The Inverse Equity Hypothesis: Analyses of Institutional Deliveries in 286 National Surveys

Cesar Gomes Victora, MD, Gary Joseph, PhD, Inacio C. M. Silva, PhD, Fatima S. Maia, PhD, J. Patrick Vaughan, MD, CBE, Fernando C. Barros, MD, and Aluisio J. D. Barros, MD

Objectives. To test the inverse equity hypothesis, which postulates that new health interventions are initially adopted by the wealthy and thus increase inequalities—as population coverage increases, only the poorest will lag behind all other groups.

Methods. We analyzed the proportion of births occurring in a health facility by wealth quintile in 286 surveys from 89 low- and middle-income countries (1993–2015) and developed an inequality pattern index. Positive values indicate that inequality is driven by early adoption by the wealthy (top inequality), whereas negative values signal bottom inequality.

Results. Absolute inequalities were widest when national coverage was around 50%. At low national coverage levels, top inequality was evident with coverage in the wealthiest quintile taking off rapidly; at 60% or higher national coverage, bottom inequality became the predominant pattern, with the poorest quintile lagging behind.

Conclusions. Policies need to be tailored to inequality patterns. When top inequalities are present, barriers that limit uptake by most of the population must be identified and addressed. When bottom inequalities exist, interventions must be targeted at specific subgroups that are left behind. (*Am J Public Health.* 2018;108:464–471. doi:10.2105/AJPH.2017.304277)

Tudor Hart's inverse care law, enunciated in 1979, stated that availability of good medical care tends to vary inversely with the need for it in the population served.[1] In 2000, the authors of a *Lancet* article proposed a corollary to this law: the inverse equity hypothesis,[2] which stated that newly introduced health interventions would be initially adopted by the wealthier segments of a population, who likely had the least need for such interventions. They suggested that absolute health inequalities would therefore increase in the short term and would only decline as the intervention gradually reaches the most deprived sectors of the population, by which time coverage among the most privileged sectors was already close to 100%.

In 2005, the same authors elaborated on the hypothesis[3] and referred to top inequality as the early adoption pattern[4] in which the wealthy picked up the service and showed substantially higher coverage than the rest of the population, and to bottom inequality as the late pattern when high coverage was reached by most groups, except for the poorest who were still lagging behind. Independently, the 2005 World Health Report[5] described similar patterns, referring to top inequality as "mass deprivation" and to bottom inequality as "marginal exclusion." We avoid the expression mass deprivation because, as we will demonstrate, the top inequality pattern may include relatively high coverage among the wealthiest, who therefore cannot be regarded as deprived.

The *Lancet* article received 347 citations so far in the Scopus database (https://www.scopus.com) and more than 650 in Google Scholar (https://goo.gl/OHYPUo) up to September 22, 2017. We were able to obtain copies of 329 of the Scopus citations, of which 191 cited the article without testing the hypothesis, and 138 tested it with their own data: according to the authors, 90 studies (72%) supported and 31 (28%) rejected the hypothesis. Studies that supported the hypothesis addressed many different outcomes including breast and cervical cancer screening,[6] blood pressure monitoring,[7] child immunization,[8] dental caries prevention,[9] management of coronary heart disease,[10] HIV/AIDS screening and treatment,[11,12] insecticide-treated nets,[13] and smoking cessation.[14] Of particular interest are articles in which the outcomes were based on attitudes related to the perceived benefits or harms associated with certain interventions, even when these were not evidence-based. For example, the authors of articles on cesarean deliveries without medical indication[15,16] and on refusal to vaccinate children in the United Kingdom[17,18] quoted the inverse equity hypothesis to explain why these behaviors were initially adopted by the better-off within a population.

