STATE OF INEQUALITY

Childhood immunization

World Health
Organization

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Foreword

Immunization programmes are guided by data. Dating back to as early as the 1970s, immunization programmes have been setting an example for data-driven programme implementation. In the 1980s, population-based coverage surveys – the so-called EPI 30 Cluster Sample Surveys – were introduced to collect immunization data from households. At the same time, immunization programmes standardized the collection of data from health facilities, including routine reporting of vaccinations and regular facility assessments to check on the availability and quality of service delivery. In the 1990s, immunization programmes were one of the first health programmes to focus on subnational data and coverage estimates based on routine reports as part of the Reaching Every District strategy.

Socioeconomic and demographic differences in child immunization coverage have generally received less attention than geographic monitoring within immunization programmes. This report addresses this gap. Through analysis of survey data, the state of inequality in childhood immunization is presented for 69 low- and middle-income countries.

The results show major successes in many countries. For instance, immunization coverage rates do not differ between girls and boys. Overall trends in coverage gaps are encouraging, as inequalities narrowed during the last decade. And a substantial number of countries have achieved high levels of coverage in even the poorest populations.

The report also demonstrates a need to pay more attention to persistent inequalities within countries. While national immunization coverage rates are high in many countries, there are still major gaps in coverage between the richest and the poorest and between children whose mothers have different levels of education. Gaps are largest for the full immunization coverage indicator and for vaccines delivered in three doses. Alarmingly, as many as one in three countries in this report has DTP3 coverage gaps between poor and rich children that are greater than 20 percentage points.

No country can reach high levels of coverage and global targets without effectively addressing the needs of disadvantaged children, including those from families that are the poorest and least educated. Success stories from several countries have demonstrated that no matter the situation of the child – whether living in the slums of cities, remote rural areas or amidst conflict – they are reachable by immunization programmes. This report presents detailed analyses (and data visualizations) of countries with the lowest immunization coverage rates to show where big gains can be made. These data, in combination with detailed routine data for small geographic areas, will help to ensure that immunization programmes reach every child, everywhere.

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Acknowledgements

Frequent abbreviations and acronyms

BCG	one dose of Bacille Calmette-Guérin vaccine
DHS	Demographic and Health Survey
DTP3	three doses of the combined diphtheria, tetanus toxoid and pertussis vaccine
GVAP	Global Vaccine Action Plan
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
PAR	population attributable risk
SDG	Sustainable Development Goal
UNICEF	United Nations Children's Fund
WHO	World Health Organization

Executive summary

The *State of inequality: childhood immunization* report addresses two overarching questions: What inequalities in childhood immunization coverage exist in low- and middle-income countries? And how have childhood immunization inequalities changed over the last 10 years? In answering these questions, this report draws on data about five childhood immunization indicators, disaggregated by four dimensions of inequality, and covering 69 countries.[1] The findings of this report indicate that there is less inequality now than 10 years ago. Global improvements have been realized with variable patterns of change across countries and by indicator and dimension of inequality. The current situation in many countries shows that further improvement is needed to lessen inequalities; in particular, inequalities related to household economic status and mother's education were the most prominent.

Key findings

- **There were major gaps in national immunization coverage between countries**

National levels of childhood immunization coverage varied widely across countries for all indicators. Based on the span of the interquartile range, Bacille Calmette-Guérin (BCG) immunization demonstrated the least variation across countries (narrowest interquartile range), and full immunization demonstrated the most variation (largest interquartile range). While more than two thirds of study countries reported levels of BCG immunization among one-year-olds that were in excess of 90%, other countries reported national coverage of around 50% or less. For the full immunization indicator, the median coverage across countries was 68%, and about one quarter of countries reported coverage of less than 50%.

Data included in the *State of inequality: childhood immunization* report	
Childhood immunization indicators	BCG immunization, measles immunization, DTP3 immunization, polio immunization, full immunization
Dimensions of inequality	Household economic status (quintiles), mother's education (three categories), place of residence (urban and rural), sex (female and male)
Study countries	Afghanistan, Armenia, Belize, Benin, Bosnia and Herzegovina, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, Chad, Colombia, Comoros, Congo, Costa Rica, Côte d'Ivoire, Cuba, Democratic Republic of the Congo, Dominican Republic, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guinea, Haiti, Honduras, Indonesia, Iraq, Jamaica, Jordan, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Liberia, Malawi, Mali, Mauritania, Mongolia, Montenegro, Mozambique, Namibia, Nepal, Niger, Nigeria, Pakistan, Panama, Peru, Philippines, Republic of Moldova, Rwanda, Senegal, Serbia, Sierra Leone, South Sudan, Sudan, Suriname, Swaziland, Tajikistan, The former Yugoslav Republic of Macedonia, Togo, Tunisia, Uganda, Ukraine, United Republic of Tanzania, Viet Nam, Yemen, Zambia, Zimbabwe
Data sources	Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) (publicly available data from 1994–2014)
Study time period	Latest situation: 2010–2014 Change over time: 2000–2004 and 2010–2014 Priority country profiles: 1994–2014

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[1] The change-over-time analysis in this report is based on data from 28 countries (identified based on data availability).

Latest situation of national average of immunization coverage among one-year-olds in low- and middle-income study countries (DHS and MICS, 2010–2014)
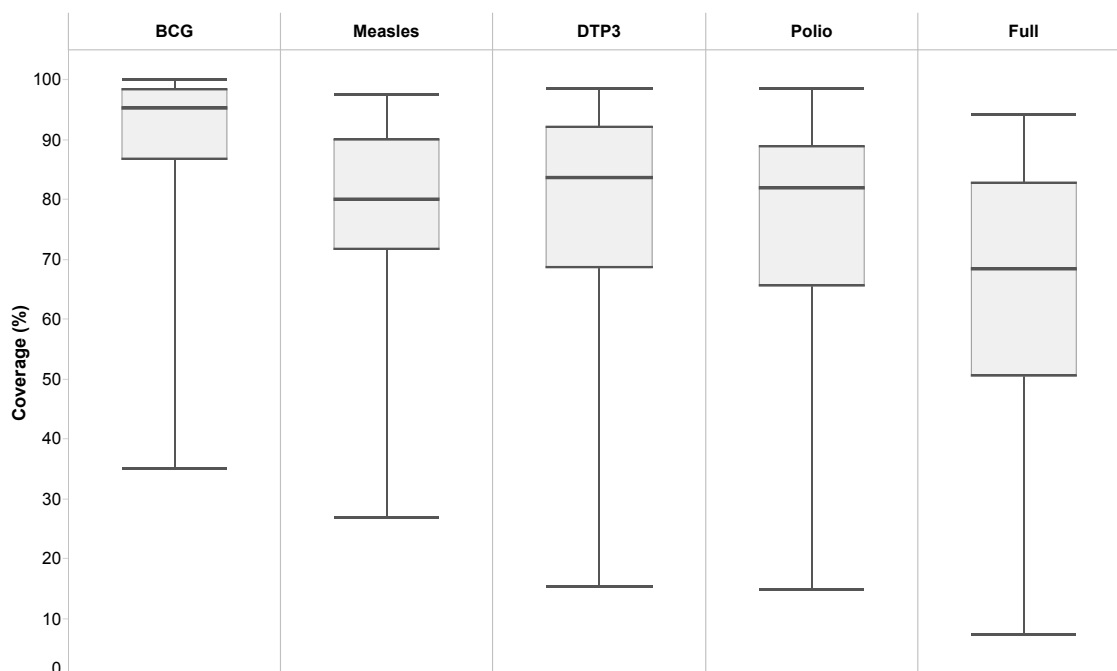
Note: Within each column, the top and bottom lines indicate maximum and minimum values, the centre line indicates the median value (middle point) and the light grey box indicates the interquartile range (middle 50% of study country estimates).

- **National immunization coverage increased across all five indicators over the past decade**

In the majority of countries, childhood immunization coverage was higher in the most recent survey year than 10 years prior. The median level of improvement across countries was about 1% per year, ranging from 0.5% for BCG to 1.1% for DTP3 and full immunization. That is, for DTP3 and full immunization indicators, half of study countries reported recent levels of coverage that were at least 11 percentage points higher than 10 years prior.

- **Economic- and education-related inequalities remain challenges for many countries**

Within-country inequalities by economic status and mother's education level were high in many countries, though the extent of inequality varied by indicator. About one in three countries faced very high levels of absolute inequality in DTP3, measles and full immunization, reporting at least 20 percentage points higher coverage in the richest than the poorest quintiles; for polio, about one in

five countries reported this high level of economic-related absolute inequality. For the DTP3 and the full immunization indicators, 11 countries had levels of coverage that were at least twice as high in the richest than the poorest quintile.

Global tally of economic-related absolute inequality in immunization coverage among one-year-olds

Indicator	Median difference between richest and poorest quintile (percentage points)	Percentage of 68 countries with coverage at least 20 percentage points[a] higher in the richest than poorest quintile
BCG	5	25%
Measles	7	31%
DTP3	9	34%
Polio	7	18%
Full	8	30%

[a]   Based on rounding of within-country difference to the nearest 1%.
Note: BCG and full immunization indicators were based on analysis of 67 study countries.

Education-related absolute inequality, measured across three subgroups as the difference in coverage between the most and least educated, was most pronounced for measles (median 18 percentage points), and least pronounced for BCG (median 8 percentage points). The percentage of countries that reported at least 20 percentage points higher coverage in the most- than the least-educated subgroup ranged from 19% (polio indicator) to 44% (measles indicator). In 15% of countries full immunization coverage was twice as high in the most-educated subgroup as the least educated, whereas only 6% of countries reported this level of relative inequality for the BCG indicator.

Global tally of education-related absolute inequality in immunization coverage among one-year-olds

Indicator	Median difference between the most and least educated (percentage points)	Percentage of 54 countries with coverage at least 20 percentage points[a] higher in the most- than least-educated subgroup
BCG	8	23%
Measles	18	44%
DTP3	14	41%
Polio	10	19%
Full	15	36%

[a]   Based on rounding of within-country difference to the nearest 1%.
Note: BCG and full immunization indicators were based on analysis of 53 study countries.

- **The poorest and least-educated subgroups had greater improvements in immunization coverage compared to the richest and most educated**

Changes in coverage over the past decade tended to be more favourable in the poorest and least educated, compared to the richest and most educated, respectively. In the poorest quintile, DTP3 and measles immunization improved at the greatest rate, increasing by a median of 1.5 percentage points per year across countries. In the least-educated subgroup, the best-performing indicator for change over time was DTP3, with a median annual increase of 1.3 percentage points across countries.

- **Immunization coverage in rural areas is catching up with urban areas, though still lags behind in some countries**

In most study countries, the urban–rural absolute difference in immunization coverage has improved. Across all indicators, at least half of study countries reported patterns of change over the past 10 years that favoured the rural subgroup and were accompanied by increased national average. According to the latest available data, the median absolute difference in immunization coverage between urban and rural areas was less than 5 percentage points for all indicators.

- **Sex-related inequalities did not exist or were minimal across all indicators, and over time**

The median in female–male difference of immunization coverage across study countries was less than 1 percentage point in all indicators. Similarly, the change in sex-related absolute inequality over the past decade was minimal, owing to low levels of inequality at the baseline measure.

Priority countries: a closer look

In about one third of study countries, the DTP3 immunization coverage levels were at least 20 percentage points higher in the richest than the poorest subgroup. In line with the equity indicator put forth by the World Health Organization (WHO) Global Vaccine Action Plan (GVAP), these countries were identified as priority countries, and disaggregated data were presented across all indicators and dimensions of inequality. These detailed analyses demonstrated that each country faces a unique state of inequality in childhood immunization, and that each country has its own successes and challenges to build upon. Selected findings from priority countries include:

- In the latest survey (2012) in **Pakistan**, most indicators demonstrated a pattern of marginal exclusion, whereby coverage in the poorest 20% was markedly lower than the remaining 80% of the population.

- Alongside gains in national coverage in **Ethiopia**, high levels of education-related absolute inequality (at least 20 percentage points difference between the most- and least-educated subgroups) persisted across all indicators and surveys.

- In **Cambodia**, all five indicators reported a substantial narrowing of absolute economic-related inequality and increasing of national coverage between 2000 and 2005; by 2014 inequality remained the same or worsened.

- Coverage across education subgroups in **South Sudan** demonstrated markedly lower coverage in the least-educated subgroup, compared with the two more educated subgroups. About 80% of the population belonged to the least-educated subgroup.

- In **Nigeria**, national DTP3 immunization coverage would be improved by over 40 percentage points by eliminating economic-related inequality (if national coverage improved to the level of coverage in the richest subgroup).

- In **Niger** in 1998 and 2006, all indicators demonstrated a pattern of mass deprivation across wealth quintiles. In the most recent survey (2012), gains were realized in the poorest 80% and the mass deprivation pattern was no longer apparent.

Among the priority countries, only one had national DTP3 coverage above 80%. If, however, the national averages were equal to the level of coverage in the richest quintile (that is, there was no economic-related within-country inequality), 17 of the 23 countries (74%) would have DTP3 coverage of about 80% or higher.

Moving forward

Expanded health inequality monitoring, especially in low-resource settings, can inform efforts to effectively "close the gap" and improve the state of inequality in childhood immunization. For instance, global monitoring of the state of inequality in childhood immunization has demonstrated lower coverage in the poorest and least educated of many low- and middle-income countries. By routinely measuring and monitoring intervention coverage, disadvantaged population subgroups can be identified, and progress on addressing inequalities can be tracked.

Establishing strong health information systems is an important prerequisite to ensuring that policies, programmes and practices are targeted to – and effective in reaching – the most-disadvantaged population subgroups. Strong equity-oriented national health information systems have the capacity to regularly collect, analyse, report and integrate data about health inequalities. Disaggregated data form the basis for health inequality monitoring, and provide a foundational understanding of the nature and extent of inequalities.

Alongside global monitoring, additional quantitative and qualitative investigations are required to explore why inequalities exist and how to best address them, taking into account context-specific considerations. Systematic approaches, such as the WHO Innov8 approach, help to guide the integration of evidence from health inequality monitoring into the development of equity-oriented programmes.

Introduction

Ideally, children everywhere should have equal access to the benefits of vaccines. However, this is not always the case. In many countries, vaccine coverage varies according to geographical, socioeconomic or demographic factors of the children; patterns of inequality emerge based on characteristics such as their household economic status, mother's education or place of residence. While some countries have taken action to reduce these types of inequalities, others still have much progress to make. Regular monitoring efforts can help to reveal whether programmes and policies are on track to reach their targets.

Assessing the state of inequality in immunization is an important step in identifying where gaps exist and planning strategies to increase coverage in unvaccinated or under-vaccinated population subgroups. This report focuses on childhood immunization, though vaccines are delivered at all life stages, and monitoring inequality in other populations is warranted. The scope of this report was determined based on the availability of high-quality, comparable data about childhood immunization and dimensions of inequality from a large set of countries.

The *State of inequality: childhood immunization* report is an exploration of the state of inequality in childhood immunization across 69 low- and middle-income countries, drawing from data about five childhood immunization indicators and four dimensions of inequality. The report adopts a rigorous, transparent and user-oriented approach to analysis and reporting to showcase the state of inequality through disaggregated data and a number of summary measures of inequality. Interactive visualization tools and accompanying text, tables and figures allow the user to explore the latest status of inequality within countries, and track how within-country inequalities have changed over

time. In addition, benchmarking enables meaningful comparisons across countries, permitting users to chart how one country is performing against other countries in the same region or country income category.

The report aims to facilitate a better overall understanding of the gaps in vaccine coverage that exist within and between countries. The main objectives of this report are:

- to report the global state of inequality in childhood immunization, using disaggregated data and summary measures of inequality to assess the latest status of inequality and the change in inequality over time;

- to make comparisons of within-country inequality between countries (benchmarking), including highlighting the best and worst performing countries; and

- to identify priority countries (those with particularly high levels of inequality), and present an extended analysis of inequality in these settings.

The report is comprised of four chapters with accompanying appendices, supplementary tables and electronic visualization components. Chapter 1 provides background on the topic, highlighting the emerging importance of equity throughout the 2030 Agenda for Sustainable Development, as well as other global initiatives to promote childhood immunization and reduce inequalities in immunization coverage. Chapter 2 is an overview of the data sources, analysis approaches and reporting methods used to prepare the report. Chapter 3, the main body of the report, presents the findings about the state of inequality in childhood immunization. This section of the report charts inequality across

countries and within countries, organized according to the four featured dimensions of inequality; it also provides country-specific summaries for 23 priority countries.[1] Finally, Chapter 4 concludes by reflecting upon the overall state of inequality in childhood immunization, and the unfinished work in reducing inequalities in immunization coverage.

This report serves as source of high-quality data for those involved in making policy decisions affecting health or those working to improve childhood immunization coverage. It was developed for a broad audience, encompassing those with considerable experience in the area of health inequality monitoring, and those interested in gaining more exposure to the practice. The main target audience includes: technical staff (for example, in ministries of health), public health professionals, policy-makers and researchers. Readers of this report are encouraged to make full use of the features of the interactive visualization technologies to customize and interact with the data – prior knowledge or experience with these tools is not required.

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[1] Priority countries were identified based on an equity indicator used by GVAP, which specifies a high level of economic-related absolute inequality in the DTP3 immunization indicator.

1. Background

Equity-driven sustainable development

The 2030 Agenda for Sustainable Development endeavours to *leave no one behind.* This slogan and the spirit that it represents demonstrate the central importance of equity in the global movement to foster economic, social and environmental sustainable development. A dedicated focus on equity means that the benefits of development should be inclusive of all, with special attention to improving the situation of vulnerable populations. Often, this entails efforts to decrease inequalities, which are defined as measurable differences between populations. Increasingly, the success of development initiatives is no longer based on improved national averages alone; rather, the hallmark of sustainable development is achieving lasting improvements that are realized alongside narrowing inequality.

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INEQUALITIES ARE THE MEASURABLE DIFFERENCES BETWEEN INDIVIDUALS OR GROUPS OF INDIVIDUALS. INEQUITY EXISTS WHEN A SITUATION OF INEQUALITY IS DEEMED TO BE UNJUST OR UNFAIR.

An equity-orientation is evident throughout the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs) and 169 targets.[1] SDG 10, for instance, calls for the reduction of inequality within and among countries. *Inequality across countries* is a concept that represents measurable differences between countries based on national averages, permitting comparisons on a global scale. *Within-country inequality* refers to measurable differences that exist at a national level, between population subgroups.

Population subgroups are defined according to dimensions of inequality, such as economic status, education level, place of residence, sex or any other factor that may serve as a basis for discrimination. Within-country inequality can be compared on a global scale.

Building country capacity for the practice of data disaggregation by relevant dimensions of inequality is specified in SDG target 17.18. Data disaggregation, which allows national data to be broken down according to population subgroups, is a key element of inequality monitoring and evaluation systems. It is also important for strengthening the means of implementation of sustainable development initiatives (SDG 17). Disaggregated data can be used to identify where gaps exist between population subgroups. These data are important to help countries chart a course of action to reduce inequalities and to track progress.

With regard to health in the SDGs, equity is central to SDG 3, which emphasizes ensuring health and well-being for all. Notably, the achievement of universal health coverage, SDG target 3.8, is based on the principle that everyone should have access to quality essential health services and essential medicines and vaccines. Target 3.b further underscores the importance of ensuring vaccines and medicines are accessible by all. In addition, a number of other SDGs uphold a movement for equity in areas that affect wider social determinants of health. These include: SDG 1, calling for an end to poverty; SDG 2, seeking to end hunger, achieve food security and improved nutrition; SDG 4, emphasizing equity in educational opportunities; SDG 5, calling for achievement of gender equality; and others.

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[1]   For more information about the SDGs and associated targets, refer to: https://sustainabledevelopment.un.org/sdgs

Selected goals and targets of the 2030 Agenda for Sustainable Development

Goal 1:
End poverty in all its forms everywhere.

Goal 2:
End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Goal 3:
Ensure healthy lives and promote well-being for all at all ages.

Target 3.8: Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all.

Target 3.b: Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all.

Goal 4:
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Goal 5:
Achieve gender equality and empower all women and girls.

Goal 10:
Reduce inequality within and among countries.

Goal 17:
Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Target 17.18: By 2020, enhance capacity-building support to developing countries, including for least-developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts.

