Bank.

References

1 The Bellagio Study Group on Child Survival. Knowledge into action for child survival. *Lancet* 2003; **362:** 323–27.

2 Bhutta ZA, Chopra M, Axelson H, et al. Countdown to 2015 decade report (2000–10): taking stock of maternal, newborn, and child survival. *Lancet* 2010; **375:** 2032–44.

3 Countdown to 2015. Tracking progress in maternal, newborn and child health. 2010 report. http://www.countdown2015mnch.org/reports-publications/2010-report/2010-report-downloads (accessed Nov 17, 2011).

4 Victora CG, Wagstaff A, Schellenberg JA, Gwatkin D, Claeson M, Habicht J-P. Applying an equity lens to child health and mortality: more of the same is not enough. *Lancet* 2003; **362:** 233–41.

5 Countdown to 2015. Maternal, newborn, and child survival. 2008 report. http://www.countdown2015mnch.org/reports-publications/2008report/2008reportdownloads (accessed Nov 17, 2011).

6 Countdown to 2015. Maternal, newborn, and child survival. 2005 report. http://www.countdown2015mnch.org/reports-publications/2005report/2005reportdownloads (accessed Nov 17, 2011).

7 Bryce J, Victora CG. Child survival: countdown to 2015. *Lancet* 2005; **365:** 2153–54.

8 Bryce J, Terreri N, Victora CG, et al. Countdown to 2015: tracking intervention coverage for child survival. *Lancet* 2006; **368:** 1067–76.

9 Boerma JT, Bryce J, Kinfu Y, Axelson H, Victora CG. Mind the gap: equity and trends in coverage of maternal, newborn, and child health services in 54 Countdown countries. *Lancet* 2008; **371:** 1259–67.

10 Rutstein SO, Johnson K. DHS comparative reports No 6: the DHS wealth index. August, 2004. http://www.childinfo.org/files/DHS_Wealth_Index_(DHS_Comparative_Reports).pdf (accessed Nov 17, 2011).

11 Mackenbach JP, Kunst AE. Measuring the magnitude of socio-economic inequalities in health: an overview of available measures illustrated with two examples from Europe. *Soc Sci Med* 1997; **44:** 757–71.

12 Kakwani N, Wagstaff A, van Doorslaer E. Socioeconomic inequalities in health: measurement, computation and statistical inference. *J Econ* 1997; **77:** 87–103.

13 Whitehead M. The concepts and principles of equity and health. *Int J Health Serv* 1992; **22:** 429–45.

14 Trussel J, Grummer-Strawn L, Rodriguez G, Vanlandingham M. Trends and differentials in breastfeeding behaviour: evidence from the WFS and DHS. *Popul Stud* 1992; **46:** 285–307.

15 Barros FC, Victora CG, Scherpbier R, Gwatkin D. Socioeconomic inequities in the health and nutrition of children in low/middle income countries. *Rev Saude Publica* 2010; **44:** 1–16.

16 Li R, Grummer-Strawn L. Racial and ethnic disparities in breastfeeding among United States infants: Third National Health and Nutrition Examination Survey, 1988–1994. *Birth* 2002; **29:** 251–57.

17 Houweling TA, Ronsmans C, Campbell OM, Kunst AE. Huge poor-rich inequalities in maternity care: an international comparative study of maternity and child care in developing countries. *Bull World Health Organ* 2007; **85:** 745–54.

18 Barros AJD, Victora CG, Cesar JA, Neumann NA, Bertoldi AD. Brazil: are health and nutrition programs reaching the neediest? In: Gwatkin DR, Wagstaff A, Yazbeck AS, eds. Reaching the poor with health, nutrition, and population services: what works, what doesn't, and why. Washington, DC: World Bank, 2005: 281–306.

19 Barros AJ, Santos IS, Bertoldi AD. Can mothers rely on the Brazilian health system for their deliveries? An assessment of use of the public system and out-of-pocket expenditure in the 2004 Pelotas Birth Cohort Study, Brazil. *BMC Health Serv Res* 2008; **8:** 57.

20 Boerma JT, Bryce J, Kinfu Y, Axelson H, Victora CG. Mind the gap: equity and trends in coverage of maternal, newborn, and child health services in 54 Countdown countries. *Lancet* 2008; **371:** 1259–67.

21 Gwatkin DR, Rutstein S, Johnson K, Suliman E, Wagstaff A, Amozou A. Socio-economic differences in health, nutrition, and population within developing countries: an overview. Sept, 2007. http://siteresources.worldbank.org/INTPAH/Resources/IndicatorsOverview.pdf (accessed Nov 17, 2011).

22 Hosseinpoor AR, Victora CG, Bergen N, Barros AJ, Boerma T. Towards universal health coverage: the role of within-country wealth-related inequality in 28 countries in sub-Saharan Africa. *Bull World Health Organ* 2011; **89:** 881–90.

23 Barros FC, Victora C, Scherpbier R, Gwatkin D. Health and nutrition of children: equity and social determinants. In: Blas E, Kurup AS, eds. Equity, social determinants, and public health programmes. Geneva, Switzerland: World Health Organization, 2010: 49–76.

24 Lagarde M, Haines A, Palmer N. Conditional cash transfers for improving uptake of health interventions in low- and middle-income countries: a systematic review. *JAMA* 2007; **298:** 1900–10.

25 Morris SS, Carletto C, Hoddinott J, Christiaensen LJM. Validity of rapid estimates of household wealth and income for health surveys in rural Africa. *J Epidemiol Community Health* 2000; **54:** 381–87.

26 Houweling TA, Kunst AE, Mackenbach JP. Measuring health inequality among children in developing countries: does the choice of the indicator of economic status matter? *Int J Equity Health* 2003; **2:** 8.

27 Howe LD, Hargreaves JR, Huttly SR. Issues in the construction of wealth indices for the measurement of socio-economic position in low-income countries. *Emerg Themes Epidemiol* 2008; **5:** 3.

28 Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—or tears: an application to educational enrollments in states of India. *Demography* 2001; **38:** 115–32.

29 Filmer D, Scott K. Assessing asset indices. *Demography* 2012; **49:** 359–92.

30 Houweling TA, Kunst AE, Huisman M, Mackenbach JP. Using relative and absolute measures for monitoring health inequalities: experiences from cross-national analyses on maternal and child health. *Int J Equity Health* 2007; **6:** 15.

31 Moser K, Frost C, Leon DA. Comparing health inequalities across time and place—rate ratios and rate differences lead to different conclusions: analysis of cross-sectional data from 22 countries 1991–2001. *Int J Epidemiol* 2007; **36:** 1285–91.

32 Harper S, King NB, Meersman SC, Reichman ME, Breen N, Lynch J. Implicit value judgments in the measurement of health inequalities. *Milbank Q* **88:** 4–29.

33 UNICEF. Progress for children 2010: achieving the MDGs with equity. Sept, 2010. http://www.unicef.org/protection/Progress_for_Children-No.9_EN_081710.pdf (accessed Nov 17, 2011).

34 Commission on information and accountability for Women's and Children's Health. Keeping promises, measuring results. Final report of the Commission. 2011. http://www.who.int/topics/millennium_development_goals/accountability_commission/Commission_Report_advance_copy.pdf (accessed Nov 17, 2011).

35 Barros FC, Victora CG, Scherpbier R, Gwatkin D. Socioeconomic inequities in the health and nutrition of children in low/middle income countries. *Rev Saude Publica* 2010; **44:** 1–16.