Most authors who failed to detect the sequence of events postulated by the hypothesis were describing the impact of programs that were specifically designed to reduce inequalities. Examples include voucher schemes for maternal services in Bangladesh[19] and Korea,[20] community-wide vitamin A treatment of children in Nepal,[21] improving poor women's access to

ABOUT THE AUTHORS

Cesar Gomes Victora, Gary Joseph, Inacio C. M. Silva, and Aluisio J. D. Barros are with the International Center for Equity in Health, Federal University of Pelotas, Pelotas, Brazil. Fatima S. Maia is with the Federal University of Rio Grande (FURG), Rio Grande, Brazil. J. Patrick Vaughan is with the Health Policy Unit, London School of Hygiene and Tropical Medicine, London, United Kingdom. Fernando C. Barros is with Post Graduate Course in Health and Behavior, Catholic University of Pelotas, Pelotas.

Correspondence should be sent to Cesar Gomes Victora, MD, Rua Marechal Deodoro, 1160, Pelotas/RS Brazil 96020220 (e-mail: cvictora@gmail.com). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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institutional delivery in Burkina Faso,[22] equity-focused maternal and child health programs in Cambodia,[23] and free access to antiretroviral treatment for HIV in Brazil.[24]

Growing availability of data from low- and middle-income countries allowed us to test the hypothesis in national surveys that provided information on socioeconomic position and on the proportion of births occurring in a health facility (institutional delivery coverage). We chose this outcome because it is measured in many surveys with high validity,[25] usually presenting marked socioeconomic gradients,[26,27] and because delivery by a skilled attendant in a health facility is a key intervention to reduce maternal and newborn mortality.[28,29]

METHODS

For this study, we used data from publicly available national demographic and health surveys carried out since 1993 that collected information on household wealth as well as on institutional deliveries. These included Demographic Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), and Reproductive Health Surveys (RHS). The surveys rely on multistage cluster sampling designs to obtain nationally representative samples of households. Standardized questionnaires were answered by women aged 15 to 49 years living in the sampled households. The 3 survey initiatives are closely coordinated and apply similar if not identical questions to the respondents. Data on births refer to those occurring up to 2 years before the survey for MICS and 3 years for DHS and RHS.

The survey data sets included wealth scores derived from characteristics of the dwelling and ownership of household assets such as a television, refrigerator, and vehicles, among others. These variables were generally similar across countries and survey types, but there was some flexibility for national teams to add locally relevant assets such as ownership of land and livestock in rural areas. Principal component analysis was used to construct a continuous wealth index,[30–32] which was then divided into quintiles, ranked from Q1 (poorest) to Q5 (wealthiest).

The outcome studied was the coverage of institutional deliveries, defined as those occurring in a health facility either in the private or public sector, regardless of which type of health worker attended the birth. We repeated all analyses for coverage with skilled birth attendants (either in an institution or at home) who include doctors, nurses, midwifes, and other recognized cadres at the national level, such as auxiliary midwifes, auxiliary nurses, family welfare visitors, or community health officers. An auxiliary nurse and auxiliary midwife are defined as someone who assists in the provision of care during childbirth; they possess some of the midwifery competencies but are not fully qualified as midwives.[33] A limitation of the skilled attendance indicator is that some mothers may be unable to discriminate whether the birth attendant was skilled.[34,35] We were unable to locate studies that directly validated the institutional delivery indicator. However, in a study from Mozambique with observation of obstetric care in facilities followed by a questionnaire applied at home 8 to 10 months later, the indicator with the highest validity (sensitivity and specificity around 80%) was whether the woman had delivered in a hospital versus a health center.[25] It is reasonable to expect that, if women can discriminate well between different types of facilities, information on whether the delivery took place on any institution or in the home would have even higher validity. Information on skilled birth attendants was available in a smaller number of surveys, and results were virtually identical to those for coverage with institutional deliveries as expected because of the high correlation between the 2 indicators (Pearson's $r = 0.956$; $P < .001$).[27] These results are available upon request.