Global context: childhood immunization

Immunization is among the safest and most effective public health interventions. Childhood immunization is a major force that helps to prevent disease and promote child survival and, as a result, creates opportunities for children to thrive. In many countries, expanding childhood immunization efforts over the past decades has helped to achieve major milestones such as the eradication of vaccine-preventable diseases, and increased herd immunity among the population.[1]

WHEN A LARGE PORTION OF THE COMMUNITY IS IMMUNIZED AGAINST A DISEASE, MOST OTHERS WILL ALSO ENJOY A LEVEL OF PROTECTION DUE TO THE LOWER LIKELIHOOD OF AN OUTBREAK OR TRANSMISSION.

Unfortunately, many children of today are unvaccinated or under-vaccinated, and vaccine-preventable diseases still remain a cause of morbidity and mortality, especially in low- and middle-income countries. Global initiatives aiming to extend vaccine coverage to all children have grown in number and strength, and have galvanized wide support from the international public health

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[1]   Immunization: keeping children alive and healthy. New York: UNICEF; 2014.

FIGURE 1.1. Selected global immunization-related milestones

2005
The WHO and UNICEF **Global Immunization Vision and Strategy** focused on ensuring equity in access to vaccines and immunization, outlining steps to achieve full attainment of MDG mortality reductions. The strategy espouses four main approaches: protecting more people; introducing new vaccine and vaccine-related technologies; integrating immunization into the health system; and immunizing in the context of global interdependence.

2000
Gavi, the Vaccine Alliance was created as a public–private partnership to increase access to immunization in poor countries, including strengthening routine vaccine delivery systems and the introduction of underused vaccines.

1984–1990
The UNICEF campaign for **Universal Child Immunization** sought to make all recommended immunizations available to all children.

1966–1980
The **Smallpox Eradication Programme**, led by WHO, was the first global surveillance and vaccination campaign to successfully eradicate an infectious disease.

1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015

1974
Expanded Programme on Immunization was launched by WHO with the aim of vaccinating children throughout the world; initially, it focused on vaccination for six diseases: diphtheria; whooping cough; tetanus; measles; poliomyelitis; and tuberculosis.

1988
The World Health Assembly passed a resolution to eradicate polio, resulting in the launch of the **Global Polio Eradication Initiative**.

2002
WHO and UNICEF developed the **Reaching Every District** strategy to strengthen immunization delivery to difficult-to-reach populations. Advocating for action at the district level, the strategy called for measures to: strengthen monitoring efforts and the use of data for action; reduce incomplete vaccination through improved management, defaulter tracing and social mobilization and communication; and provide timely funding, logistical support and supplies for programme implementation across every district.

2012
The WHO **Global Vaccine Action Plan (GVAP)**, endorsed by the 194 Member States of the World Health Assembly, calls for extending, by 2020 and beyond, the full benefits of immunization to all, regardless of where they are born, who they are or where they live.

community (Figure 1.1). In recent years, however, progress on the ground has stalled, especially in hard-to-reach populations and among the most vulnerable.[1] Increasingly, childhood immunization efforts are being re-focused to reduce inequalities that exist between countries as well as inequalities that exist between subpopulations within countries.

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[1] For example, according to the Millennium Development Goal Report 2015 (http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf), measles immunization coverage had steady gains from 2000 to 2010, but remained stagnant from 2010 to 2013; many of the unimmunized children are in poor and marginalized communities. For more information and examples, refer to the 2016 Midterm Review of the Global Vaccine Action Plan: http://www.who.int/immunization/global_vaccine_action_plan/SAGE_GVAP_Assessment_Report_2016_EN.pdf

Achievements during the Millennium Development Goal (MDG) period (2000–2015)

Looking back over the MDG period (2000–2015), childhood immunization efforts have contributed to overall improvements in health and morbidity, especially in low- and middle-income countries. The MDGs called for ambitious action on a global scale, and prompted concerted efforts to expand the reach and impact of childhood immunization. Increasing childhood immunization was an integral part of making progress on MDG 4, the goal to reduce child mortality. Accordingly, the global

health community endeavoured to revitalize the spirit of the immunization successes of the 1980s, and overcome the sense of stagnation that occurred during the 1990s.

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VACCINATION HAS HELPED COUNTRIES TO ACHIEVE IMPROVEMENTS IN CHILD MORTALITY.

Although the target for MDG 4 – to reduce the under-five mortality rate by two thirds between 1990 and 2015 – was not met, there were several notable achievements in childhood immunization over the MDG period.

- **Initiatives to promote childhood immunization gained exposure and attention.** Building on previous and existing efforts, new programmes were created, and more dedicated funding was committed to increasing their impact. The major global agencies that were involved in promoting childhood immunization include: the United Nations Children's Fund (UNICEF); the World Health Organization (WHO); Gavi, the Vaccine Alliance; the United States Centers for Disease Control; the Bill & Melinda Gates Foundation; and others, such as numerous nongovernmental organizations.

- **Global decreases in child mortality and disease burden are partially attributed to vaccines.** The under-five mortality rate fell from 90 to 43 deaths per 1000 live births between 1990 and 2015.[1] Although this falls short of the target for MDG 4, the progress to date means that 6 million fewer children under five years die each year in developing countries.

- **Many countries have seen great increases in the number of children vaccinated.** As of 2015, for instance, about 85% of children worldwide received at least one dose of measles-containing vaccine, whereas only 72% did so in 2000. Similarly, the global coverage of children receiving at least three doses of polio-containing vaccines rose from 73% to 86% between 2000 and 2015, driving progress towards the global eradication of poliomyelitis.[2]

- **Vaccines continue to be accepted in the medical community as safe, affordable and effective.** Globally, health professionals work to promote vaccine uptake in their communities, and researchers continue to look to vaccine technology to address both longstanding diseases as well as emerging disease outbreaks. Vaccine innovation has led to the development of new vaccines, the improvement of existing vaccines, advancements in how vaccines are procured, transported and administered, and progress on how vaccination is recorded (e.g. through electronic immunization registries).

Looking ahead to the era of the SDGs (2015–2030)

In light of emerging global health priorities and needs, childhood immunization has an important role to play in helping to meet the health-related SDG 3: to ensure healthy lives and promote well-being for all at all ages. Childhood immunization is an implicit component of strategies to achieve SDG target 3.2, focusing on ending preventable deaths of newborns and children under five years, and SDG target 3.8, aiming to achieve universal health coverage of essential medicines and vaccines. For example, a set of proposed indicators for the health-related SDGs includes *full immunization coverage* as one marker to track progress on achieving universal health coverage.[3]

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[1] For more information, refer to the Millennium Development Goal Report 2015: http://www.un.org/millenniumgoals/2015_MDG_ Report/pdf/MDG%202015%20rev%20(July%201).pdf

[2] For more information, refer to the World Health Organization Global and Regional Immunization Profile: http://www.who.int/ immunization/monitoring_surveillance/data/gs_gloprofile.pdf

[3] For a complete list of tracer indicators for universal health care service coverage, refer to World Health Statistics 2016: http:// www.who.int/gho/publications/world_health_statistics/2016/ EN_WHS2016_Chapter4.pdf?ua=1 (Table 4.1)

Ensuring that vaccine coverage is equitably extended to all populations, especially in countries with high levels of inequality, is a priority in GVAP. The GVAP Monitoring and Evaluation Accountability Framework contains strategic objectives and goals that prompt action to reduce inequalities; annual reporting (e.g. at the World Health Assembly) on progress according to corresponding indicators helps to ensure that countries are held accountable in meeting these aims.[1] For instance, the GVAP strategic objective three is that *the benefits of immunization are equitably extended to all people*, and the GVAP goal three is to *meet vaccination coverage targets in every region, country and community*. Countries are called upon to work towards reducing coverage gaps between wealth quintiles and other appropriate dimensions of inequality, including subnational districts. For example, country progress is tracked according to the following targets:

• By 2015, reach 90% national coverage and 80% in every district or equivalent administrative unit with three doses of DTP-containing vaccines.

• By 2020, reach 90% national coverage and 80% in every district or equivalent administrative unit for all vaccines in national programmes, unless otherwise recommended.

• The proportion of countries with <20 percentage points difference in DTP3 coverage between the lowest and highest wealth quintile (and for which the poorest population is less covered than the richest population) reaches 60% by 2015 and 75% by 2020.

According to reporting by GVAP, in 2015 the majority of countries had not met the first of these targets, and were not on track to meet the other two.[2] Progress towards the third target has been made, however, vigilant efforts are needed to ensure that countries maintain and strengthen improvements, especially in poorer quintiles.[3] In some cases, countries have regressed from achievements in earlier years. Furthermore, several countries lacked reliable data, and could not disaggregate data according to dimensions of inequality.

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[1]   The GVAP Monitoring and Evaluation Accountability Framework is aligned to support the work of the MDGs and SDGs. For more information about GVAP, refer to: http://www.who.int/ immunization/global_vaccine_action_plan/en/

[2]   For more information, refer to: http://www.who.int/entity/ immunization/global_vaccine_action_plan/gvap_secretariat_ report_2016.pdf?ua=1

[3]   See also: Hosseinpoor AR, Bergen N, Schlotheuber A, Gacic-Dobo M, Hansen PM, Senouci K et al. State of inequality in diphtheria-tetanus-pertussis immunisation coverage in low-income and middle-income countries: a multicountry study of household health surveys. The Lancet Glob Health. 2016 September 30;4(9):e617–e626.

2. Methods

Data

Data sources

To assess the state of inequality in childhood immunization, two types of data were sourced: data about immunization indicators and data about dimensions of inequality. All data used in this report are derived from secondary data from low- and middle-income countries, collected as part of Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS). DHS and MICS are large-scale, nationally-representative household surveys that are administered on a routine basis. Face-to-face interviews are conducted with women aged 15–49 years using standardized questionnaires. Data cover various health topics, as well as demographic and socioeconomic categories. By virtue of their design, DHS and MICS data have high comparability between settings and over time. Data from rounds of DHS and MICS in participating countries are publicly available online.[1]

Childhood immunization indicators

This report covers five childhood immunization indicators (Table 2.1). This selection of indicators includes two types of vaccines that are usually administered in a single dose (Bacille Calmette-Guérin [BCG] and measles), two types of vaccines that are administered in three or more doses (combined diphtheria, tetanus toxoid and pertussis [DTP3] and polio), and an indicator of full immunization coverage for one-year-olds (one dose of BCG vaccine, three doses of polio vaccine, three doses of DTP vaccine and one dose of measles vaccine). Note that some countries have different vaccination delivery practices than indicated above

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[1]   For more on DHS, refer to: http://dhsprogram.com; for more on MICS, refer to: http://mics.unicef.org

TABLE 2.1. Childhood immunization indicator definitions

Indicator	Definition
BCG immunization coverage among one-year-olds	Percentage of one-year-olds who have received one dose of BCG vaccine
Measles immunization coverage among one-year-olds	Percentage of one-year-olds who have received at least one dose of measles-containing vaccine
DTP3 immunization coverage among one-year-olds	Percentage of one-year-olds who have received three doses of the combined diphtheria, tetanus toxoid and pertussis vaccine
Polio immunization coverage among one-year-olds	Percentage of one-year-olds who have received three doses of polio vaccine
Full immunization coverage among one-year-olds	Percentage of one-year-olds who have received one dose of BCG vaccine, three doses of polio vaccine, three doses of DTP, and one dose of measles vaccine

Technical definitions of indicators are available from: http://www.who.int/entity/gho/health_equity/outcomes/health_equity_compendium.pdf?ua=1

(e.g. measles vaccine may be provided in two doses). Also, there are currently no standard criteria used to define a full immunization indicator, and the definition adopted in this report may differ from other definitions. Refer to Appendix 1 for more information on alternate immunization schedules and delivery in some countries and alternate criteria used to define full or complete immunization indicators.

The childhood immunization data in this report reflect the situation over the two years preceding the survey. At the national level, however, there is variation in the recommended delivery of childhood vaccines. In most cases, the data in this report reflect the percentage of children aged 12–23 months that have received the vaccine(s), however,

a few countries used a slightly different reference age group of either 15–26 months or 18–29 months, aligning with national immunization periods.

Dimensions of inequality

To assess the state of inequality, childhood immunization data were disaggregated according to four dimensions of inequality: household economic status; mother's education; place of residence; and sex (Table 2.2). These four dimensions represent common sources of discrimination at the global level, and can be applied to populations in low- and middle-income countries.

Study countries

This report includes data from 69 low- and middle-income countries, spanning all WHO regions. Based on classification by the World Bank in July 2016, 26 of these countries are low income and 43 are middle income.[1] These 69 countries were selected

because they had a recent DHS or MICS (conducted between 2010 and 2014) that reported data about at least one relevant dimension of inequality and at least one of the childhood immunization indicators. For the assessment of change in inequality over time, 28 of the 69 countries had survey data available for a previous time point between 2000 and 2004. Supplementary Table 1 provides a full list of study countries, including details about the survey type and year.

Priority countries were identified based on the criteria specified by the GVAP equity indicator pertaining to economic-related absolute inequality in DTP3 immunization: the level of coverage in quintile 5 was at least 20 percentage points higher than the level of coverage in quintile 1.[2] In total, 23 countries were identified as priority countries.

Note that more detailed information about the data used in this report is available in Appendix 1.

TABLE 2.2. Dimensions of inequality subgroup categorizations and descriptions

Dimension of inequality	Subgroup categorization	Description
Household economic status	Five subgroups: quintile 1 (poorest) to quintile 5 (richest)	Determined at the household level using a wealth index. Country-specific indices were based on household assets, dwelling construction materials, infrastructure and access to services; they were constructed using principal component analysis. Within each country, the index was used to divide the households into five equally-sized subgroups.[a]
Mother's education	Three subgroups: no education; primary school (any); secondary school (any) or higher	Reflects the highest level of education attained by the child's mother
Place of residence	Two subgroups: urban and rural	Country-specific criteria were applied
Sex	Two subgroups: female and male	

[a] For more information about the wealth index, refer to: https://dhsprogram.com/pubs/pdf/CR6/CR6.pdf

[1] For more information about the World Bank and its classification of countries, refer to: http://www.worldbank.org/

[2] For more information about the GVAP equity indicator, refer to: http://www.who.int/entity/immunization/global_vaccine_action_plan/gvap_secretariat_report_2016.pdf?ua=1

Analysis

Data disaggregation

The analysis method used in this report starts with disaggregation of childhood immunization data according to dimensions of inequality. Data disaggregation breaks down the national average to show the coverage according to subgroups. In other words, it shows the level of coverage in each subgroup of a given dimension of inequality, across each country. For example, in Cambodia, national measles immunization coverage is around 80%; however, disaggregated data according to economic status illustrate that coverage is much higher among the richest quintile (around 95%) than the poorest quintile (around 65%).

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ASSESSING DISAGGREGATED DATA CAN IDENTIFY WHERE INEQUALITIES EXIST, AND WHICH SUBGROUPS ARE FALLING BEHIND.

Comparisons of disaggregated data from two or more time points help to reveal how inequality has changed over time. For instance, considering DTP3 immunization coverage by place of residence, an analysis of disaggregated data from different time points can help to answer questions such as: For a given country, did DTP3 immunization coverage increase or decrease in the rural subgroup? In the urban subgroup? Were gains in DTP3 immunization coverage realized in both urban and rural subgroups? Did one subgroup have greater gains than the other?

Detailed analysis of disaggregated data across all subgroups provides important insight into patterns of inequality. In this report, detailed analysis of disaggregated data was done for 23 priority countries (though disaggregated data from all 69 study countries are available through the interactive visuals).

Disaggregated data are the basis upon which summary measures of inequality are calculated. Disaggregated data, along with summary measures of inequality, are used to assess the latest situation of inequality, and can then be used to determine how inequalities have changed over time.

Summary measures: latest situation

Summary measures are used for their convenience and ease of understanding to quantify health inequalities in a single numerical figure. In this way, they summarize the findings that emerge from the disaggregated data. For this report, three summary measures – difference, ratio and population attributable risk (PAR) – were calculated to present the latest situation of inequality, according to each dimension of inequality.

Difference and ratio are simple measures of inequality, meaning that they express inequality between two population subgroups. For place of residence, populations are divided into two subgroups (urban and rural); this is also the case for sex (female and male). Thus, for each of these dimensions of inequality, simple measures of inequality can be calculated based on the two defined subgroups. For household economic status and mother's education, which are each arranged into more than two subgroups, simple measures of inequality are based on the subgroups at the extreme ends of the spectrum: the richest (quintile 5) and the poorest (quintile 1), and the most educated (secondary school or higher subgroup) and least educated (no education subgroup). The difference between subgroups shows the level of absolute inequality, and is calculated by subtracting the level of coverage in one subgroup from the level of coverage in another. It is expressed in the unit of percentage points. The ratio shows the level of relative inequality, and is calculated by dividing the level of coverage in one subgroup by the level of coverage in another (Table 2.3).

TABLE 2.3. Calculating simple measures of inequality according to four dimensions of inequality

Dimension of inequality	Difference calculation	Ratio calculation
Household economic status	quintile 5 – quintile 1	quintile 5 / quintile 1
Mother's education	secondary school or higher – no education	secondary school or higher / no education
Place of residence	urban – rural	urban / rural
Sex	female – male	female / male

PAR is a complex measure of inequality, as it takes into account the situation in all population subgroups. In this report, PAR was used to demonstrate the possible improvement in national coverage that would be achieved by eliminating within-country inequality related to household economic status, mother's education level, place of residence or sex – that is, the potential for improvement if all subgroups had the same level of coverage as in the most-advantaged subgroup. (Refer to Appendix 2 for more information about how the most-advantaged subgroup was assigned for each of the dimensions of inequality.)

Summary measures: change over time

The absolute excess change summary measure demonstrates how inequalities have changed over time. For a given dimension of inequality, absolute excess change compares the pace of change in coverage between two subgroups: it shows the extent of coverage change in one subgroup compared to another. Absolute excess change was calculated for countries that had the necessary DHS or MICS data available from a recent survey (conducted between 2010 and 2014) and an older survey (conducted between 2000 and 2004).

The calculation of absolute excess change for immunization indicators can be broken down into two steps. First, annual absolute change in coverage between two time points is determined for each of the two subgroups; that is, the level of coverage in the most recent survey minus the level of coverage in an older survey, divided by the number of years between the two surveys. This annual absolute change is expressed in units of percentage points per year. Next, in the same way that difference is calculated, absolute excess change is calculated by subtracting the level of annual absolute change in one subgroup from another. For instance, the rate of change in quintile 1 is subtracted from the rate of change in quintile 5. A positive excess change value generally indicates that the pace of change in immunization coverage over time was more favourable among quintile 1 than quintile 5, whereas a negative excess change value generally indicates a more favourable situation in quintile 5. Like other summary measures, absolute excess change can be better understood when looking at the data to get a sense of the underlying scenario.

Detailed descriptions and technical notes about the analysis approaches adopted in this report and their interpretation are available in Appendix 2. Note that 95% confidence intervals were calculated for disaggregated data and summary measures of inequality; information about population share (and sample size, if this is small) are available by population subgroups according to each dimension of inequality. This information can be accessed through the interactive visuals that accompany this report.

Interpreting absolute excess change

A positive excess change value may indicate:

- **Increasing annual absolute change in both subgroups[a]**
  ➜ The increase in coverage occurred faster in the disadvantaged than the advantaged subgroup.
- **Decreasing annual absolute change in both subgroups**
  ➜ The decrease in coverage occurred slower in the disadvantaged than the advantaged subgroup.
- **Mixed annual absolute change in subgroups**
  ➜ Increase (or no change) occurred in the disadvantaged subgroup and decrease (or no change) occurred in the advantaged subgroup.

A negative excess change value may indicate:

- **Increasing annual absolute change in both subgroups**
  ➜ The increase in coverage occurred slower in the disadvantaged than the advantaged subgroup.
- **Decreasing annual absolute change in both subgroups[b]**
  ➜ The decrease in coverage occurred faster in the disadvantaged than the advantaged subgroup.
- **Mixed annual absolute change in subgroups**
  ➜ Decrease (or no change) occurred in the disadvantaged subgroup and increase (or no change) occurred in the advantaged subgroup.

An excess change value of zero may indicate:

- **No change in either subgroup.**
- **Same direction and pace of change in both subgroups.**

[a] Signals the most desirable path to reducing inequalities.
[b] Signals the least desirable situation where inequality is widening.
Notes: Disadvantaged subgroup refers to quintile 1, no education, rural and male. Advantaged subgroup refers to quintile 5, secondary school or higher, urban and female. These labels reflect the tendency for disadvantaged subgroups to have lower coverage than advantaged subgroups, though this was not always the case. For sex, this selection does not represent an assumed advantage of one sex over the other.