Data used in this study have been anonymized to ensure the confidentiality of respondents. Ethical approval was obtained from the institutions in charge of each survey. More details on DHS, MICS, and RHS can be found elsewhere.[36–38]

The surveys used in the analyses included 3 types of questionnaires (household, women, and children), each resulting in a data set or file. The DHS data were extracted from the women's data set and for MICS and RHS from the children's data set. We matched these data to the household file that contains the wealth score, when necessary. Participants were women aged 15 to 49 years with at least 1 live birth in the past 2 years (MICS) or in the past 3 years (DHS and RHS). For MICS, information was collected only for the last birth, and for DHS and RHS it was collected for all births within the window of time.

We used descriptive analyses, including frequencies, means, and medians, to estimate coverage of institutional deliveries for national populations and wealth quintile groups. We report on absolute (describing the differences in coverage between rich and poor) and relative (describing the ratio between coverage in the rich and in the poor) inequalities. The summary measure for absolute differences is the slope index of inequality, which considers the whole distribution of the coverage outcome over the 5 wealth quintiles by using a regression approach. It is expressed as the difference in percentage points between the fitted coverage levels at the 2 extremes of the wealth distribution—that is, the B parameter of the regression equation.[39,40] For relative inequalities, we calculated the concentration index expressed on a scale from −1 to 1, in which the value of zero corresponds to perfect equality and positive values express prorich relative inequalities.[39,40] This index is similar to the Gini index that is often used to describe the concentration of income.

Neither of these 2 summary indices describes which wealth quintiles are driving the observed inequalities. To express whether inequality was mostly attributable to coverage in the richest quintile being markedly higher than coverage in the other 4 quintiles (top inequality) or whether it was mostly attributable to the poorest quintile lagging behind the other 4 quintiles (bottom inequality), we created a variable by using the following formula:

(1) Inequality pattern index

$$= (C_{Q5} - C_n) - (C_n - C_{Q1})$$
$$= C_{Q1} + C_{Q5} - 2C_n$$

in which C_n represents national coverage, C_{Q1} represents coverage in the poorest quintile, and C_{Q5} represents coverage in the wealthiest quintile. Positive values represent greater gaps between the richer end of the wealth scale and the national level (top inequality), whereas negative values indicate larger differences between the poorer end of the wealth scale and the national level (bottom inequality). The index is expressed in

percentage points. The differences between the 2 patterns of inequality will become evident in the Results section.

We examined how the slope, concentration, and inequality pattern indices varied according to national coverage, derived curves for expressing these relationships, and calculated the R^2 values for the proportion of variance explained by these curves. We used 2017 data from the World Bank to classify surveys according to national income groups.[41]

We carried out all analyses with Stata software release 13 (StataCorp LP, College Station, TX) and Microsoft Excel 2013 (Microsoft Corp, Redmond, WA), taking into account the sampling design, stratification, and weights of each survey.

RESULTS

We initially analyzed data from 329 surveys (206 DHS, 100 MICS, and 23 RHS) from 111 low- and middle-income countries, carried out since 1993, with information on institutional delivery and wealth scores; 28 countries had 1 survey, 25 had 2, 19 had 3, 18 had 4, and 21 had 5 or more surveys. The median number of deliveries with available information was 5092 (range = 98–51 555) per survey, totaling 2 067 616 deliveries.

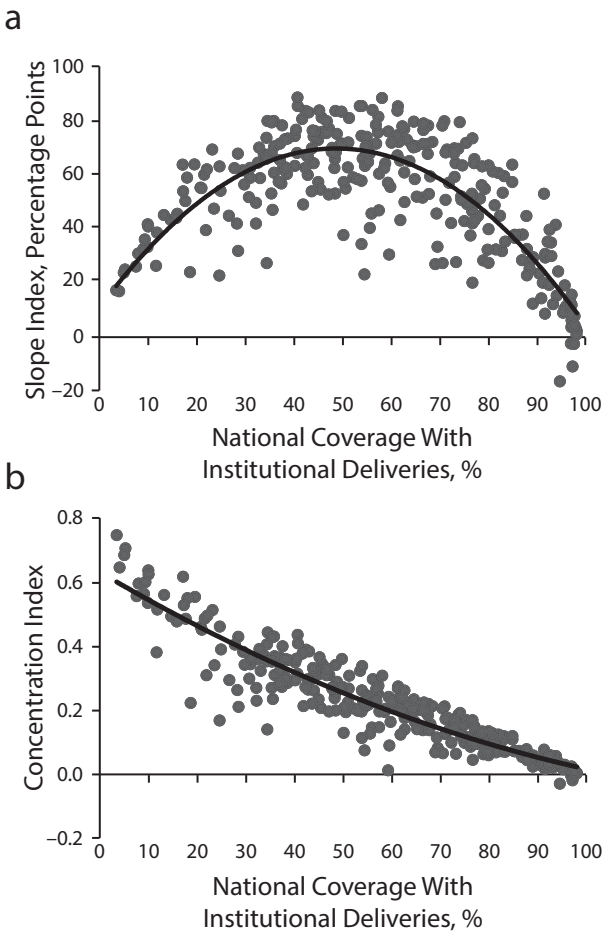
For all surveys under study, national coverage with institutional deliveries ranged from 3.5% (Bangladesh, 1993) to more than 99% in 19 surveys (mostly from Eastern Europe, Central Asia, and the Caribbean), with a mean of 63.4% (SD = 27.0) and a median of 64.2%. Forty-three of the 329 surveys (13.1%) had national coverage levels of 98% or greater for institutional delivery and differences between the quintiles were small. We excluded these surveys from the analyses.

Of the remaining 286 surveys from 89 countries, 240 (83.9%) from 73 countries showed stepwise, or monotonic increases in institutional delivery coverage by quintile. Only 4 (1.4%) surveys (from Albania, Dominican Republic, Serbia, and Trinidad and Tobago) had higher coverage in the poorest than in the wealthiest quintiles; national coverage was greater than 95% in all of these.

Important inequalities were present in most countries, with mean values of 51.7 percentage points for the slope index and 0.222 for the concentration index, both showing prorich inequality (Table A, available as supplement to the online version of this article at http://www.ajph.org). The mean value of the inequality pattern index was 5.9 percentage points with a standard deviation of 11.9, thus showing substantial variability.

The slope index of inequality showed a distinctive pattern when plotted against the national population coverage, with lower values at very low or very high coverage (Figure 1). The index, a measure of absolute inequality expressed in percentage points, tended to increase as national coverage increased and to decrease after national coverage reached 50% or higher as shown in Figure 1. This relationship follows a parabola with an R^2 of 0.680. By contrast, the relative inequality measure (the concentration index, ranging from −1 to 1) showed an inverse association with national coverage (Figure 1), which followed a second-order polynomial with an R^2 of 0.861. Figure A (available as a supplement to the online version of this article at http://www.ajph.org) shows the same analyses for the most recent survey in each country.

Figure 2 shows the average coverage by wealth quintile groups, according to 4 categories of national coverage. For surveys in which national coverage was less than 40%, the average values ranged from 9.4% in the poorest quintile to 59.5% in the richest quintile, and the latter had considerably higher mean coverage than other groups (top inequality). By contrast, among the group of countries with national coverage of 80% or



Note. Equations: slope index = $10.7 + 2.45C_n - 0.025C_n^2$ and concentration index = $0.625 - 0.0088C_n + 0.00003C_n^2$, where C_n is the national coverage level.