Reporting

Approach to reporting

In general, reports about the state of inequality should aim to highlight content that is most relevant to the target audience, in a manner that is effective for that audience. The *State of inequality: childhood immunization* report was developed for a broad group of stakeholders, with diverse interests and different levels of technical knowledge about health inequality monitoring. The report encompasses a large amount of data – spanning 69 countries, five childhood immunization indicators and four dimensions of inequality – and a number of analysis methods. Thus, the report adopts an approach to reporting that is both selective and comprehensive, aiming to provide multiple ways for users to engage with the results. The state of inequality is reported using two complementary methods: conventional reporting and interactive visuals.

Conventional reporting

Conventional reporting methods in this report use text, tables and figures to provide a salient selection of key messages about the state of inequality. The presentation of results begins by describing the state of inequality between countries. This is followed by an elaboration of within-country inequality (organized according to the four dimensions of inequality) and summaries of results for 23 priority countries. Overall trends in the results – and the supporting underlying data – are described and illustrated using a variety of figures (Figure 2.1).

Specific examples are selected to highlight pertinent findings. Note that country examples of difference and absolute change were only highlighted by name when the results were statistically significant, based on 95% confidence intervals.

Through the text and figures featured in this report, users are provided with a preliminary set of results that emerge from the myriad of findings contained in the large database. Conventional reporting in this report serves as an entry point for users to explore the data interactively through the interactive visuals that are referenced throughout the results section of this report (see Chapter 3).
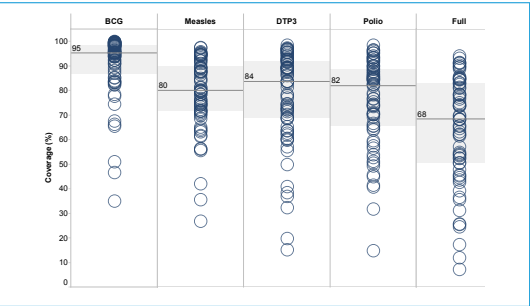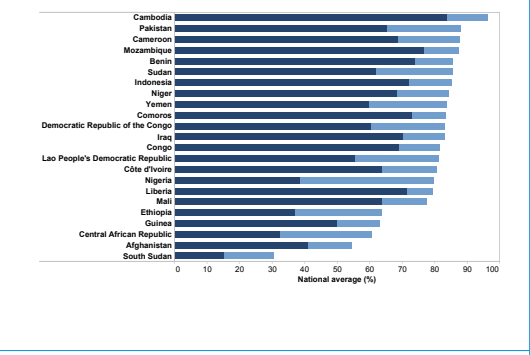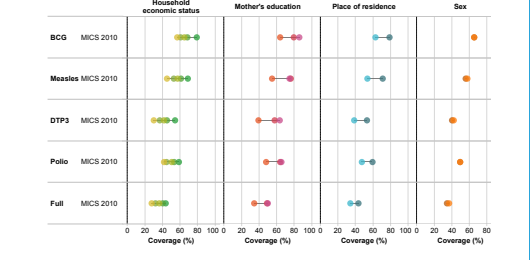
FIGURE 2.1. Static figures used in this report

Type of figure	Application	Description	Snapshot
Vertical circle graph	Across country comparisons of national data, disaggregated data, difference, or absolute excess change	Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the inter-quartile range (middle 50% of study country estimates).	
Horizontal bar chart	PAR	The potential for improvement (pale blue shaded area) represents the improvement possible if the whole population had the same level of coverage as the most-advantaged subgroup (richest wealth quintile, secondary school or higher, urban, or in case of sex, whichever subgroup that had the higher immunization coverage).	
Equiplot (horizontal dot plot)	Disaggregated data	Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.	

Interactive data visualization

The use of data visualization technology facilitates an interactive experience, allowing users to identify and explore patterns in the data according to their own interests by creating customized visual outputs. When used effectively, interactive visuals facilitate navigation through cumbersome and complex datasets. For instance, users can tailor their visual display to show the indicator, dimension of inequality, country income group and/or region of interest to them. These customized visual displays of data help to communicate large amounts of

information efficiently, and provide opportunities for a deeper, more nuanced understanding of the dataset. In this way, data visualization technology enables data exploration to be meaningful and relevant to the user.

In addition to providing versatility and customization, the use of interactive visualization can also make the reporting process more transparent. In this report, all of the underlying data are available to the user through interactive visuals. Interactive visuals are used to enhance conventional reporting: all static figures in the results section

are also available as interactive visuals, which are accessible by scanning the QR codes or visiting the URL indicated in the text (see Chapter 3). For readers that desire additional technical details, the interactive visuals contain information about 95% confidence intervals, population share and sample size limitations (where applicable).

Additional interactive visuals – story points and reference table – are also available (see Appendix 3). Story points consist of a series of interactive visuals (referred to as "dashboards") that are linked together. Each dashboard builds on the previous to tell a story about the state of inequality. Through story points, users can explore the comprehensive set of data, which includes national averages, disaggregated data and summary measures. The interactive reference table shows disaggregated data from all available surveys across study countries; data cells are colour-coded according to the level of coverage, and can be filtered by indicator, dimension of inequality, data source and survey period.

Median and interquartile range

In this report, two statistical measures are commonly used when describing the state of inequality: median, as a measure of central tendency, and interquartile range, as a measure of spread. The median value is the middle point of a set of estimates; half of the estimates fall at or above the median, and half of the estimates fall at or below the median. The interquartile range is the middle 50% of estimates; that is, 25% of estimates fall at or below the lower limit of the interquartile range (quartile 1) and 25% of estimates fall at or above the upper limit of the interquartile range (quartile 3). The interquartile range may be reported as a single figure (in percentage points) or as a range from quartile 1 to quartile 3. For example, the national averages of DTP3 immunization across 69 study countries demonstrated a median of 84%, with an interquartile range of 23 percentage points, from 69% (quartile 1) to 92% (quartile 3).

3. Results

State of inequality between countries

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COMPARISONS OF NATIONAL AVERAGES PROVIDE A GLOBAL OVERVIEW OF INEQUALITY BETWEEN COUNTRIES.

Interactive visual 1: inequality between countries

The state of inequality between countries figures about the latest situation (Figure 3.1) and change over time (Figure 3.2) can be viewed as interactive visuals.

To access these interactive visuals:

SCAN HERE:	*or*	VISIT:
		http://apps.who.int/gho/data/view.wrapper.HE-VIZ12?lang=en&menu=hide

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Latest situation

National average estimates serve as a useful starting point when assessing how a country is performing on childhood immunization coverage. In each of the five indicators, low- and middle-income countries reported a range of national average coverage based on data from the latest available survey. Low-income countries tended to report lower median national average coverage than middle-income countries.[1]

In terms of national average, the **BCG indicator** had the highest median of the five indicators (Figure 3.1). The median national average of BCG immunization coverage was 95%, with an interquartile range of

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[1] Note that the national estimates reported here are based on data from household health surveys, and may be slightly different than official WHO and UNICEF estimates, or estimates generated by national authorities, which may be derived from triangulation of survey and facility data.

11 percentage points. The middle 50% of study countries reported national average coverage between 87% and 98%. The minimum national average was 35% (South Sudan), and the maximum was 100% (several countries). More than two thirds of the study countries (71%) achieved national coverage of 90% or higher, and nearly 9 in 10 countries (87%) had national coverage of 80% or higher. Three countries reported national BCG coverage of about 50% or less: Chad; Nigeria; and South Sudan.

The median values of national averages of DTP3, measles and polio indicators were all above 80%. **DTP3** and **polio immunization** indicators demonstrated similar between country inequality based on national averages. The interquartile ranges of national coverage of DTP3 and polio immunization indicators were each about 23 percentage points; each indicator had national averages that ranged from a minimum of 15% (South Sudan) to nearly 100% (Jordan). For the DTP3 indicator, one third of study countries (33%) had national coverage of 90% or higher, and for the polio indicator, one quarter of study countries (25%) had national coverage over 90%. For each of the DTP3 and polio indicators, seven study countries reported national coverage of 50% or less. The national average of the **measles** indicator demonstrated a narrower spread, with an interquartile range of 18 percentage points. The lowest national coverage of measles was reported by South Sudan (27%) and the highest national coverage was reported by Costa Rica (98%) and The former Yugoslav Republic of Macedonia (97%); 19 study countries (28%) had measles immunization coverage of 90% or higher.

The **full immunization indicator** had the lowest median national average of the five indicators (68%), based on data from 67 low- and middle-

FIGURE 3.1. Latest situation of national average of immunization coverage among one-year-olds in low- and middle-income study countries (DHS and MICS, 2010–2014)

Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

income study countries. The interquartile range spanned 51% to 83% (32 percentage points). In 16 countries (24%), less than half of one-year-olds received full immunization; in Central African Republic, Chad, Ethiopia and South Sudan, less than one in four children was fully immunized. The median national average in the 26 low-income study countries was 58%; one low-income country had national average coverage over 90% (Rwanda), and four low-income countries had national average coverage between 80% and 90% (Burkina Faso, Burundi, Nepal and Zimbabwe). The median national average across 41 middle-income countries was 74%; 15 middle-income countries reported national average of 80% or higher, and 7 of these countries had national average in excess of 90%.

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ANNUAL ABSOLUTE CHANGE DEMONSTRATES THE AVERAGE INCREASE (OR DECREASE) PER YEAR BETWEEN TWO SURVEY TIME POINTS.

Change over time

Overall, in the majority of study countries, national coverage of the five childhood immunization indicators increased between the two surveys (a period of approximately 10 years). The magnitude of the increase (or decrease) varied by indicator and by country (Figure 3.2).

The **DTP3 immunization** indicator demonstrated a median annual absolute increase of 1.1 percentage points across the 28 study countries. Thus, half of the study countries reported an increase in national

FIGURE 3.2. Annual absolute change in national average of immunization coverage among one-year-olds in low- and middle-income study countries (DHS and MICS, 2000–2004 and 2010–2014)
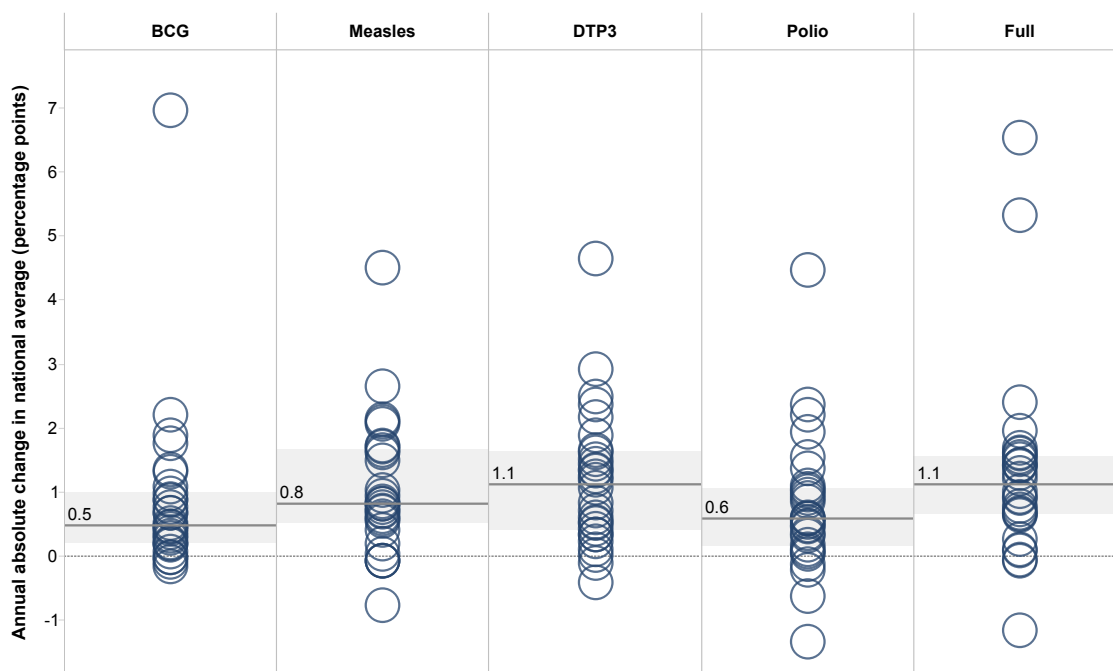
Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

average of about 11 percentage points or more over the 10-year period. The biggest improvement in national average of DTP3 coverage was reported by Burkina Faso, where coverage increased from 57% in 2003 to 90% in 2010 (annual absolute change of 4.6 percentage points); Cambodia, Gabon, Mali and Uganda also reported an annual absolute change greater than 2.0 percentage points. Three countries (Benin, Chad and Jordan) demonstrated no change in national average.[1] The middle 50% of countries reported annual absolute change values in the range from 0.4 to 1.6 percentage points.

The national average of **measles immunization** among one-year olds had a median annual absolute

change of 0.8 percentage points across study countries. Five countries reported an increase in national average of 2.0 percentage points or more per year (Armenia, Burkina Faso, Chad, Ethiopia and Mali). National levels of **polio immunization** coverage increased by an average of 0.6 percentage points or more each year in half of study countries. The greatest pace of improvement was reported by Burkina Faso, where national coverage increased by an average of 4.5 percentage points per year between 2003 and 2010. In Cambodia and Nigeria, national polio immunization coverage increased by more than 2.0 percentage points per year, on average. National **BCG immunization** coverage increased by 0.5 percentage points or more per year in half of the study countries. Two study countries reported absolute increases in national average of

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[1]   Annual absolute change values in the range from -0.1 to +0.1 percentage points were interpreted as no change.

at least 2.0 percentage points per year (Burkina Faso and Jordan), and four countries had no change in national average (Dominican Republic, Egypt, Peru and Zambia).

Across the 28 study countries, the median annual absolute change in national average of **full immunization** coverage was 1.1 percentage points. Half of study countries had increases of about 11 percentage points or more between the two surveys, including Armenia, Burkina Faso, Cambodia and Jordan, the four countries with annual absolute increases of at least 2.0 percentage points. The interquartile range of annual absolute change in full immunization coverage was 0.7 to 1.6 percentage points. Benin was the only country to report an average decrease in national coverage, which amounted to about 1.1 percentage points per year.

State of inequality within countries

Inequality by household economic status

Interactive visual 2: inequality by household economic status

Figures showing the latest situation of economic-related inequality (Figures 3.3 and 3.4) and change in economic-related inequality over time (Figure 3.5) can be viewed as interactive visuals.

To access these interactive visuals:

SCAN HERE: *or*   **VISIT:**

http://apps.who.int/gho/ data/view.wrapper.HE-VIZ13?lang=en&menu=hide

Notes: See Appendix 3 for additional interactive visuals that present the state of economic-related inequality in childhood immunization through a story containing eight story point dashboards. These story points illustrate the latest situation and change-over-time results reported below, and provide additional information about the data across subgroups. For further reference, see the interactive reference table, also available in Appendix 3.

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THE MEDIAN LEVEL OF IMMUNIZATION DEMONSTRATED A GRADIENT OF INCREASING COVERAGE, MOVING FROM THE POOREST TO THE RICHEST QUINTILE.

Latest situation

Economic-related inequality was explored by looking at immunization coverage in five population subgroups that span quintile 1 (the poorest) to quintile 5 (the richest). Across study countries, a pattern of increasing coverage across progressively richer quintiles prevailed: the highest median level of coverage was reported in quintile 5 for each of the five immunization indicators. The interquartile range in the poorest quintile was larger than the interquartile range in the richest, demonstrating a higher level of variation in coverage across the poorest quintile (Figure 3.3).

Economic-related absolute inequality was calculated as the difference in coverage in quintile 5 and quintile 1 (Figure 3.4). Overall, the **BCG immunization** indicator demonstrated the lowest median level of absolute inequality of the five indicators. Across the 67 study countries, the median absolute difference was 5 percentage points. Among the richest quintile, the median level of BCG coverage was 97%, and 11 countries reported 100% coverage. The middle 50% of countries reported coverage in the richest quintile between 95% and 99%. In the poorest quintile, the median BCG coverage was 93%, and in quintile 3 median coverage was 95%. While a little over one third of study countries (36%) reported an absolute difference of less than 2 percentage points between the richest and the poorest, one quarter of study countries (25%) had a difference of at least 20 percentage points.

Measles and polio immunization indicators each demonstrated median economic-related absolute inequality of about 7 percentage points. The median level of **measles immunization** coverage across 68 study countries was 78% in quintile 1, 83% in quintile 3 and 86% in quintile 5. The middle 50%

FIGURE 3.3. Latest situation of immunization coverage among one-year-olds in low- and middle-income study countries, disaggregated by household economic status (DHS and MICS, 2010–2014)
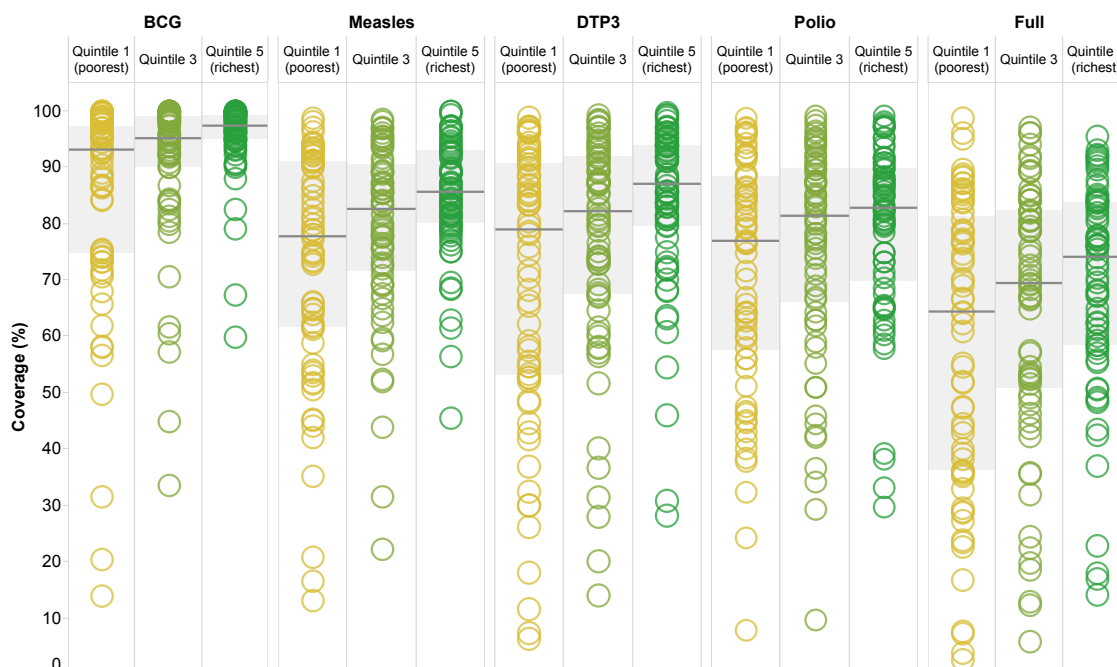
Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

of countries reported an economic-related absolute difference between 3 and 24 percentage points. Almost one third of study countries (31%) reported a rich–poor difference of at least 20 percentage points; in two countries (Nigeria and Pakistan), this difference was greater than 40 percentage points. The median level of **polio immunization** coverage across study countries was 77% in quintile 1, 81% in quintiles 2 and 3 and 83% in quintiles 4 and 5. Of the 68 study countries, 10 (15%) reported minimal or no economic-related absolute inequality, with an absolute difference of 2 percentage points or less. In nearly one fifth of study countries (18%), the rich–poor difference was 20 percentage points or more.

The median economic-related absolute inequality in **DTP3 immunization** coverage was 9 percentage points, with an interquartile range spanning from 2 to 26 percentage points. In quintile 1, DTP3 coverage was 79% on average across 68 study countries. In

19 study countries (28%), DTP3 coverage was 90% or higher in the poorest quintile; in 13 of the study countries (19%), DTP3 coverage was less than 50% among the poorest one-year-olds. More than one third of the study countries (34%) reported economic-related absolute inequality amounting to 20 percentage points or more in favour of the richest subgroup.

The **full immunization** indicator demonstrated that the average level of economic-related absolute inequality was 8 percentage points across study countries. The median level of coverage increased in a step-wise fashion across economic quintiles, from 64% in quintile 1 to 69% in quintile 3 to 74% in quintile 5. The variation in country estimates was greater in quintile 1 (the interquartile range spanned 45 percentage points from 36% to 81%) than in quintile 5 (the interquartile range spanned 25 percentage points from 59% to 84%). In nearly

FIGURE 3.4. Economic-related absolute inequality in immunization coverage among one-year-olds in low- and middle-income study countries: difference in coverage between the richest and poorest subgroups (DHS and MICS, 2010–2014)
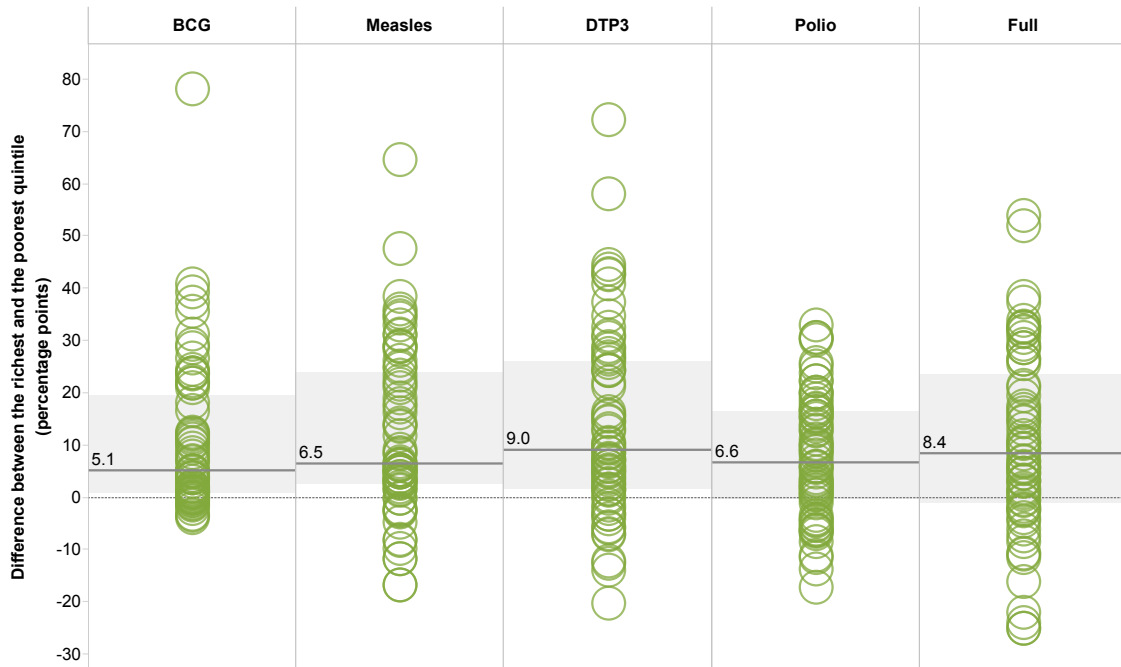
Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

one third of study countries (30%), the level of coverage in quintile 5 was at least 20 percentage points higher than the level of coverage in quintile 1. In 9 of the 67 study countries (9%), the absolute difference was less than 2 percentage points.

Change over time

Change over time was reported as annual absolute excess change between the richest and poorest quintiles over a period reflecting, on average, the previous 10 years. Across study countries, results indicated a situation that was more favourable in the poorest compared to the richest, as demonstrated by positive median excess change reported in all five indicators. Study countries reported different patterns of how change over time was realized across wealth quintiles (Figure 3.5).

The highest median level of annual absolute excess change was reported for DTP3, polio and full

immunization indicators, at 1.1 percentage points. **DTP3 immunization** coverage in quintile 1 increased by a median of 1.5 percentage points across 28 study countries, with an interquartile range from 0.4 to 2.1 percentage points. Three quarters of study countries (75%) reported substantial increases in DTP3 coverage in the poorest quintile, amounting to at least 1% per year, on average. Likewise, in the richest quintile, the majority of study countries (71%) reported an increase in coverage over the past 10 years. Overall, the absolute excess change in DTP3 coverage was positive in 18 of the 28 study countries (64%), and 16 countries (57%) also reported increased national average. **Polio immunization** coverage increased in the poorest quintile by an average of 1.1 percentage points per year across study countries, with nearly four fifths of countries (79%) reporting increased coverage. In the richest subgroup, polio coverage increased over the past 10 years in half of study countries

FIGURE 3.5. Annual absolute excess change in the poorest compared to the richest quintile in immunization coverage among one-year-olds in low- and middle-income study countries (DHS and MICS, 2000–2004 and 2010–2014)

Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

(50%); the remaining countries reported no change (21% of countries) or decreased coverage (29%). The annual absolute excess change values for polio immunization fell between -0.1 percentage points and 1.8 percentage points for the middle 50% of study countries.

Across the 28 study countries, **measles immunization** demonstrated an average annual absolute excess change value of 0.7 percentage points. The median rate of increase over the past 10 years in the poorest quintile was 1.5 percentage points. About one third of study countries (32%) realized annual gains in measles coverage of 2.0 percentage points or more in the poorest quintile. In the richest quintile, the coverage of measles immunization had a median of 0.5 percentage points increase per year over the past 10 years. In 17 study countries (61%), the annual absolute excess change was positive, indicating a more

favourable situation in the poorest than the richest quintile. Countries that reported a positive absolute excess change also reported an increase in national average, with the exception of two countries: Peru (positive excess change and no change in national average) and Dominican Republic (positive excess change and a decrease in national average).

The average annual absolute excess change in **BCG immunization** coverage was 0.6 percentage points. In the poorest quintile, the annual absolute change in coverage increased by 0.9 percentage points on average across 28 study countries. The middle 50% of study countries reported an increase over time in the poorest quintile of 0.2 to 1.5 percentage points. Just over half of study countries (54%) reported gains in coverage over the past 10 years in the richest quintile; over a third of study countries (36%) had no change in BCG immunization coverage. Comparing

absolute annual change over time in the poorest and richest quintiles, the middle 50% of countries reported an excess change between 0.1 and 1.1 percentage points. In three countries, the excess change exceeded 2.0 percentage points: Chad demonstrated no change in coverage in the richest and an increase in coverage in the poorest; Burkina Faso demonstrated increased coverage in the poorest that outpaced increases in the richest; and Mozambique reported an increase in the poorest and a decrease in the richest.

Full immunization coverage in the poorest quintile increased by a median of 1.4 percentage points per year across the 28 study countries. Unlike the other indicators, the full immunization indicator demonstrated less variation across countries in the poorest than the richest quintile. The interquartile range for annual increases in coverage in the poorest quintile was 0.9 to 2.3 percentage points, whereas the interquartile range for the richest quintile spanned -0.4 to 1.7 percentage points. Five countries (Armenia, Burkina Faso, Dominican Republic, Jordan and Uganda) reported that the change over time was at least 2.0 percentage points per year in the richest quintile, and 10 study countries (36%) achieved this level of increase in the poorest quintile. The median absolute excess change amounted to 1.1 percentage points per year, with about two thirds of study countries (64%) reporting a situation that favoured the poorest quintile. Out of the eight countries that reported an annual absolute excess change of at least 2.0 percentage points, two countries (Burkina Faso and Malawi) realized increases in both the richest and poorest quintiles, and six countries had increased coverage in the poorest alongside a decrease in the richest.

Inequality by mother's education

● ● ●

ACROSS COUNTRIES, EDUCATION-RELATED ABSOLUTE INEQUALITY WAS HIGHEST IN MEASLES AND LOWEST IN BCG.

Latest situation

Education-related inequality is demonstrated by disaggregated data of immunization coverage across mother's education, according to three subgroups: mothers with no education; mothers with primary school education; and mothers with secondary school or higher education. In general, childhood immunization coverage tended to be highest among children whose mothers reported the highest levels of education, and lowest among the least educated. Across study countries, there tended to be more variation in the coverage among the no education subgroup than the primary school subgroup, as indicated by the interquartile range; the secondary school or higher subgroup reported the least variation in coverage across countries (Figure 3.6).

FIGURE 3.6. Latest situation of immunization coverage among one-year-olds in low- and middle-income study countries, disaggregated by mother's education (DHS and MICS, 2010–2014)
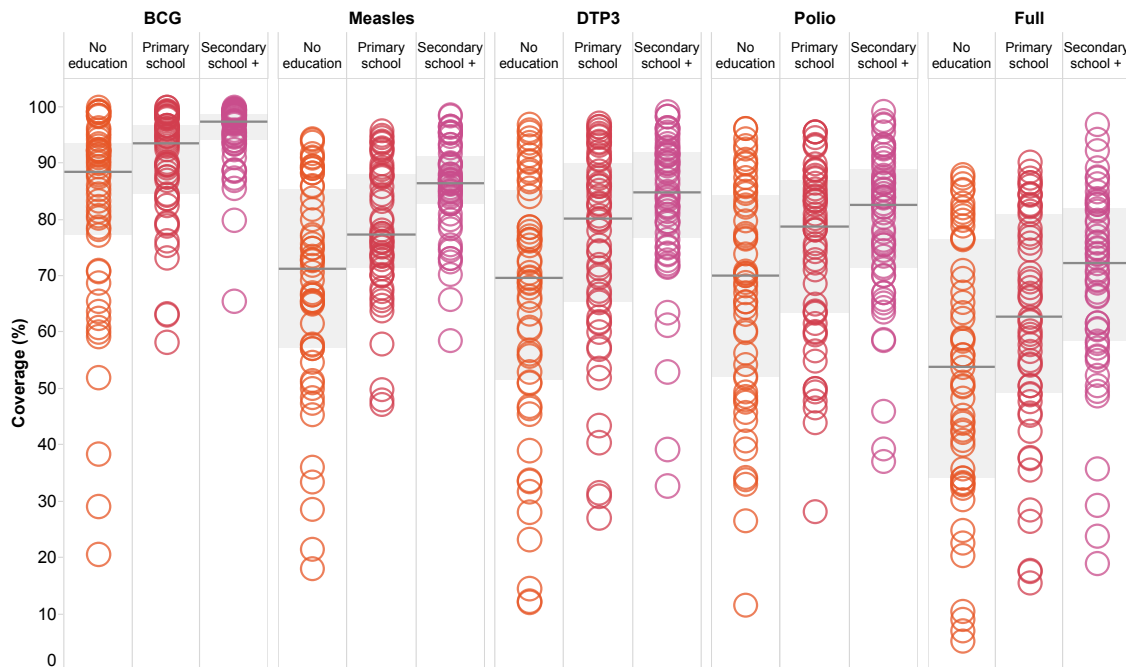
Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

The **BCG indicator** had the smallest median difference between coverage in the secondary school or higher subgroup and the no education subgroup, at 8 percentage points (Figure 3.7). Data from the 53 study countries showed that median BCG immunization coverage increased incrementally across the three subgroups, from 88% to 94% to 97%. In the most-educated subgroup, the middle 50% of study countries (interquartile range) reported BCG immunization coverage in the range from 94% to 99%; in the least-educated subgroup, the interquartile range was from 77% to 93%. The country with the most pronounced absolute education-related inequality was Nigeria, where the difference between coverage in the most- and least-educated subgroups was 66 percentage points. Chad, Ethiopia and Indonesia also reported education-related absolute inequality of 40 percentage points or higher; and 12 study

countries (23%) had very low levels of education-related inequality, with differences of less than 2 percentage points.

For polio, DTP3 and measles indicators, the median difference across study countries between coverage in the most- and least-educated subgroups was 10 percentage points (polio), 14 percentage points (DTP3) and 18 percentage points (measles). The education-related absolute inequality in **polio immunization** coverage was between 3 and 18 percentage points for the middle 50% of countries. Indonesia and Philippines each reported a difference of more than 45 percentage points between polio immunization coverage in the most- and least-educated subgroups; in 10 study countries (19%), this difference was less than 2 percentage points. The median **DTP3 immunization** coverage increased across subgroups, from 70% in the no

FIGURE 3.7. Education-related absolute inequality in immunization coverage among one-year-olds in low- and middle-income study countries: difference in coverage between most- and least-educated subgroups (DHS and MICS, 2010−2014)

Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

education subgroup to 80% in the primary school subgroup to 85% in the secondary school or higher subgroup. In three countries, Chad, Nigeria and South Sudan, DTP3 immunization coverage in the no education subgroup was 15% or less. Six study countries (11%) had low education-related absolute inequality, amounting to less than 2 percentage points, while five study countries had a substantial difference of at least 40 percentage points (Ethiopia, Indonesia, Lao People's Democratic Republic, Nigeria and Philippines). **Measles immunization** coverage was more variable in the least-educated than the more-educated subgroups, demonstrating an interquartile range from 57% to 85% (28 percentage points) in the no education subgroup, 71% to 88% (17 percentage points) in the primary school subgroup and 83% to 91% (8 percentage points) in the secondary school or higher subgroup. The middle 50% of study countries reported

education-related absolute inequality in measles coverage between 6 and 24 percentage points; in four study countries, education-related absolute inequality was greater than 40 percentage points (Ethiopia, Indonesia, Nigeria and Philippines) whereas seven countries (13%) had a difference of 2 percentage points or less.

The **full immunization** indicator demonstrated median education-related absolute inequality of 15 percentage points across 53 study countries. The middle 50% of study countries had education-related absolute inequality between 5 and 24 percentage points. Five countries reported a difference of less than 2 percentage points (Burkina Faso, Burundi, Honduras, Mongolia and Swaziland) and three countries had a difference of more than 40 percentage points (Indonesia, Nigeria and Philippines). In four study countries, only about

FIGURE 3.8. Annual absolute excess change in the least-educated compared to the most-educated subgroups in immunization coverage among one-year-olds in low- and middle-income study countries (DHS and MICS, 2000–2004 and 2010–2014)

Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

1 in 10 children (or fewer) in the no education subgroup was fully immunized (Central African Republic, Chad, Nigeria and South Sudan); in the secondary school or higher subgroup of all study countries, at least one in five children was fully immunized. Across the 26 low-income countries, the median education-related absolute inequality was 14 percentage points; the middle 50% of these values ranged between 7 and 19 percentage points. Across the 27 middle-income countries, the median education-related absolute inequality was more pronounced than in the low-income countries, at 19 percentage points; also, the interquartile range was wider, ranging from 4 to 27 percentage points.

Change over time

The change over time in education-related inequality in childhood immunization tended to be favourable towards the no education subgroup:

a so-called pro-disadvantaged change. Across all five indicators, the majority of countries reported positive excess change over time (Figure 3.8). The nature of the change over time in the no education and secondary school or higher secondary subgroups was variable.

The median absolute annual excess change over time for the **BCG immunization** indicator was 0.8 percentage points: in half of study countries, the rate of increase in coverage in the least-educated subgroup outpaced the rate of increase in the most-educated subgroup by about 8 percentage points or more over 10 years. The level of coverage in the no education subgroup increased in most study countries, with a median average change of 1.3 percentage points per year. In four countries the annual increase was 2.0 percentage points or higher (Burkina Faso, Cambodia, Jordan and

Uganda). Peru reported decreased coverage in the no education subgroup over time by an average of 1.3 percentage points per year. Change over time in the secondary school or higher subgroup increased in 16 of the 26 study countries (62%); the median increase was 0.7 percentage points per year. Sixteen study countries (62%) had the best-case scenario of pro-disadvantaged change alongside an increase in national average.

The **measles immunization** indicator demonstrated a median annual excess change value of 0.5 percentage points. The middle 50% of countries had annual excess change values in the range from 0.0 to 2.0 percentage points. The change over time in the no education subgroup was positive, indicating an increase in 22 out of 26 study countries (85%). In eight study countries (31%), measles coverage increased by at least 2.0 percentage points per year in the no education subgroup. The secondary school or higher subgroup reported a median change over time of 0.4 percentage points per year, with increases exceeding 2.0 percentage points per year in Burkina Faso and Ethiopia.

Both DTP3 and polio immunization indicators reported a median annual excess change of 0.3 percentage points. The excess change over time in **DTP3 immunization** coverage had an interquartile range from -0.3 to 1.7 percentage points. DTP3 coverage in the no education subgroup increased over the 10-year period between surveys in the majority of study countries, with a median increase of 1.3 percentage points per year; similarly, coverage in the secondary school or higher subgroup

also increased in most study countries. **Polio immunization** coverage demonstrated a tendency for increased annual coverage across education subgroups, with median values of 0.7 percentage points (no education), and 0.4 percentage points (secondary school or higher). The annual excess change over time in polio immunization coverage had an interquartile range from -0.2 to 1.1 percentage points. Of the 26 study countries (31%), 8 had negative excess change values, ranging from -0.2 to -1.8 percentage points per year.

Full immunization coverage demonstrated a median annual excess change value of 0.2 percentage points. The interquartile range for annual excess change ranged from -0.2 to 1.6 percentage points. Fourteen of the 26 study countries (54%) had a positive excess change value, indicating a pro-disadvantaged change. Across study countries, the coverage of full immunization in the no education subgroup tended to increase: the median annual absolute increase was 1.0 percentage point. Benin reported decreased full immunization coverage in the no education subgroup between study periods and seven countries (27%) had an increase of at least 2.0 percentage points per year. The median increase in coverage in the secondary school or higher subgroup was 0.7 percentage points per year. The countries with the highest annual increases were Jordan (6.5 percentage points per year) and Nigeria (2.0 percentage points per year). Mozambique reported a decrease of 3.0 percentage points per year in full immunization coverage in the most-educated subgroup.

Inequality by place of residence

Interactive visual 4: inequality by place of residence

Figures showing the latest situation of place of residence inequality (Figures 3.9 and 3.10) and change in place of residence inequality over time (Figure 3.11) can be viewed as interactive visuals.

To access these interactive visuals:

SCAN HERE: *or*   **VISIT:**

http://apps.who.int/gho/ data/view.wrapper.HE- VIZ15?lang=en&menu=hide

Notes: See Appendix 3 for additional interactive visuals that present the state of place of residence inequality in childhood immunization through a story containing eight story point dashboards. These story points illustrate the latest situation and change-over-time results reported below, and provide additional information about the data across subgroups. For further reference, see the interactive reference table, also available in Appendix 3.

ON AVERAGE ACROSS COUNTRIES, PLACE OF RESIDENCE ABSOLUTE INEQUALITY WAS LOW, THOUGH SOME COUNTRIES REPORTED WIDE GAPS BETWEEN URBAN AND RURAL.

Latest situation

Inequality by place of residence is shown across study countries as disaggregated data in urban and rural subgroups for five immunization indicators. Overall, the levels of immunization coverage in urban and rural areas varied across countries. Study countries reported greater variance in the level of coverage in rural areas than urban areas, as demonstrated by wider interquartile ranges in the rural subgroups. For instance, for the DTP3 immunization indicator, the interquartile range was 31 percentage points in the rural subgroup (ranging from 61% to 92%), whereas in the urban subgroup, the interquartile range was 16 percentage points (ranging from 76% to 92%) (Figure 3.9).