FIGURE 1—National Coverage With Institutional Deliveries by (a) Slope Index of Inequality and (b) Concentration Index: 286 Surveys in 89 Countries, 1993–2015

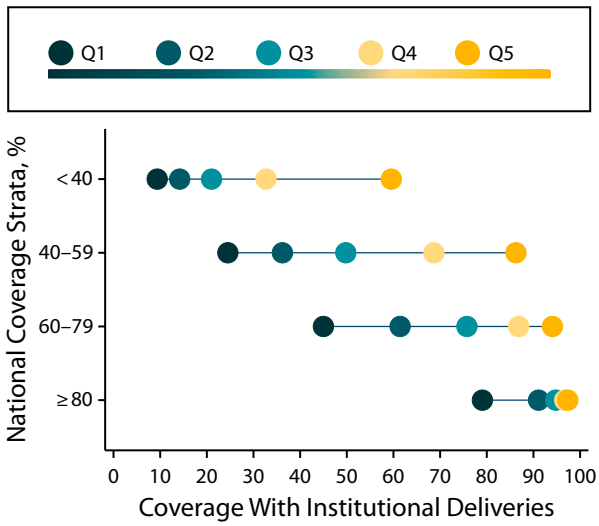


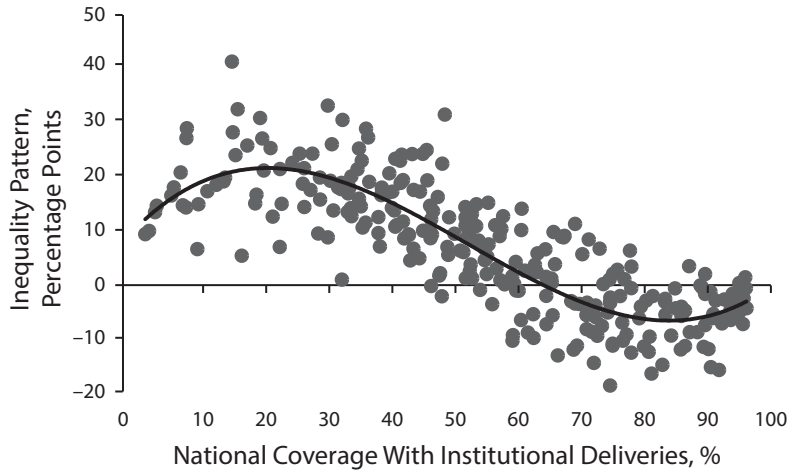
FIGURE 2—Average Coverage With Institutional Deliveries by Wealth Quintile, According to Strata of National Coverage: 286 Surveys in 89 Countries, 1993–2015

higher, the mean gap between the poorest and richest quintiles was much narrower, with only the poorest quintile having mean national coverage less than 80% and the rest tending to have 90% or higher coverage (bottom inequality).

Table A shows the mean levels of coverage and of summary indices by World Bank country income groupings. Coverage in all quintiles, particularly the poorest, increased with country income. Absolute and relative inequalities were also reduced as income increased. The inequality pattern index was positive (top inequality) in the low- and lower-middle–income country groups and negative in the upper-middle–income group. Results for the most recent survey in each country show similar patterns (Table B, available as a supplement to the online version of this article at http://www.ajph.org).

These results are confirmed by Figure 3, in which positive values reflect top inequality; this is observed when national coverage lies between 10% and 55%, with a peak at around 20% coverage. At higher coverage levels, bottom inequality becomes evident, with the gap among the richest quintiles closing and the poorest quintile lagging behind (Figure 3). As expected, when national coverage is close to 0% or 100%, there is little inequality. When absolute inequalities (Figure 1a) are widest, coverage in the 5 quintiles tends to be spread more or less uniformly, so that top or bottom inequality patterns are not marked. A cubic equation fitted the data with an R^2 of 0.702 (Figure 3).

These results are based on cross-sectional analyses in which each data point represents 1 survey. We did time-trend analyses for the 5 countries with increases of 40 percentage points or more in hospital deliveries during the study period (Figure 4). In Cambodia and Egypt, the full transition is evident, although in the latter the poorest 40% are still lagging behind. In Indonesia and Nepal, the transition is still incomplete, but the changes in the inequality pattern are evident. In Rwanda, the wealthiest quintile is still ahead of the remainder, but coverage is increasing rapidly in the other 4 quintiles and the gap is closing.



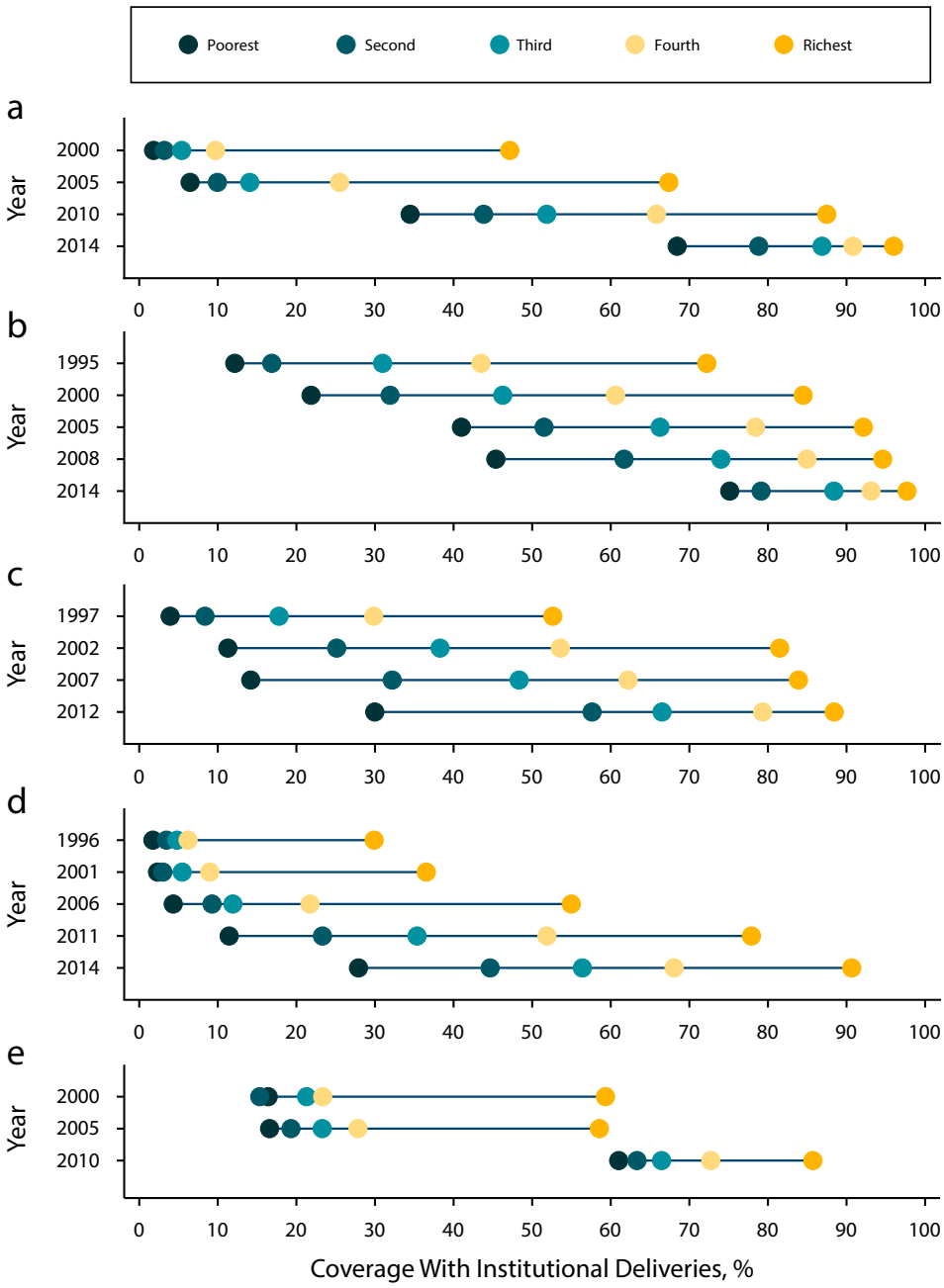
Note. Positive values (top inequality) refer to wider gaps between the wealthiest quintile and national coverage than between national coverage and the poorest quintile; negative values (bottom inequality) refer to the opposite situation. Equation: inequality pattern index = $7.993 + 1.312\ C_n - 0.0365C_n^2 + 0.0002C_n^3$.