FIGURE 3.9. Latest situation of immunization coverage among one-year-olds in low- and middle-income study countries, disaggregated by place of residence (DHS and MICS, 2010–2014)
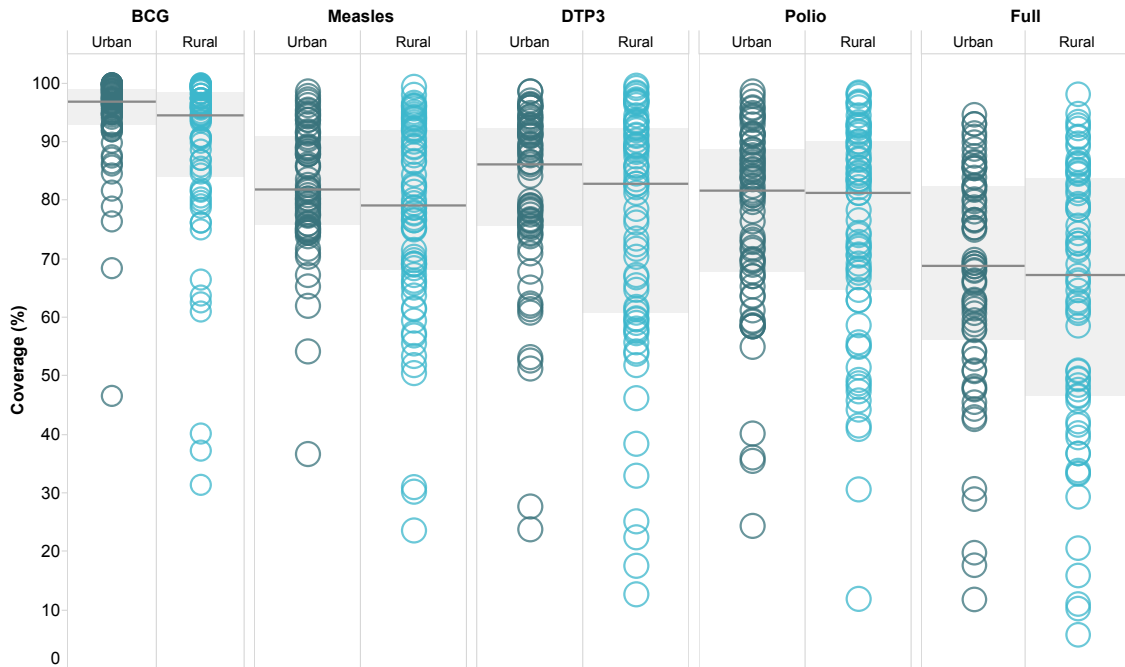
Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

The median urban–rural difference in immunization coverage was between 1 and 4 percentage points across study countries for all five indicators, indicating that the majority of countries reported higher coverage in urban than rural areas. The magnitude and directionality of place of residence inequality, however, varied across countries (Figure 3.10). **Polio immunization** demonstrated the lowest median value of absolute difference of urban–rural coverage across 69 study countries, at 1 percentage point (favouring urban areas). The middle 50% of study countries reported an absolute difference between -2 percentage points (higher coverage in rural) and 7 percentage points (higher coverage in urban). While one third of study countries (33%) reported place of residence absolute inequality of 2 percentage points or less, Ethiopia had a gap in excess of 20 percentage points (coverage in rural areas was 41% and coverage in urban areas was 67%).

For both BCG and DTP3 immunization indicators, a median urban–rural difference across study countries of around 3 percentage points was reported (favouring urban areas). For **BCG immunization**, nearly half of study countries (47%) had low levels of place of residence absolute inequality: a difference of 2 percentage points or less between coverage levels in urban and rural subgroups. The level of coverage in the urban subgroup tended to be high across study countries, with an interquartile range from 93% to 99%. In four countries, the level of BCG immunization coverage was at least 20 percentage points higher in urban than rural areas (Central African Republic, Chad, Nigeria and Yemen). For the **DTP3 immunization** indicator, one third of study countries (32%) reported low or no place of residence absolute inequality, with a difference of 2 percentage points or less between subgroups. Where inequality was reported, a greater number of countries had inequality that favoured urban

FIGURE 3.10. Place of residence absolute inequality in immunization coverage among one-year-olds in low- and middle-income study countries: difference in coverage between urban and rural areas (DHS and MICS, 2010–2014)

Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

areas than rural areas. Eight study countries (12%) reported that DTP3 coverage in urban areas was at least 20 percentage points higher in urban than rural areas.

Across study countries, the median urban–rural difference in **measles immunization** coverage was 4 percentage points (favouring urban areas). Several countries demonstrated place of residence absolute inequality that favoured the urban subgroup (54% of study countries), or amounted to less than 2 percentage points difference (29% of study countries). Chad, Congo, Ethiopia and Nigeria had a gap of at least 20 percentage points between subgroups that favoured urban over rural areas.

Across 67 study countries, the urban–rural difference in **full immunization** coverage amounted to, on average, 2 percentage points in favour of urban areas. Study countries demonstrated greater variance of coverage in the rural subgroup (interquartile

range spanning from 47% to 84%) than the urban subgroup (interquartile range spanning from 56% to 83%). The greatest magnitude of absolute inequality favouring urban areas was reported by Ethiopia (28 percentage points), Nigeria (27 percentage points), Yemen (22 percentage points) and Côte d'Ivoire (21 percentage points). Namibia reported elevated absolute inequality favouring rural areas, where coverage was 20 percentage points higher than in urban areas.

Change over time

Over the 10-year period between survey years, the median level of coverage in urban and rural subgroups across countries increased. Comparing the absolute annual change in urban and rural subgroups revealed that most study countries had excess change that favoured the rural subgroup. The median annual absolute excess change values were from 0.4 to 0.5 percentage points across the five indicators (Figure 3.11). For all indicators,

FIGURE 3.11. Annual absolute excess change in rural compared to urban areas in immunization coverage among one-year-olds in low- and middle-income study countries (DHS and MICS, 2000–2004 and 2010–2014)
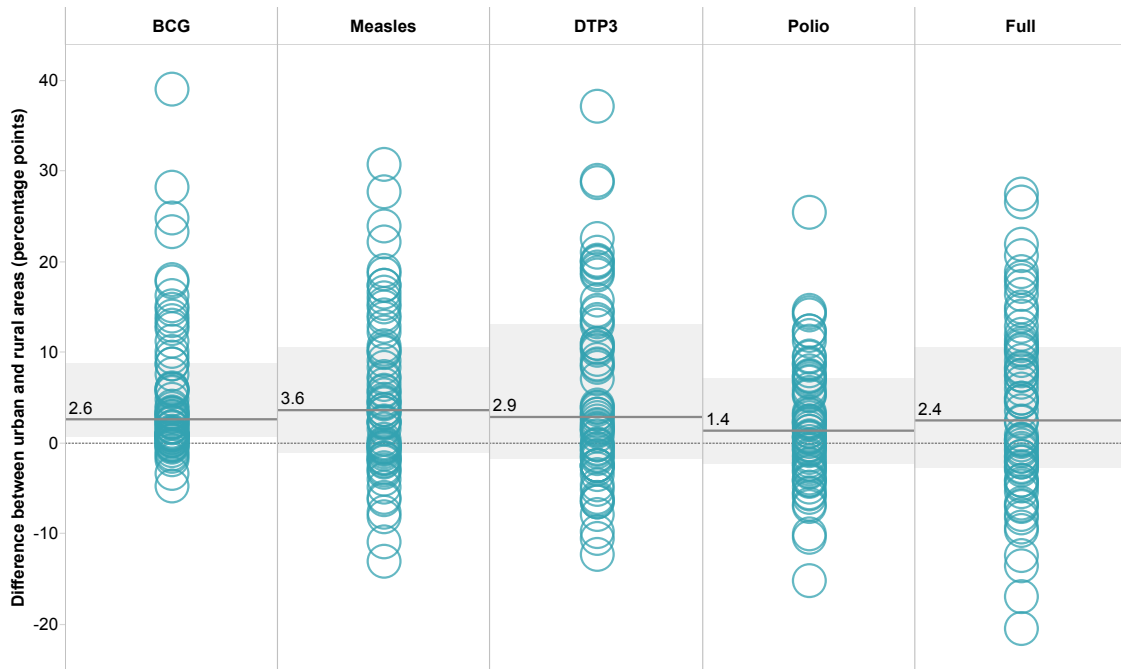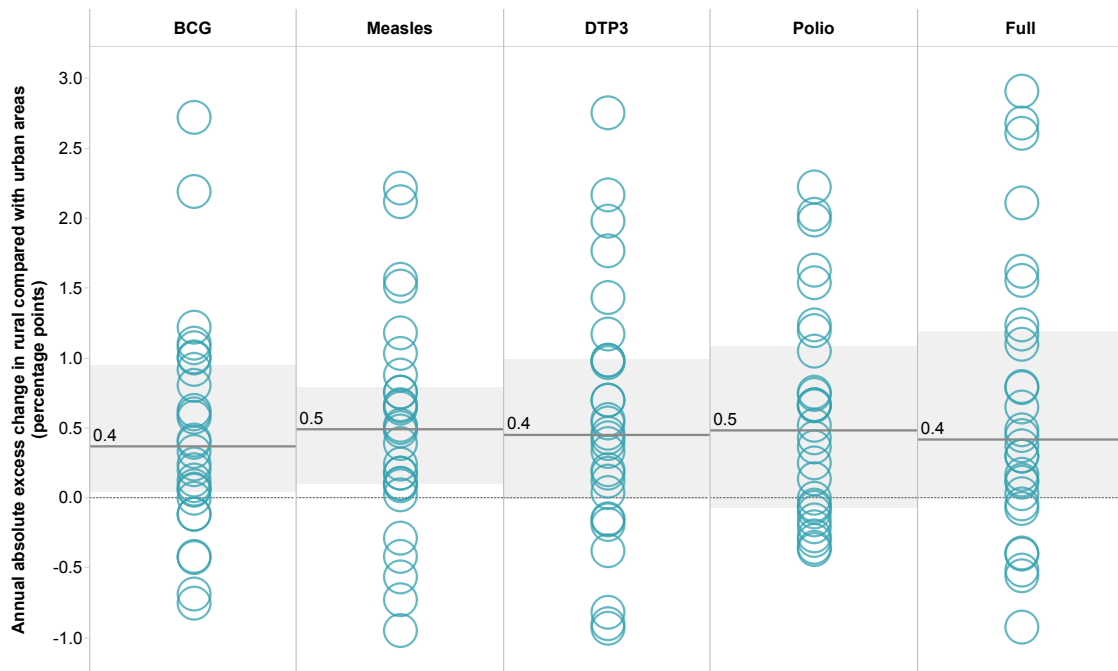

Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

at least half of study countries reported annual absolute excess change that favoured the rural subgroup accompanied by an increase in national coverage.

The median annual absolute excess change in both the BCG and DTP3 immunization indicators was 0.4 percentage points. In the majority of study countries (61%), the change in **BCG immunization** coverage was more favourable in rural than urban areas. BCG immunization coverage in rural areas increased over time by a median of 0.8 percentage points per year. In Burkina Faso and Jordan, the improvement in the rural subgroup was, on average, at least 2.0 percentage points per year greater than in the urban subgroup. **DTP3 immunization** coverage did not decrease over time in the rural subgroup of any study country, though four countries reported no change in coverage (Armenia, Cameroon, Jordan and Peru). In the urban subgroup, the median increase in coverage was 0.9 percentage points per year; the middle 50% of countries had average yearly increases between 0.2 and 1.3 percentage points. The annual absolute excess change in DTP3 immunization was at least 2.0 percentage points in three countries: Burkina Faso; Chad; and Viet Nam.

Measles and polio indicators reported a median absolute excess change of 0.5 percentage points per year. **Measles immunization** coverage in rural areas increased by an average of 1.0 percentage point per year across study countries. The middle 50% of study countries reported yearly increases in rural coverage between 0.4 and 1.7 percentage points. Measles immunization coverage also increased in the urban subgroup in the majority of study countries (71%). In two countries, the increase in coverage over 10 years was greater in the rural than the urban subgroup by an annual average of at least 2.0 percentage points or more (Burkina

Faso and Gabon). In four countries, absolute excess change was minimal, at about 1.0 percentage point difference or less over 10 years (Benin, Colombia, Philippines and Rwanda). The median coverage of **polio immunization** demonstrated increases in both urban and rural subgroups. In rural areas, the middle 50% of study countries had annual increases in coverage of 0.1 to 1.6 percentage points, while the interquartile range for the urban subgroup was 0.0 to 0.4 percentage points. The annual absolute excess change in rural compared to urban areas was more favourable in rural areas in 17 out of 28 of study countries (61%). Three countries demonstrated excess change that was favourable for the rural subgroup by at least 2.0 percentage points per year, on average (Burkina Faso, Mali and Viet Nam).

Full immunization coverage demonstrated a median annual absolute excess change of 0.5 percentage points across study countries. In 15 out of 28 study countries (54%), a positive absolute excess change value was reported alongside an improvement in national coverage. In three countries, positive absolute excess change was recorded alongside a decreased (Benin) or unchanged (Chad, Mozambique) national average. The highest absolute excess change, in excess of 2.0 percentage points per year in favour of the rural subgroup, was reported by Burkina Faso, Jordan, Namibia and Viet Nam. Full immunization coverage increased by a median of 1.3 percentage point per year in rural areas, with average annual gains of at least 2.0 percentage points in eight study countries (29%). More than two thirds of study countries (68%) reported an annual absolute increase in coverage in urban areas. Three countries reported an annual absolute increase of 2.0 percentage points or more in urban areas (Burkina Faso, Cambodia and Jordan).

Inequality by sex

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MOST COUNTRIES REPORTED VERY LOW OR NO
INEQUALITY ACCORDING TO SEX.

Interactive visual 5: inequality by sex

Figures showing the latest situation of sex-related inequality (Figure 3.12 and 3.13) and change in sex-related inequality over time (Figure 3.14) can be viewed as interactive visuals.

To access these interactive visuals:

SCAN HERE: *or*   **VISIT:**

http://apps.who.int/gho/
data/view.wrapper.HE-
VIZ16?lang=en&menu=hide

Notes: See Appendix 3 for additional interactive visuals that present the state of sex-related inequality in childhood immunization through a story containing eight story point dashboards. These story points illustrate the latest situation and change-over-time results reported below, and provide additional information about the data across subgroups. For further reference, see the interactive reference table, also available in Appendix 3.

Latest situation

Figure 3.12 illustrates coverage of five immunization indicators, disaggregated by sex, across study countries. Countries reported variable levels of coverage within female and male subgroups, however, the extent of variation across countries (interquartile range) tended to be similar in subgroups of each indicator. The BCG indicator demonstrated the narrowest interquartile range in both females (10 percentages points) and males (14 percentage points), and the full immunization indicator had the widest interquartile ranges, at 33 percentage points in females and 31 percentage points in males.

FIGURE 3.12. Latest situation of immunization coverage among one-year-olds in low- and middle-income study countries, disaggregated by sex (DHS and MICS, 2010–2014)
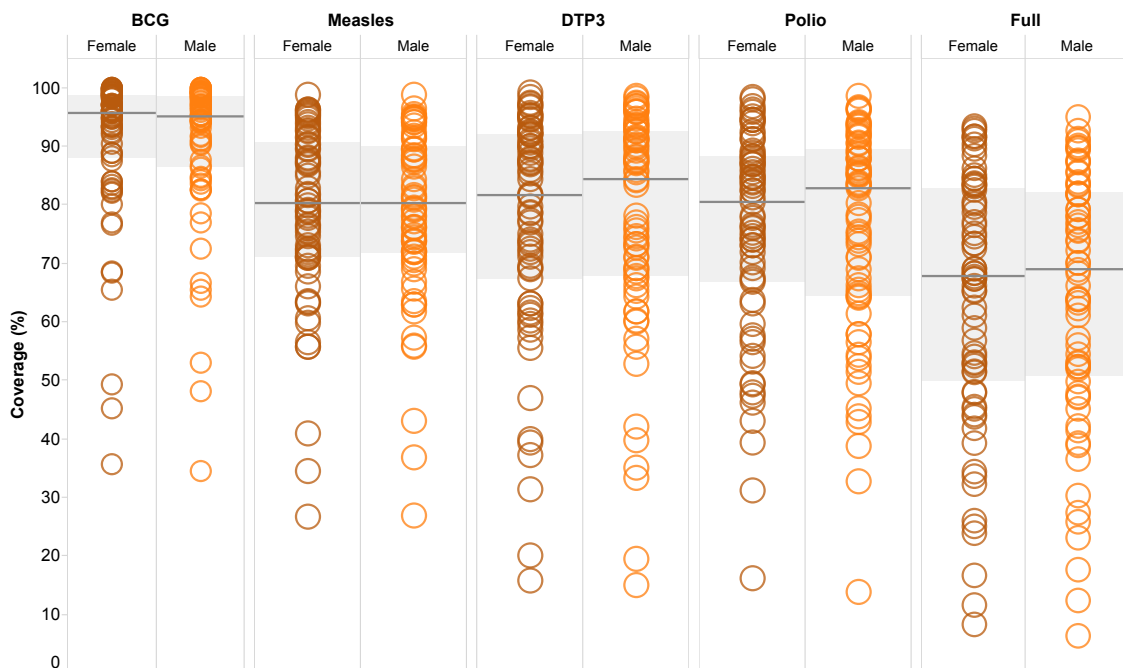
Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

The median in female–male difference of immunization coverage across study countries was less than 1 percentage point in all indicators (Figure 3.13). For the **BCG immunization** indicator, the middle 50% of study countries reported a female–male difference between -0.8 percentage points (absolute inequality favouring males) and 1.1 percentage points (absolute inequality favouring females). In 59 of the 68 study countries (87%), the gap between coverage in female and male subgroups was 2 percentage points or less. **Measles immunization** tended to be similar in females and males in the majority of study countries, with about three quarters of countries (74%) reporting an absolute difference of 2 percentage points or less. **DTP3 immunization** demonstrated a gap between females and males of 2 percentage points or less in 48 of the 69 study countries (70%). Tunisia reported a 6 percentage point margin favouring females over males. In **polio immunization**, the interquartile range of absolute

sex-related inequality (female–male difference) was from -2.1 to 1.5 percentage points. Comoros and Peru reported a gap of at least 5 percentage points between females and males: the situation in Comoros favoured females, whereas the situation in Peru favoured males.

Sex-related absolute inequality in the **full immunization** indicator, on average across study countries, was about 1 percentage point (favouring females). In 43 of the 67 study countries (64%), the absolute difference between the two subgroups was 2 percentage points or less. The magnitude of sex-related absolute inequality in Comoros was 10 percentage points, favouring females.

Change over time

On average, the change over time in sex-related inequality in childhood immunization across study countries was minimal. Across the five indicators, the median levels of annual absolute excess change

FIGURE 3.13. Sex-related absolute inequality in immunization coverage among one-year-olds in low- and middle-income study countries: difference in coverage between females and males (DHS and MICS, 2010–2014)
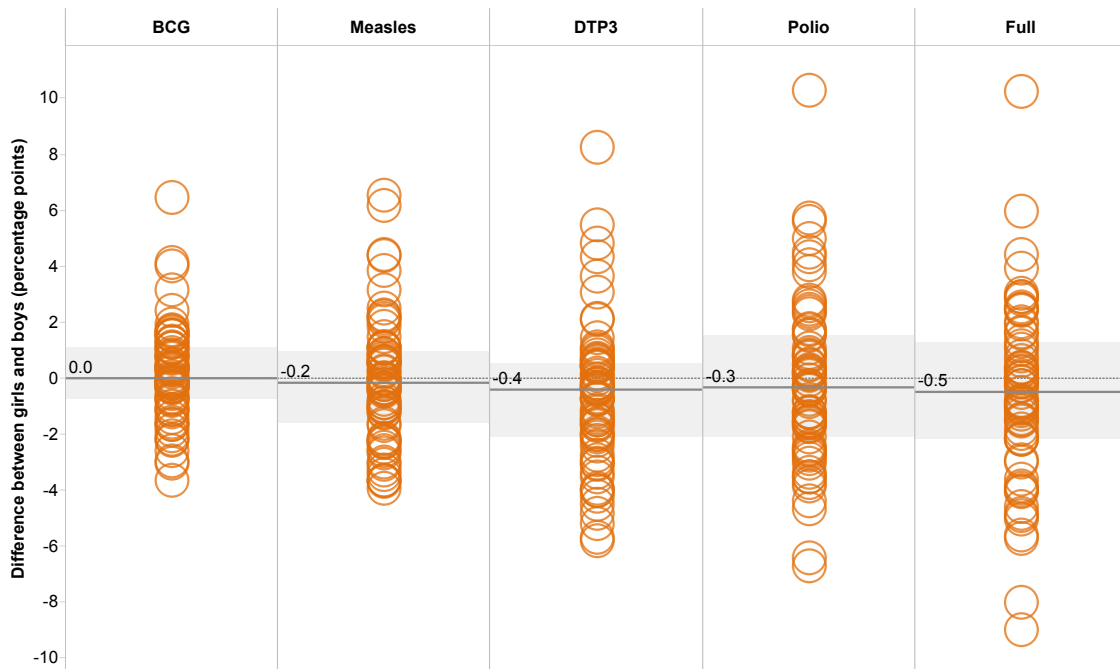
Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

were between 0.0 and 0.1 percentage points (Figure 3.14).

Overall, comparisons of the rate of change in **BCG immunization** coverage between sexes revealed change that favoured males in 8 of the 28 study countries (29%) and change that favoured females in 5 countries (18%); in the remaining majority of the countries, the absolute excess change was minimal, at about 1 percentage point difference over 10 years. Over the last decade, BCG immunization coverage tended to increase in both females and males. In the male subgroup, the median increase across countries was 0.6 percentage points per year; average increases of at least 2.0 percentage points per year were reported by Burkina Faso and Jordan. In females, the median annual coverage increase across countries was also 0.6 percentage points, and Burkina Faso, Ethiopia and Jordan reported annual increases of over 2.0 percentage points.

Study countries reported changes in **measles immunization** coverage that were favourable for males (21% of study countries) or for females (39% of study countries). In the male subgroup, one study country (Dominican Republic) reported a decrease in measles immunization coverage of 0.9 percentage points per year, and five countries reported increases of at least 2.0 percentage points per year (Armenia, Burkina Faso, Chad, Ethiopia and Mali). Similarly, in females, an average increase of at least 2.0 percentage points per year was reported by Burkina Faso, Ethiopia, and Mali.

The **DTP3 immunization** indicator had annual absolute excess change ranging from -0.2 to 0.4 percentage points in the middle 50% of countries. A greater proportion of countries (43%) reported excess change that favoured females than countries where excess change favoured males (25%). In females, Peru reported a decline in DTP3 coverage of 0.9 percentage points per year. Five study countries

FIGURE 3.14. Annual absolute excess change in males compared to females in immunization coverage among one-year-olds in low- and middle-income study countries (DHS and MICS, 2000–2004 and 2010–2014)
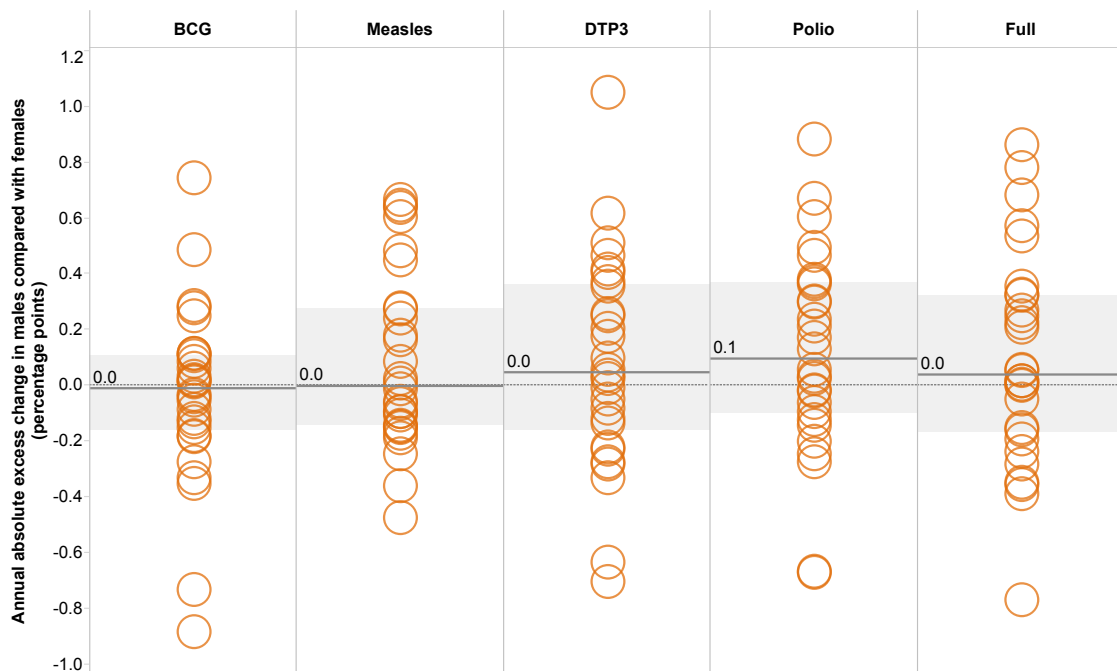
Notes: Circles indicate countries. Horizontal lines indicate the median value (middle point) across study countries. Light grey bands indicate the interquartile range (middle 50% of study country estimates).

reported an increase of at least 2.0 percentage points per year in females: Burkina Faso; Cambodia; Gabon; Mali; and Uganda. In the male subgroup, none of the study countries reported decreases in coverage between the two study periods; six countries had increased coverage at an average pace of 2.0 percentage points or more per year.

Polio immunization coverage had a median absolute excess change of 0.1 percentage points per year, with the middle 50% of values ranging from -0.1 to 0.4 percentage points. Of the 28 study countries (46%), 13 had excess change that was favourable for females. In males, the majority of countries (71%) reported increased coverage between the two study periods. The largest increase was reported by Burkina Faso, where the average increase in males was 4.7 percentage points per year. In females, 19 of 28 study countries (68%) reported increased coverage over the 10-year period; annual change over time among females was 2.0 percentage points or greater in Burkina Faso, Cambodia, Dominican Republic and Nigeria.

Across the 28 study countries, the median annual absolute excess change in males compared to females for the **full immunization** indicator was 0.0 percentage points. In one quarter of study countries (25%), the absolute excess change value indicated no change in sex-related inequality. The increase in coverage in females outpaced that of males by a maximum of 0.9 percentage points per year in Nigeria. Full immunization coverage in the male subgroup decreased in only one study country (Benin), by 13 percentage points over 10 years. Increases in coverage among males were most notable in Armenia, Burkina Faso, Cambodia and Jordan, exceeding 2.0 percentage points per year. For females, the interquartile range of annual absolute change ranged from 0.5 to 1.6 percentage points.

Inequality in priority countries

Interactive visual 6: inequality in priority countries

Figures demonstrating the state of inequality in 23 priority countries through PAR (Figure 3.15) and equiplots (horizontal dot plots) (Figures 3.16–3.38) can be viewed as interactive visuals.

To access these interactive visuals:

SCAN HERE: *or*   VISIT:

http://apps.who.int/gho/
data/view.wrapper.HE-
VIZ17?lang=en&menu=hide

The 23 priority countries were selected on the basis of having at least 20 percentage points higher coverage of DTP3 immunization in quintile 5 than quintile 1. Figure 3.15 illustrates the PAR summary measure for this indicator across countries, demonstrating the potential for improvement in DTP3 immunization coverage that would be achieved if within-country economic-related inequality were eliminated (that is, if the national average were equal to the level of coverage in the richest subgroup). The PAR results reflect data from the latest available survey across the 23 priority study countries. In addition to household economic status, PAR is also applied to demonstrate the potential for improvement in other dimensions of inequality in the accompanying interactive visual.

Overall, the greatest potential for improvement was reported in Nigeria, where national average of DTP3 immunization coverage would be improved by over 40 percentage points by eliminating economic-related inequality. In three other study countries (Central African Republic, Ethiopia and Lao People's

FIGURE 3.15. Potential for improvement in DTP3 immunization coverage among one-year-olds by eliminating within-country economic-related inequality in 23 priority study countries (DHS and MICS 2010–2014)
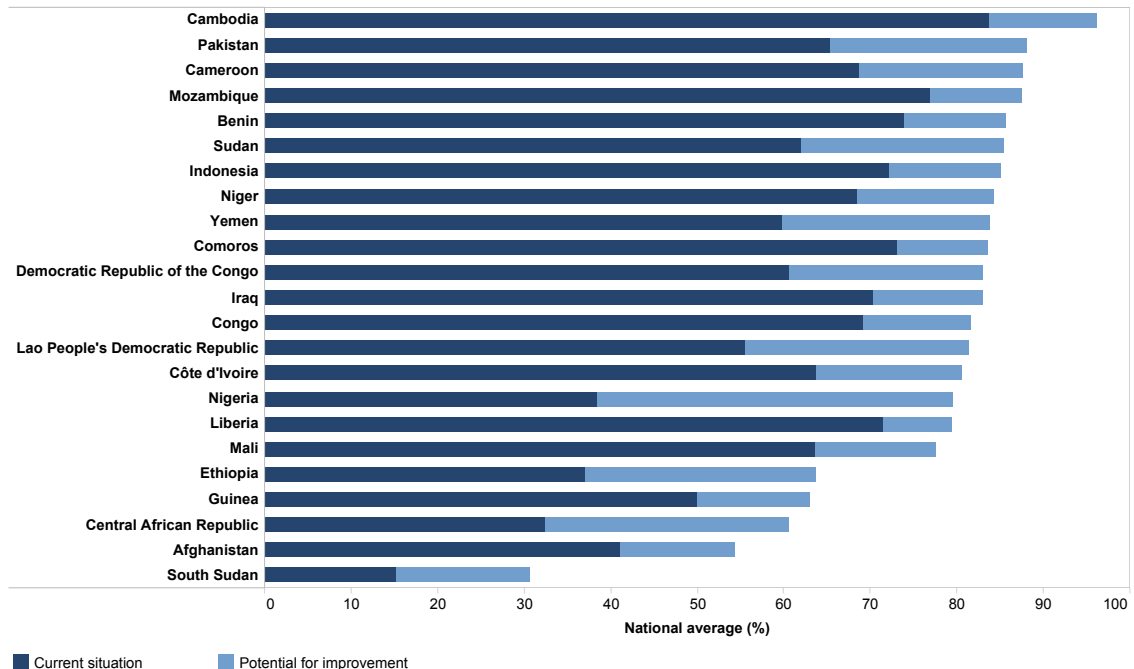
Note: The potential for improvement (pale blue shaded area) represents the improvement possible if the whole population had the same level of coverage as the most-advantaged subgroup (richest quintile).

Democratic Republic), PAR indicated a potential for a 25 percentage point or higher increase in national average, and in four other countries (Democratic Republic of the Congo, Pakistan, Sudan and Yemen) this increase would exceed 20 percentage points. According to the latest data, only one country had national average DTP3 coverage above 80%; if national averages were equal to the level of coverage in quintile 5, however, 17 out of the 23 countries (74%) would have DTP3 coverage of about 80% or higher.

The 23 priority countries, spanning both low- and middle-income country groups, reported variable degrees of inequality across other childhood immunization indicators and dimensions of inequality. The following country profiles detail patterns in disaggregated data from all available DHS and MICS surveys, dating from as early as 1994 to as recent as 2014 (see Supplementary Table 1).

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EACH COUNTRY FACES A UNIQUE STATE OF INEQUALITY IN CHILDHOOD IMMUNIZATION, THOUGH GLOBAL TRENDS AND SIMILARITIES CAN BE OBSERVED.

Afghanistan

FIGURE 3.16. Disaggregated data for immunization coverage among one-year-olds in Afghanistan (MICS 2010)
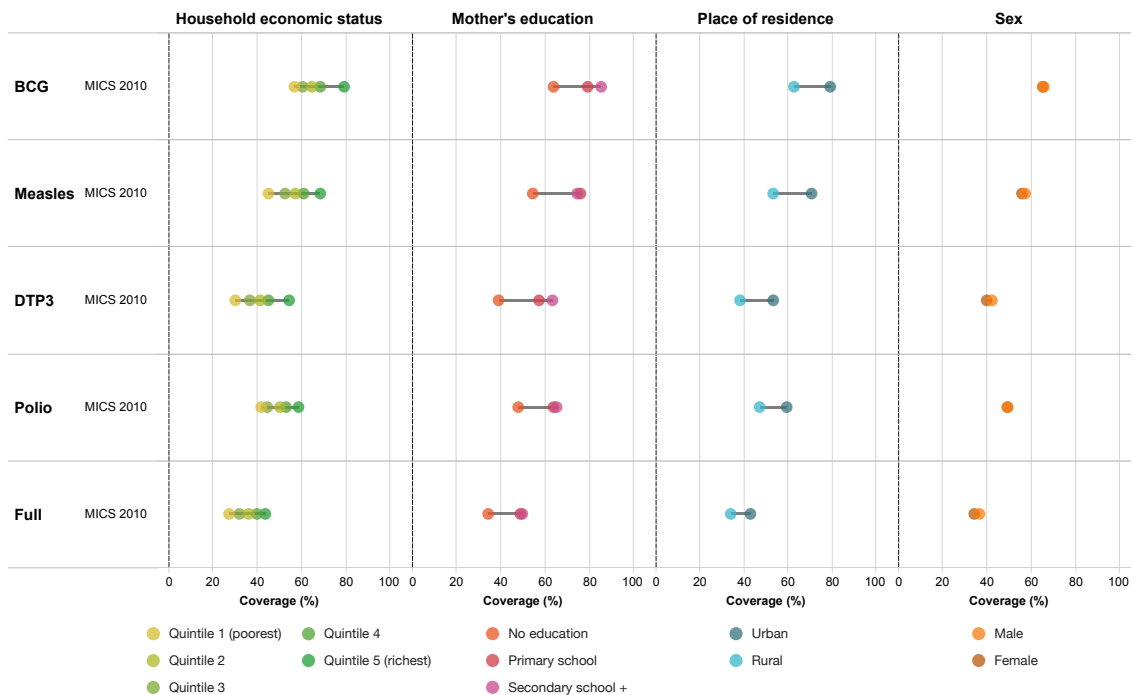
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Afghanistan reported data from 2010. Economic-related absolute inequality was over 15 percentage points for all five childhood immunization indicators, and over 20 percentage points for BCG, measles and DTP3 indicators. For all indicators, coverage was highest in quintile 5 and lowest in quintile 1; the intermediary quintiles demonstrated a pattern where coverage was consistently higher in quintile 2 than quintile 3 by a margin of about 5 percentage points for all indicators. In the BCG and DTP3 indicators, the difference in coverage between quintiles 4 and 5 was about 10 percentage points, which was the largest gap reported between any adjacent quintiles. Whereas the coverage of BCG immunization was greater than 50% in all quintiles, the coverage of full immunization was less than 50% in all quintiles.

Inequality according to mother's education reflected absolute differences in coverage between the most- and least-educated subgroups of 20 percentage points or higher for the BCG, measles and DTP3 indicators. For polio and full immunization indicators, this difference exceeded 15 percentage points. (For reference, note that the proportion of the population of one-year-olds classified in

the no education subgroup was over 90%.) In all indicators, there was a more sizeable difference between the no education and primary school subgroups than between the primary school and secondary school or higher subgroups. For instance, coverage of measles immunization was around 75% in the two more-educated subgroups, and around 55% in the least-educated subgroup. Around half of one-year-olds in the primary school and secondary school or higher subgroups had full immunization, whereas full immunization coverage among the no education subgroup was 35%.

Place of residence inequality in Afghanistan demonstrated higher levels of coverage in urban than rural areas. The BCG, measles and DTP3 indicators reported an absolute difference of 15 percentage points or higher. The absolute differences for polio and full immunization indicators were each around 10 percentage points. About 80% of one-year-olds lived in rural areas, and about 20% in urban areas.

The level of sex-related absolute inequality in Afghanistan was minimal for all five indicators.

Benin

FIGURE 3.17. Disaggregated data for immunization coverage among one-year-olds in Benin (DHS 1996, 2001, 2006, 2011)
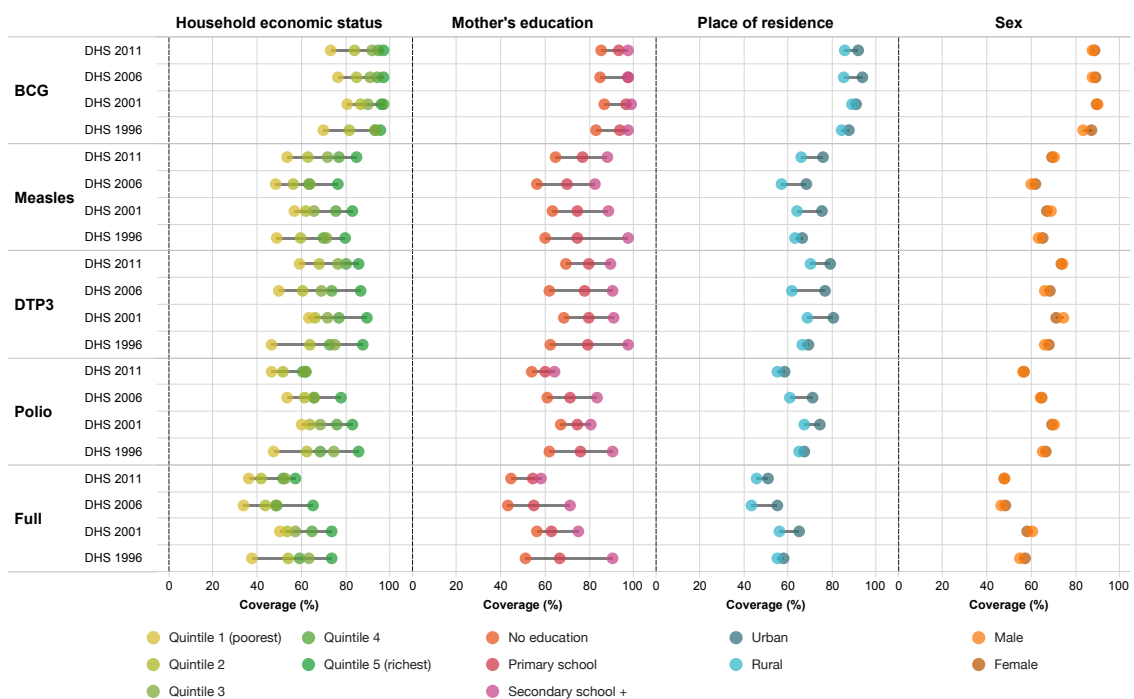
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Benin demonstrated consistently high levels of economic-related absolute inequality across four surveys, conducted over 1996–2011. The difference in coverage between quintiles 1 and 5 exceeded 20 percentage points for all indicators in all surveys, with only two exceptions: BCG coverage in 2001 and polio coverage in 2011 each had a difference of about 15 percentage points. For BCG and DTP3 indicators, the level of coverage in quintile 5 remained over 80% in all surveys, while the levels of coverage in poorer quintiles fluctuated, especially in the DTP3 indicator. The latest situation, based on data from DHS 2011, indicated absolute economic-related inequality across all indicators, ranging from about 15 percentage points for polio to a maximum of just over 30 percentage points for measles. Absolute economic-related inequality in polio coverage narrowed between 1996 and 2011, however, this was driven by decreasing coverage in the richer quintiles and overall decreases in national coverage. About one third of the poorest children reported full immunization coverage; full immunization coverage was under 60% in the richest children.

Education-related inequality was evident in all indicators. The difference between the most- and least-educated subgroups was consistently less than 15 percentage points for the BCG indicator, and coverage was greater than 80% in all subgroups at all time points.

Benin demonstrated high levels of absolute inequality in measles and DTP3 coverage, with differences exceeding 20 percentage points between the most- and least-educated subgroups in all surveys. Polio and full immunization indicators demonstrated overall decreasing coverage between 1996 and 2011 surveys; education-related inequality was lower in 2011 than other surveys, but this tended to be accompanied by decreases in coverage in the primary school and secondary school or higher subgroups.

Across all indicators and surveys, immunization coverage was higher in urban areas than rural areas. Looking at the most recent survey (DHS 2011), this difference was most pronounced in measles and DTP3 indicators. For DTP3, polio and full immunization indicators, absolute inequality narrowed between 2006 and 2011. The DTP3 indicator had increasing national coverage alongside accelerated improvement in rural areas. In contrast, narrowing absolute inequality in polio and full immunization coverage indicators was accompanied by decreased national coverage (polio) or unchanged national coverage (full immunization).

The level of coverage of the five immunization indicators was similar or the same between females and males in all surveys. The female–male difference did not exceed 5 percentage points.