FIGURE 3—National Coverage With Institutional Deliveries by Inequality Pattern: 286 Surveys in 89 Countries, 1993–2015

DISCUSSION

We show that absolute inequalities in population coverage for institutional deliveries tend to increase as national coverage rises to about 50% and to decline at higher levels of coverage, resulting in an inverted U-shaped pattern. This is not unexpected, because inequalities will necessarily be small when national coverage is either very low or very high. Relative inequalities, on the other hand, decline constantly with increasing coverage. This is also expected because, as coverage among the poor increases, similar absolute differences result in lower ratios or relative inequalities (e.g., the ratio between 100% and 90% coverage is 1.1, whereas the ratio between 20% and 10% is equal to 2.0).

In low- and middle-income countries, institutional deliveries and skilled birth



Note. These countries represent the 5 countries with increases of 40 percentage points or more in hospital deliveries during the study period.

FIGURE 4—Changes in Inequality Patterns Over Time by Income Percentile in the High National Institutional Delivery Coverage Countries (a) Cambodia, (b) Egypt, (c) Indonesia, (d) Nepal, and (e) Rwanda: 1995–2014

attendance are among the most unequally distributed among all reproductive and maternal health coverage indicators.[26,27] This is confirmed by our finding of an average difference greater than 50 percentage points between the 2 extremes of the wealth distribution in all surveys. We point out that similar magnitudes of absolute gaps may represent very different inequality patterns. When national coverage is low, the richest quintile is usually way ahead of the rest of the population; when coverage is high, inequalities are mostly attributable to the poorest lagging behind (Figure 2). This pattern is consistent with the inverse equity hypothesis, as is the case for a 2013 publication of institutional deliveries in 33 countries, which included separate analyses for urban and rural residents.[42] The latter described a pattern of early adoption by rich urban dwellers, while all rural dwellers lagged behind; as national coverage increases, urban areas are reached first, and socioeconomic inequalities increase; at a later stage, only poor

rural dwellers are left behind, and eventually universal access is reached.

Past research has suggested that such inequalities are associated with the geographical concentration of facilities in wealthier and urban areas, cultural and educational barriers to accessing facility delivery, and out-of-pocket costs incurred with transportation and user fees.[34,35,43–45] Several initiatives have been launched since the 1980s to address these barriers faced by poor and rural women in low- and middle-income countries, such as increased access to institutional deliveries for poor women, home delivery by skilled attendants, training of traditional birth attendants, and vouchers for delivery in a health facility, among others.[46–49] Although some of these initiatives were successful at local or national level, they were not sufficiently scaled up to have an impact at global level. An analysis of 75 countries with high maternal and child mortality showed that coverage with skilled birth attendance increased by less than 1 percentage point a year from 41% in 1990 to 65% in 2015.[50] In light of the strong association between skilled attendance and institutional deliveries,[27] the rates of improvement for the latter must have also been small.

Limitations

Our analyses have limitations. First, our evidence was largely derived from cross-sectional analyses, yet longitudinal evidence from 5 countries with large increases in coverage (Figure 4) support the hypothesis that patterns change over time as predicted from the cross-sectional data. Second, although we present absolute (slope index) and relative (concentration index) measures of inequality, we give more emphasis to the former, which are more palpable and easier to interpret than the latter, particularly when coverage is very low or high. Third, the classification of wealth quintiles depends on the choice of assets, but it is remarkable that in almost every survey, coverage increased monotonically with wealth, thus indicating that the classification was highly predictive of the outcome. Last, the use of more than 1 survey per country might have affected the results, but when we repeated the analyses by using only the last survey in each country, the results were virtually unchanged (Table B and Figure A).

Guidance for Policymakers

The inverse equity hypothesis was postulated for situations in which—at least initially—access is limited by economic, cultural, and geographical barriers that constrain the adoption of new interventions. Our findings have important policy implications. We address 3 scenarios.

First, when national coverage is low and top inequality prevails, governments should work to increase access in all groups. This situation is most common in low-income countries (Table A). We argue that rapid uptake by the better-off (often the early adopters)[4] may motivate other groups to follow suit. Policymakers can use this opportunity to identify social, cultural, geographical, and economic barriers to adoption by the poor, and speed up the uptake of the intervention by removing such barriers. Targeting specific population subgroups may not be advisable under these conditions.

Second, when national coverage is high and bottom inequality is present, targeting makes sense. Such situations are more frequent in upper-middle–income countries (Table A). Policymakers must understand the geographical, economic, and cultural barriers that preclude adoption by the poor, and target appropriate services at these groups. For example, Latin American countries such as Brazil[51] and Peru[52] tackled bottom inequality by deploying free, culturally appropriate services in the neediest areas. In Brazil, the Family Health Program was strongly implemented in poor and remote areas; in Peru, low coverage was observed among poor indigenous populations, and adoption of vertical or squatting birthing position in health facilities addressed a cultural barrier that previously discouraged indigenous women from delivering in institutions.[52]

These 2 scenarios refer to interventions that have already been available for a number of years, as is the case for institutional deliveries. A third scenario refers to the introduction of new interventions by a government. These may be deployed in ways that will reduce or even invert the usual inequality gradients. For instance, Peru introduced *Haemophilus influenzae* type b vaccine in 1998 in high-mortality, low-income districts; the vaccine was only introduced in the more developed areas of the country in 2004, by when high coverage had already been achieved in the districts that were targeted initially.[53] In Bangladesh, the Integrated Management of Childhood Illness strategy was also launched in high child mortality districts, and only rolled out to the rest of the country at a later stage (M. Hossein, oral communication, 2011). In an ideal world, all interventions should be initially deployed in the neediest areas, yet market forces and political preferences make the examples from Peru and Bangladesh rare occurrences.

As equity-focused strategies for increasing intervention coverage are implemented globally, the inverse equity hypothesis can provide policy guidance for minimizing inequalities.[54] Tracking changes in coverage by wealth can help assess the impact of health and related initiatives. For example, in Rwanda (Figure 4), recent changes including decentralization and increased availability of local facilities[55] helped close the gap even before universal coverage was reached among the richest. Rwanda became one of the few low- and middle-income countries to reach both Millennium Development Goals 4 on maternal health and 5 on child survival.[50]

Regardless of what approach is adopted for rolling out new interventions, monitoring changes in population coverage with an equity lens can contribute to reaching out to the segments of the population that are most likely to benefit from life-saving interventions, such as vaccines or case management of maternal and newborn illnesses.

The inverse equity hypothesis was based both on Tudor Hart's inverse equity law and on Rogers's theory of diffusion of innovations,[4] according to which early adopters include families with greater access to information and to the resources required, in this case for institutional childbirth. Our hypothesis has now been cited hundreds of times and applied to diverse outcomes such as immunization coverage, dental caries, cervical cancer, HIV treatment, smoking cessation, breastfeeding promotion, and many others. The present findings from nearly 300 surveys from more than 100 countries strongly support the hypothesis.

Public Health Implications

Proactive policy interventions are required to revert the prevailing pattern in which new, effective interventions tend to first reach those who probably need them less than poorer groups. AJPH

CONTRIBUTORS

C. G. Victora, F. C. Barros, and J. P. Vaughan authored the publication with the original hypothesis in 2000, and jointly originated the idea of the present article. G. Joseph, I. C. M. Silva, and A. J. D. Barros obtained and analyzed the survey data. F. S. Maia and F. C. Barros carried out the systematic review of the literature and summarized its results. All authors commented on the draft article and approved its final version.

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HUMAN PARTICIPANT PROTECTION

Human participant protection was not required because this study did not involve human participants.

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