Cambodia

FIGURE 3.18. Disaggregated data for immunization coverage among one-year-olds in Cambodia (DHS 2000, 2005, 2010, 2014)
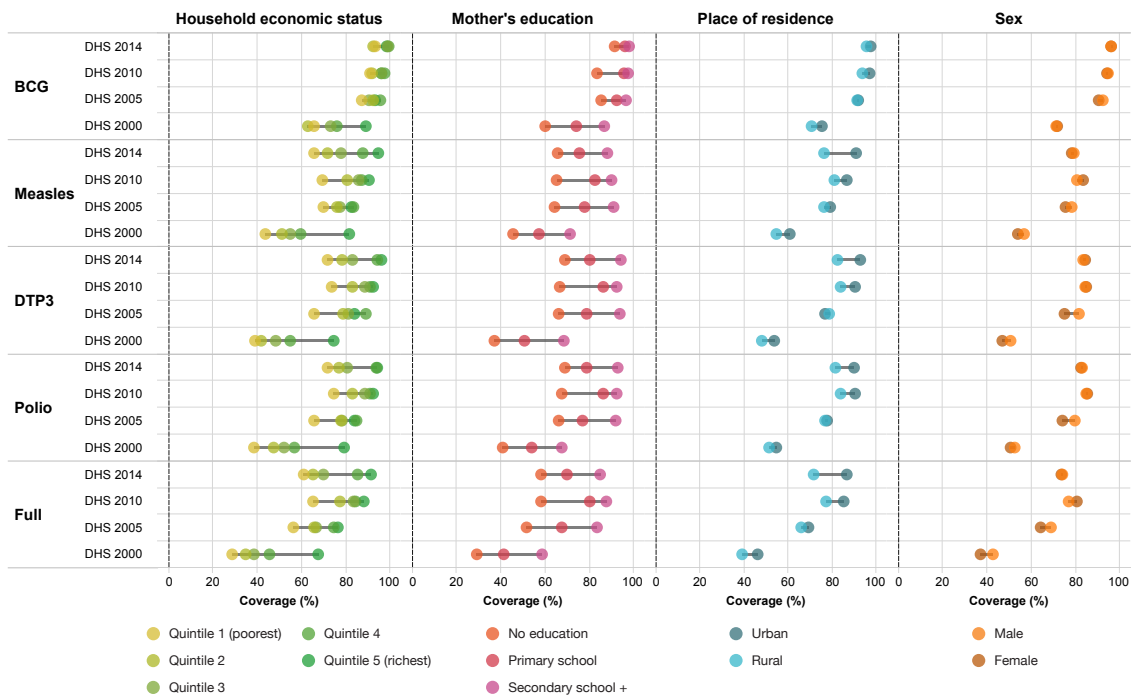
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Cambodia, all five immunization indicators reported a substantial narrowing of absolute economic-related inequality and increasing of national coverage between 2000 and 2005. In the 2005 and 2010 surveys, DTP3, polio and full immunization indicators had high, yet stable, levels of economic-related inequality (around 20 percentage points difference between quintiles 1 and 5) alongside modest increases in national coverage between 2005 and 2010; in 2014, however, the situation in these three indicators worsened: coverage in quintiles 1–3 decreased and absolute economic-related inequality widened slightly. In the BCG indicator, absolute economic-related inequality improved over time, decreasing to around 5 percentage points difference between quintiles 1 and 5 in 2010, a level that was maintained in 2014. The level of absolute economic-related inequality in measles immunization coverage has not improved since 2005.

Absolute education-related inequality in Cambodia demonstrated a similar pattern across measles, DTP3, polio and full immunization indicators. The difference between the least- and most-educated subgroups was consistent and high (about 25 percentage points). The intermediate primary school subgroup, which comprised at least half of the population of one-year old children at each of the four

time points, reported increased coverage between 2000–2005 and 2005–2010, and then demonstrated a regression in 2014 to about the same level of coverage as reported in 2005.

Absolute inequalities according to place of residence did not exceed 15 percentage points difference between urban and rural subgroups for any indicator in any survey. Where inequality was reported, coverage was higher in urban than rural subgroups. While inequality in the BCG indicator remained low across all surveys, inequality in the other four indicators was worse in 2014 than in 2000, due to faster improvement in urban subgroups than rural subgroups. For instance, the urban–rural difference in full immunization coverage increased from less than 10 percentage points in 2000 to 15 percentage points in 2014.

Sex-related inequality was low or non-existent across the five indicators. While the 2005 survey demonstrated a small difference favouring males (reaching a maximum of just over 5 percentage points in the DTP3 indicator), this trend was reversed (inequality slightly favoured females) or inequality nearly eliminated in all indicators in the following survey in 2010.

Cameroon

FIGURE 3.19. Disaggregated data for immunization coverage among one-year-olds in Cameroon (DHS 1998, DHS 2004, MICS 2006, DHS 2011)
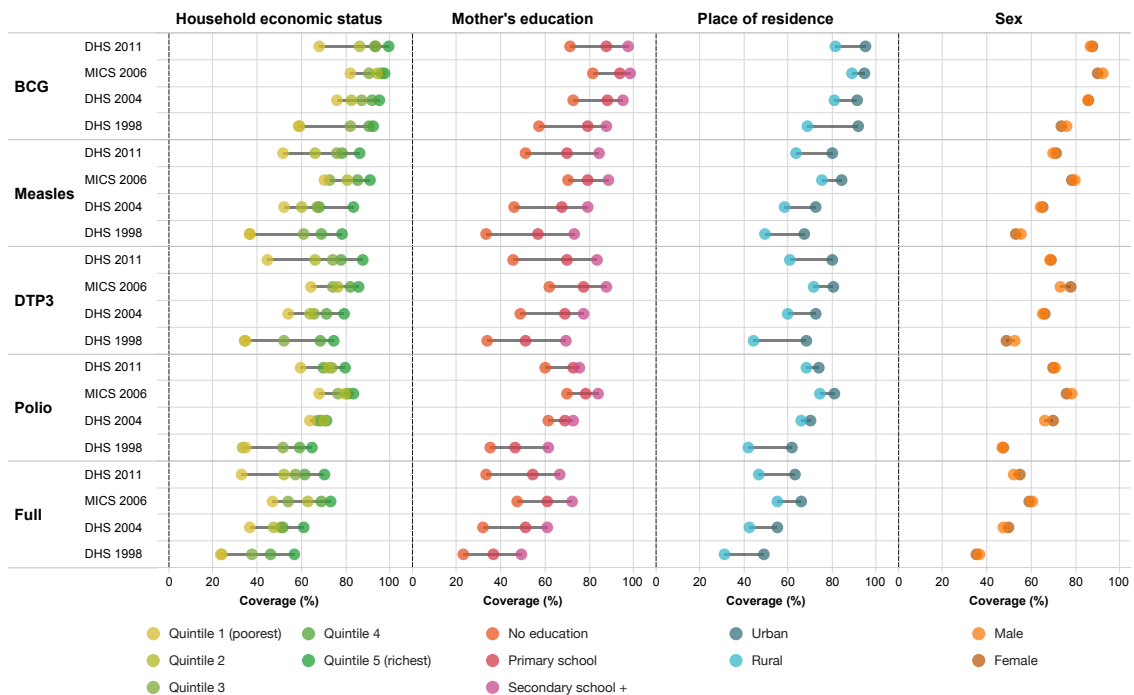
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Cameroon demonstrated economic-related absolute inequality across all five childhood immunization indicators in 2011, 2006, 2004 and 1998. In all indicators, the difference between the richest and poorest quintiles was more pronounced in 2011 than in 2006. The level of inequality in the DTP3 and full immunization indicators was larger in the most recent survey than in any of the three other surveys, at nearly 45 percentage points (DTP3) and over 35 percentage points (full immunization) in 2011. The increased level of inequality in 2011 was largely due to decreased coverage in quintile 1; quintiles 2–5 tended to report smaller decreases or no change between 2006 and 2011. In three indicators (BCG, measles and DTP3), economic-related absolute inequality decreased between 1998 and 2004, and then reached a minimum of around 15–20 percentage points in 2006, followed by an increase in 2011. Polio reported a minimum level of economic-related absolute inequality in 2004 (less than 10 percentage points), which increased to about 20 percentage points in 2011.

Education-related absolute inequality, the difference between the most- and least-educated subgroups, tended to be high in immunization indicators in Cameroon. In 2011, inequality amounted to more than 25 percentage points in all indicators except polio (where the difference was around 15 percentage points). In all indicators, the level of education-related absolute inequality increased between 2006 and 2011. Between these surveys, the level

of coverage decreased most rapidly in the no education subgroup, and decreases were also reported in the primary school subgroup; the level of coverage in the secondary school or higher subgroup decreased for all indicators except BCG, where coverage remained about the same. In all five indicators, the level of immunization coverage in the least-educated subgroup increased substantially between 1998 and 2006 (by a margin of at least 25 percentage points).

Place of residence inequality in childhood immunization demonstrated variable patterns over time in Cameroon, though coverage in urban areas was consistently higher than in rural areas. The latest status of absolute inequality indicated an urban–rural gap of about 15 percentage points or higher for measles, DTP3 and full immunization indicators. These four indicators reported decreases in absolute inequality from 1998 to 2003, and from 2003 to 2006, followed by an increase in absolute inequality in 2011. Polio reported lower levels of inequality in 2003, 2006 and 2011, with an urban–rural difference of about 5 percentage points, an improvement from the 20 percentage point gap reported in 1998.

Sex-related absolute inequality was minimal across all indicators and time points. The difference in coverage between females and males did not exceed 5 percentage points in any of the five indicators.

Central African Republic

FIGURE 3.20. Disaggregated data for immunization coverage among one-year-olds in Central African Republic (DHS 1994, MICS 2006, MICS 2010)
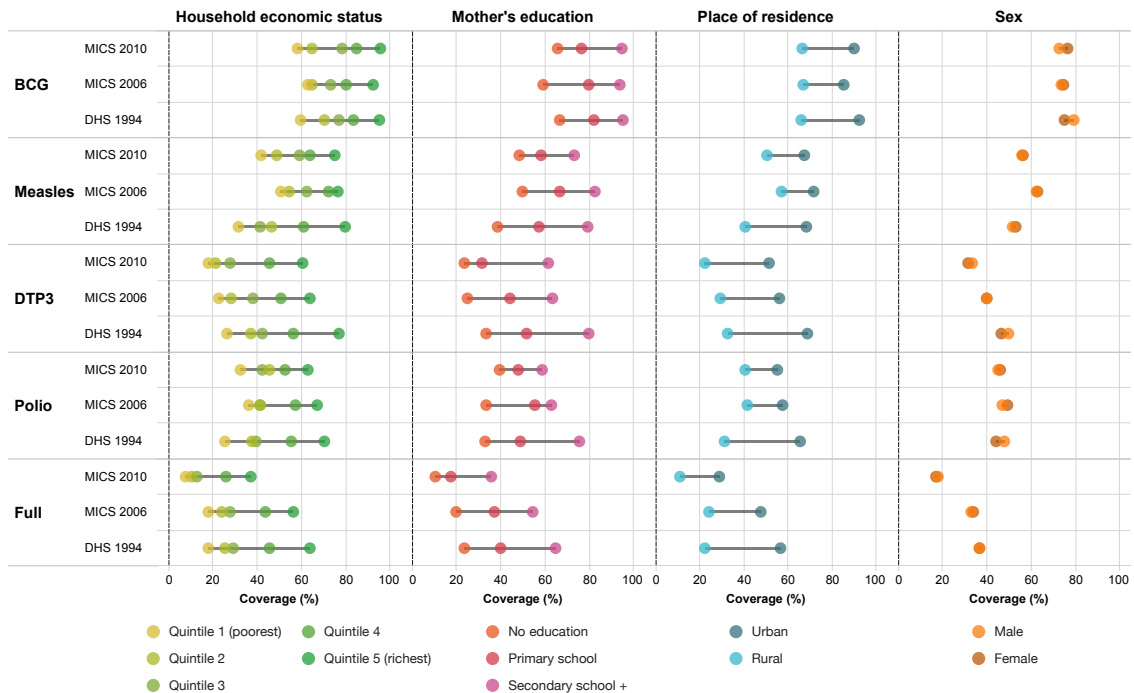
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Central African Republic, childhood immunization coverage demonstrated a gradient pattern across wealth quintiles, with the highest level of coverage reported in the richest subgroup, and the lowest level of coverage in the poorest. In the BCG indicator, the level of economic-related absolute inequality (difference between coverage in quintiles 1 and 5) was around 30–40 percentage points at all three time points (1994, 2006 and 2010). The level of absolute inequality in the measles indicator decreased from almost 50 percentage points in 1994 to about 25 percentage points in 2006, followed by an increase to nearly 35 percentage points in 2010. In the DTP3 indicator, all quintiles realized progressive declines in coverage over time alongside a drop in national average from nearly 50% in 1994 to just over 30% in 2010. The polio indicator had economic-related absolute inequality of about 45 percentage points in 1994, which narrowed to around 30 percentage points in 2006 and 2010. In all three surveys, more than half of one-year-olds in quintiles 4 and 5 received polio coverage, whereas coverage in quintiles 1–3 was below 50%. In the latest survey, less than one third of one-year-olds in quintile 1 received polio immunization. The full immunization indicator demonstrated a pattern of lower coverage in quintiles 1–3, intermediate coverage in quintile 4 and higher coverage in quintile 5. Economic-related absolute inequality in full immunization decreased over time (from 45 percentage points in 1994 to 30 percentage points in 2010), accompanied by decreased national coverage by about 20 percentage points between 1994 and 2010.

Childhood immunization coverage was consistently highest in the most-educated subgroup and lowest in the least-educated subgroup.

Coverage of the BCG indicator was around 95% in the most-educated subgroup in 1994, 2006 and 2010, whereas coverage in the least-educated subgroup was around 65% or lower in all surveys. Education-related absolute inequality in the measles indicator was reported as a 40 percentage point gap between the most and least educated in 1994, and decreased over time to a 25 percentage point gap in 2010. In DTP3 immunization, coverage levels across the three education subgroups demonstrated a pattern with a larger gap in coverage between the secondary school or higher subgroup and the primary school subgroup than the primary school subgroup and the no education subgroup. In polio immunization, education-related absolute inequality decreased over time, from a maximum of nearly 45 percentage points in 1994 to around 20 percentage points in 2010. The level of coverage of the full immunization indicator did not improve in any of the subgroups over the three surveys.

In all surveys and indicators, urban areas reported higher coverage than rural areas. The 2010 data revealed an urban–rural difference ranging from about 15 percentage points in the measles and polio indicators to nearly 30 percentage points for the DTP3 indicator. Between 1994 and 2010, inequality decreased in the measles, DTP3, polio and full immunization indicators.

Sex-related absolute inequality in Central African Republic was less than 5 percentage points across childhood immunization indicators reported by the three surveys.

Comoros

FIGURE 3.21. Disaggregated data for immunization coverage among one-year-olds in Comoros (DHS 1996, 2012)
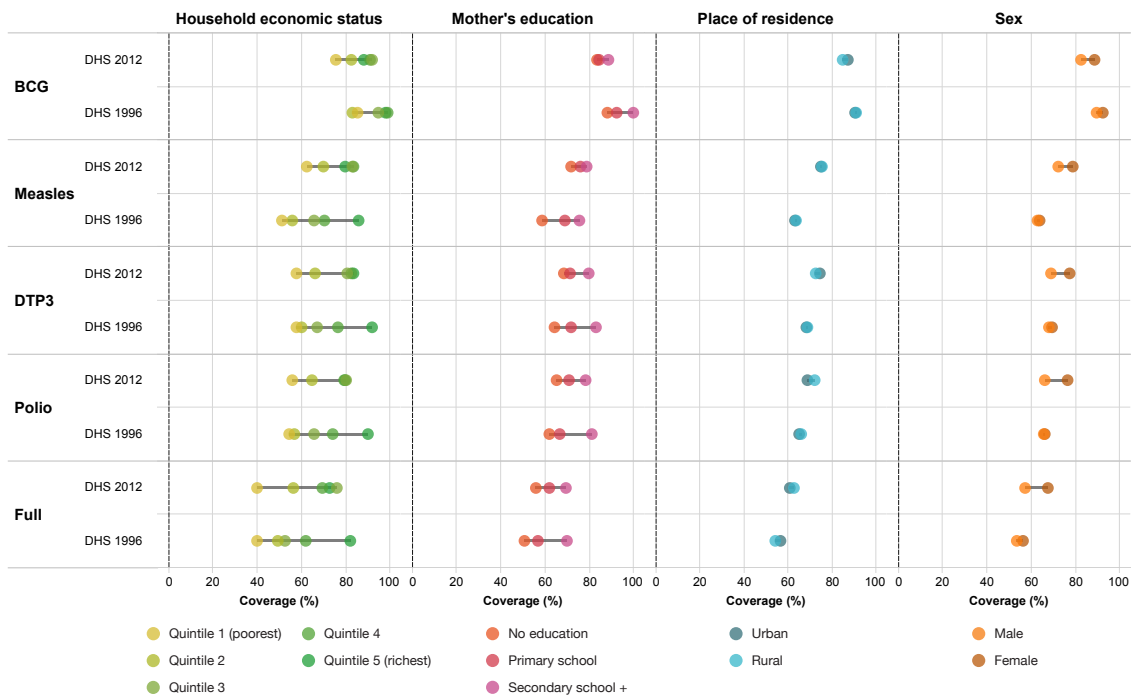
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Economic-related inequality in Comoros demonstrated three distinct patterns across immunization indicators. First, for the BCG indicator, absolute inequality remained the same but national average decreased between the two survey points (the difference between quintiles 1 and 5 was approximately the same in 1996 and 2012, however, national average decreased by about 5 percentage points). The other four indicators all had modest increases in national average. The second pattern, demonstrated by the measles indicator, reported narrowing absolute inequality, with gains in quintiles 1–4. Third, the DTP3, polio and full immunization indicators also had narrowing absolute inequality, however, this was realized through declining levels of coverage in quintile 5. Meanwhile, the levels of coverage in each of the intermediate quintiles (quintiles 2–4) improved.

Between 1996 and 2012, absolute education-related inequality improved in all five immunization indicators. In the case of the BCG indicator, the level of coverage decreased in all subgroups, but

more markedly in the most-educated subgroup. DTP3 and polio indicators also reported decreased coverage in the most-educated subgroup, however, in the case of these two indicators, coverage levels increased or stayed about the same in the no education and primary school subgroups. The measles indicator demonstrated a desirable pattern, whereby coverage increased in all subgroups, with accelerated gains in the least-educated subgroup. The full immunization indicator demonstrated moderate increases in the no education and primary school subgroups, and approximately the same level of coverage in the secondary school or higher subgroup.

For all five indicators, the level of absolute inequality according to place of residence was very low in 1996, with small or no change in inequality in 2012.

Absolute sex-related inequality was very low across all five indicators in 1996. In 2012, females had higher levels of coverage in all indicators by a margin of about 5–10 percentage points.

Congo

FIGURE 3.22. Disaggregated data for immunization coverage among one-year-olds in Congo (DHS 2005, 2011)
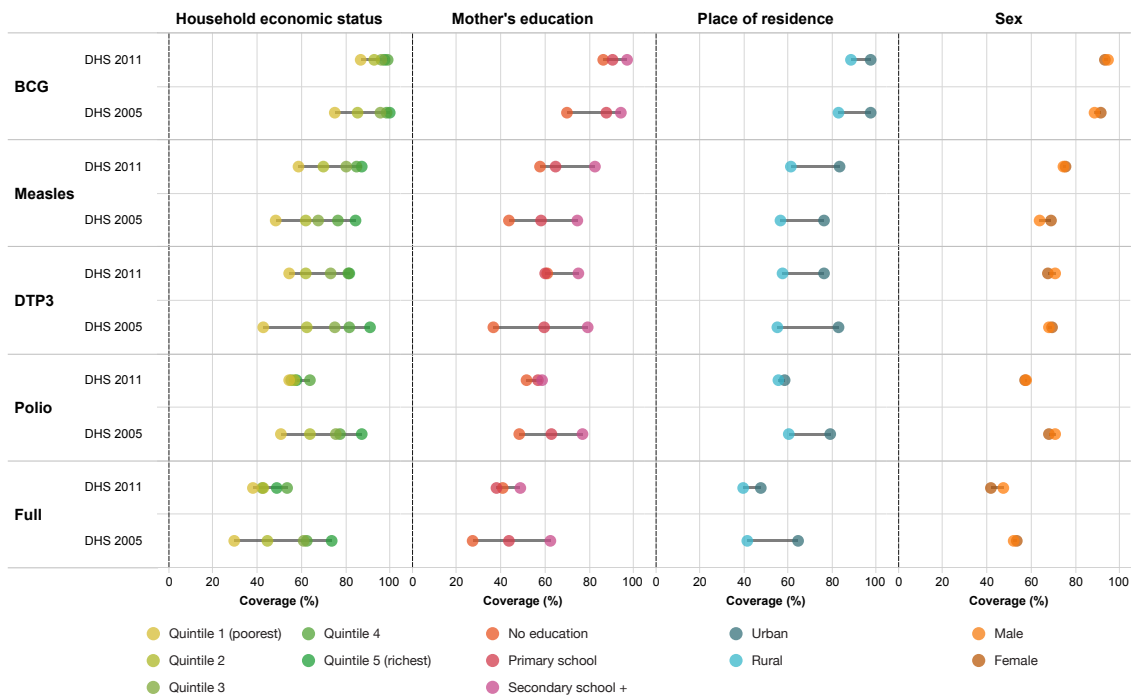
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Congo, absolute economic-related inequality decreased in all five immunization indicators between 2005 and 2011. In BCG, measles and DTP3 indicators, the national average increased or stayed about the same, while coverage in the poorest quintile of each indicator increased more markedly to narrow the gap. For DTP3, coverage in quintile 5 decreased by almost 10 percentage points between 2005 and 2011. Polio and full immunization indicators each reported lower absolute economic-related inequality alongside lower national coverage in 2011 than 2005; decreased levels of inequality were attributed to increasing coverage in quintile 1 and declining coverage in other quintiles (especially quintiles 3–5).

The level of absolute inequality related to mother's education decreased across all five immunization indicators, demonstrating different patterns. Declining inequality in the BCG indicator was driven by increased coverage in the no education subgroup by over 15 percentage points, while coverage levels in the primary school and secondary school or higher subgroups remained about the same. Measles immunization coverage increased in all three subgroups, with fastest gains in the least educated. In the DTP3 indicator, coverage in the no education subgroup increased by nearly 25 percentage points, while coverage in the primary school subgroup was similar in both surveys, and coverage in the secondary school or higher subgroup decreased by less than 5 percentage points. For polio and full immunization indicators, decreased absolute

education-related inequality was mainly due to declining coverage in the most-educated subgroups, and increased coverage in the least-educated subgroups.

In Congo, place of residence inequality demonstrated higher coverage in the urban subgroup across all indicators. Absolute inequality in BCG coverage decreased between 2005 and 2011 thanks to increased coverage in rural areas — coverage in urban areas was unchanged. Absolute place of residence inequality in measles immunization remained around 20 percentage points, with improvements in both urban and rural subgroups. The DTP3 indicator also demonstrated decreasing inequality, realized mainly due to decreased levels of coverage in the urban subgroup. Polio and full immunization indicators demonstrated decreases in the level of absolute inequality from over 20 percentage points difference in 2005 to less than 10 percentage points difference in 2011. Both indicators had substantially lower urban coverage in 2011 than 2005.

With a few exceptions, absolute sex-related inequality was generally very low across indicators. Measles coverage in 2005 was about 5 percentage points higher in females than males, though levels were about the same in 2011. Full immunization coverage had very low levels of absolute sex-related inequality in 2005, however, in 2011 coverage in males exceeded coverage in females by about 5 percentage points.

Côte d'Ivoire

FIGURE 3.23. Disaggregated data for immunization coverage among one-year-olds in Côte d'Ivoire (DHS 1994, DHS 1998, MICS 2006, DHS 2011)
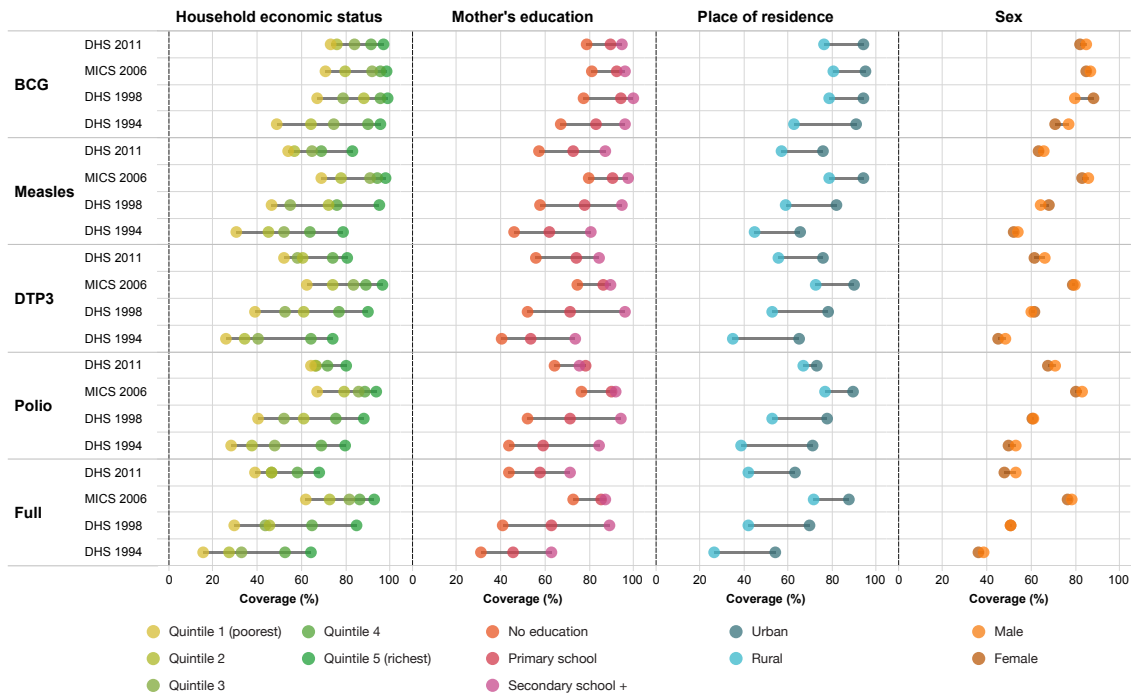
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Côte d'Ivoire reported data about childhood immunization indicators in four surveys, conducted in 1994, 1998, 2006 and 2011. In measles, DTP3, polio and full immunization indicators, the level of coverage in each quintile improved in 1998 and 2006, followed by a decrease in all quintiles in 2011. In all indicators, the level of coverage in the poorest wealth quintile improved substantially between 1994 and 2006. In 1994, the level of coverage among the poorest one-year-olds was below 50% for BCG immunization, and around 30% or lower for measles, DTP3, polio and full immunization; by 2006, these values were all over 60% in quintile 1. In quintile 5, marked improvements were reported between 1994 and 1998. The extent of economic-related absolute inequality decreased over time by a margin of at least 20 percentage points between 1994 and 2011 in all indicators. The largest decrease was in polio, where the rich–poor difference decreased from over 50 percentage points in 1994 to 15 percentage points in 2011.

Across the four surveys, education-related absolute inequality in childhood immunization tended to reach a minimum in 2006. The difference in coverage between the most- and least-educated subgroups was at least as small in 2006 as in 2011 with the exception of polio (where absolute inequality was about 5 percentage points higher in 2006). Between 1994 and 1998, gains in coverage were realized in all subgroups, though in four indicators (measles, DTP3,

polio and full immunization) the magnitude of increase was higher in the primary school subgroup and in the secondary school subgroup than the no education subgroup; between 1998 and 2006, these four indicators realized substantial improvements in coverage in the least-educated subgroup. According to the latest data from 2011, the largest education-related absolute inequality was in measles (30 percentage points), and the smallest inequality was in polio (10 percentage points).

Place of residence inequality was reported in all indicators and in all surveys, with higher coverage in urban than rural areas. In DTP3, polio and full immunization indicators, absolute inequality was smaller in 2006 and 2011 than in 1994 and 1998. The BCG indicator had an urban–rural difference of nearly 30 percentage points in 1994, which dropped to around 20 percentage points or less in the three other surveys. The measles indicator reported maximum place of residence absolute inequality that approached 25 percentage points in 1998, but fell between 15 and 20 percentage points in the other surveys.

The difference in coverage between females and males did not exceed 10 percentage points for any of the five indicators, at any time point. The latest data from 2011 demonstrated a difference around 5 percentage points or less (favouring males) across all indicators.

Democratic Republic of the Congo

FIGURE 3.24. Disaggregated data for immunization coverage among one-year-olds in Democratic Republic of the Congo (DHS 2007, MICS 2010, DHS 2013)
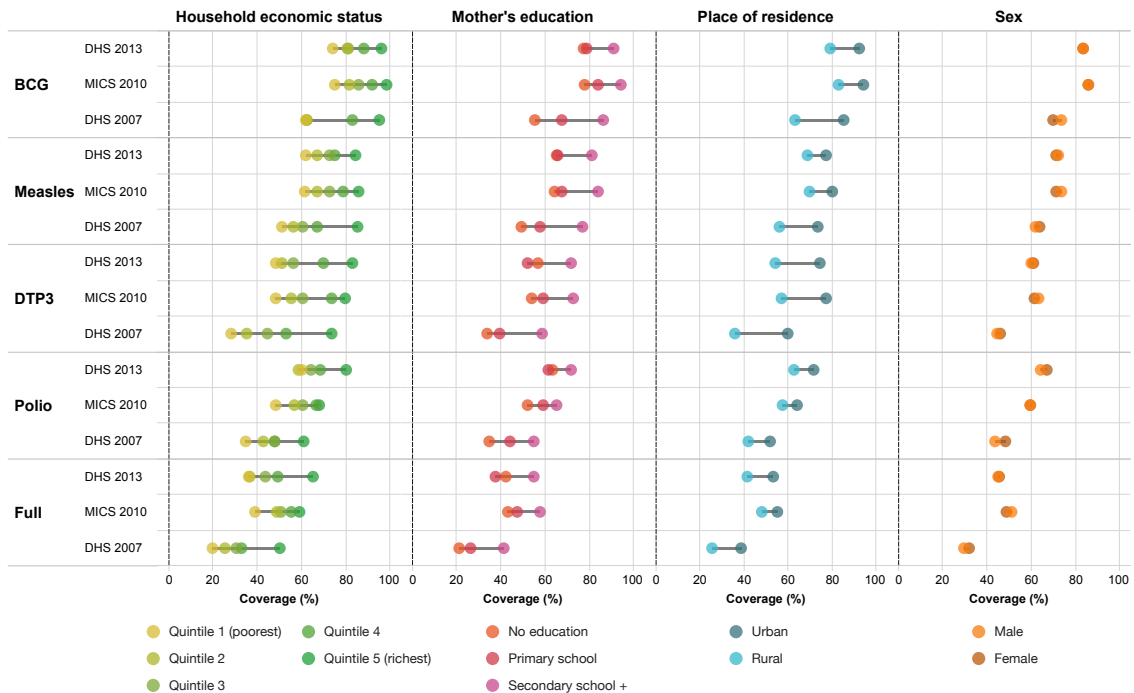
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Democratic Republic of the Congo, absolute economic-related inequality was high (over 20 percentage points difference between quintiles 1 and 5) and persistent across all five indicators, and all surveys. In all indicators, the national coverage increased between 2007 and 2010, and absolute inequality decreased due to substantial gains in quintiles 1–4. For four of the indicators – BCG, measles DTP3 and full immunization – the national coverage remained similar or was slightly lower in 2013 than in 2010; the coverage across quintiles tended to stay the same or decrease in these four indicators, with the exception of full immunization, where quintile 5 demonstrated a small increase in coverage. The polio indicator had continual improvements in national coverage over the three surveys with sustained gains over time in the richest and poorest quintiles. Absolute economic-related inequality in polio coverage decreased marginally between 2007 and 2010, as the gap between the richest and poorest quintiles decreased by about 5 percentage points; this gap remained about the same between 2010 and 2013, at about 20 percentage points.

Inequality according to mother's education demonstrated a pattern similar to economic-related inequality. The level of absolute inequality across all indicators improved between 2007 and 2010, driven by accelerated gains in the no education and primary school

subgroups, and in 2013 the situation was stagnant or slightly worse than in 2010 (with the exception of the polio indicator, where education-related inequality narrowed). In all indicators, the level of coverage in the primary school subgroup – which accounts for the greatest proportion of the population of one-year-olds – decreased or stayed about the same between 2010 and 2013.

The urban subgroup reported higher coverage than the rural subgroup across all five indicators and all surveys. In BCG and measles indicators, the level of absolute inequality between urban and rural subgroups declined from over 20 percentage points difference in 2007 to around 10 percentage points or less in 2010. Absolute inequality in DTP3 coverage remained high (20 percentage points or higher difference between urban and rural) in all surveys, whereas absolute inequality in polio remained at 10 percentage points or less.

Sex-related inequality tended to be very low, especially in the latest survey. In the BCG indicator, low levels of absolute inequality favouring males were reported in 2007, however the difference in coverage between subgroups was less than 5 percentage points. In the polio indicator, low levels of absolute inequality (less than 5 percentage points) favouring females were reported in 2007.

Ethiopia

FIGURE 3.25. Disaggregated data for immunization coverage among one-year-olds in Ethiopia (DHS 2000, 2005, 2011)
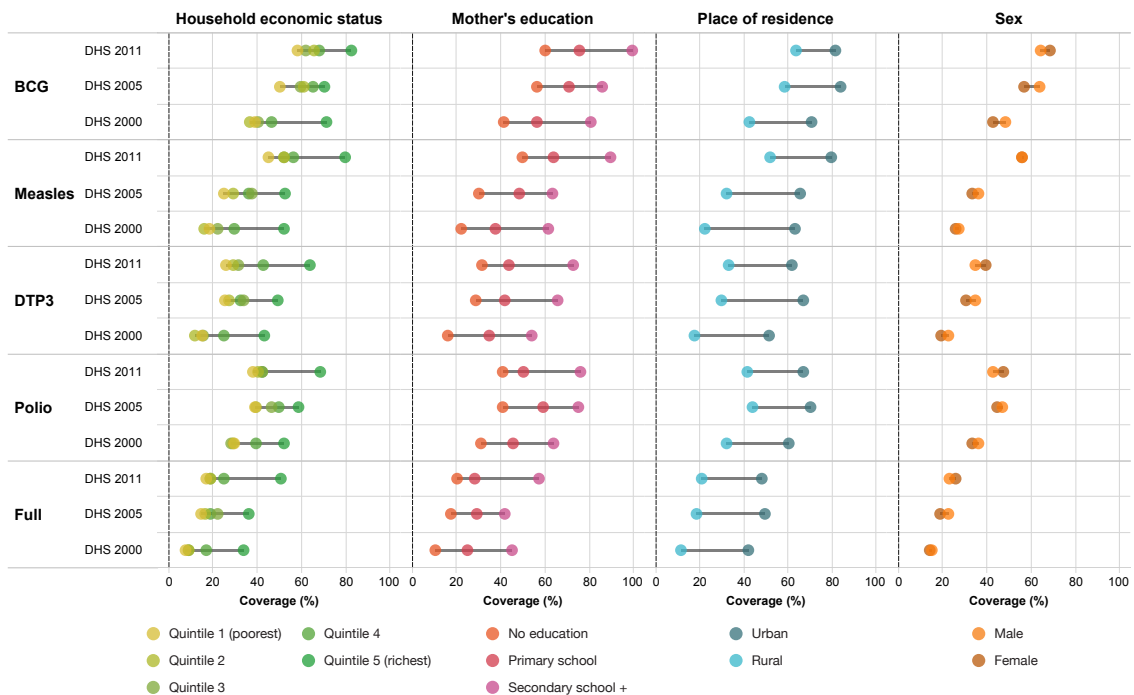
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Ethiopia, high levels of absolute economic-related inequality in all five immunization indicators persisted across the three surveys conducted in 2000, 2005 and 2011: the difference in coverage between quintiles 1 and 5 remained around 20 percentage points or higher. The BCG, measles and DTP3 indicators had progressive gains (or no change) in coverage in all quintiles, while polio and full immunization indicators reported a lack of progress in quintiles 1–4 over the period 2005–2011. In all indicators, the gap between quintiles 4 and 5 increased between 2005 and 2011, indicating that coverage tended to improve faster in the richest subgroup than among the intermediate subgroups.

Absolute inequality according to mother's education was high across all indicators and surveys, exceeding 20 percentage points difference between the most- and least-educated subgroups. High levels of inequality persisted across the surveys alongside gains in national coverage. The measles indicator, for instance, demonstrated a substantial increase in coverage in all education subgroups between 2005 and 2011, though improvements were greater in the most-educated subgroup, resulting in widening absolute inequality. For

the full immunization indicator, the no education and primary school subgroups had almost no change in the level of coverage between 2005 and 2011, yet the coverage in the secondary school or higher subgroup increased by over 15 percentage points during this period.

Place of residence inequality demonstrated advantage in the urban subgroup, as coverage exceeded the rural subgroup by 20 percentage points or more in all indicators in all surveys (except for BCG in 2011). The extent of absolute inequality decreased over the survey periods in the BCG and measles indicators.

Overall, absolute sex-related inequality in Ethiopia tended to be low, and did not demonstrate a clear pattern of advantage for the female or male subgroup. In 2011, all indicators had a difference of less than 5 percentage points between the two subgroups and, where marginal differences were reported, females had higher coverage. In 2000 and 2005, males tended to have similar or marginally higher coverage than females, reaching a maximum difference of just over 5 percentage points in the BCG indicator (2005 data).

Guinea

FIGURE 3.26. Disaggregated data for immunization coverage among one-year-olds in Guinea (DHS 1999, 2005, 2012)
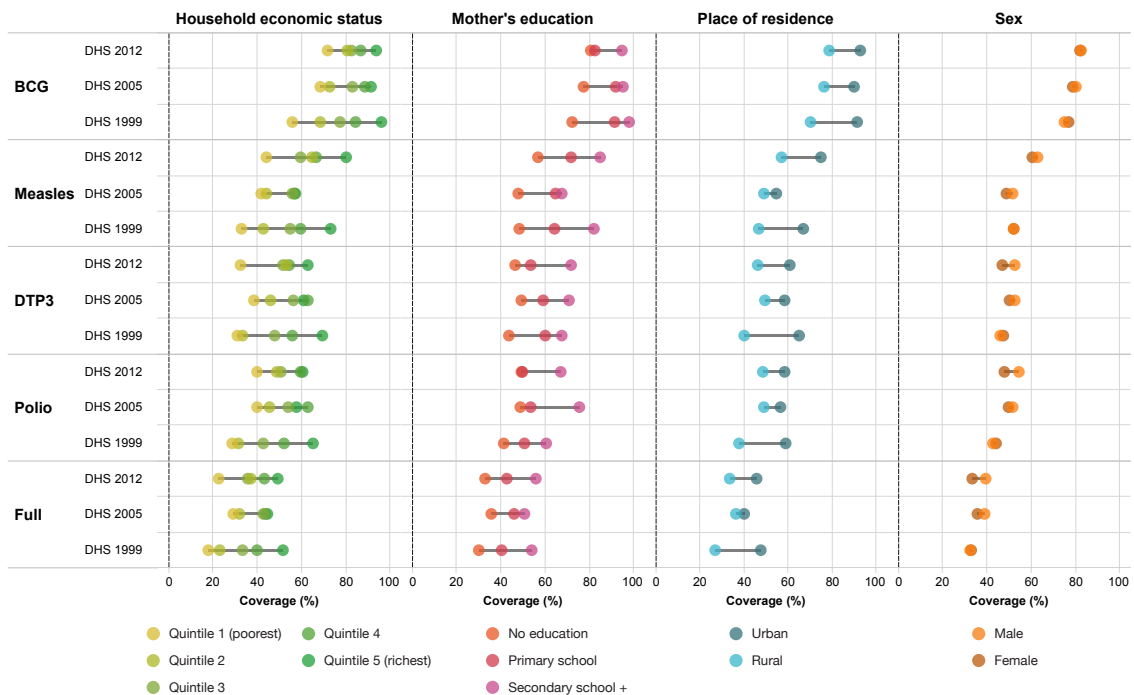
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Guinea, the latest available data from 2012 demonstrated high levels of absolute economic-related inequality, with a difference of over 20 percentage points between quintiles 1 and 5 in all indicators. Over the three surveys in 1999, 2005 and 2012, all indicators had a characteristic pattern: absolute economic-related inequality declined between 1999 and 2005, typically due to increasing coverage in quintiles 1 and 2, and decreasing coverage in quintile 5. Then, absolute inequality between quintiles 1 and 5 widened or stayed the same between 2005 and 2012; in all indicators, coverage in the all but the poorest subgroup (quintiles 2–5) tended to increase or stay the same between 2005 and 2012. For indicators where absolute inequality widened, this was due to increased coverage in quintile 5 (measles indicator), decreased coverage in quintile 1 (DTP3 indicator) or both increased coverage in quintile 5 and decreased coverage in quintile 1 (full immunization indicator).

Education-related inequality was evident across all indicators, though indicators demonstrated different patterns of change over time. For example, in the BCG indicator, absolute inequality decreased from a difference of over 25 percentage points between the most- and least-educated subgroups in 1999 to just under 15 percentage points in 2012. This change was driven by increasing coverage in the least-educated subgroup and decreasing coverage in the most-educated subgroup, and accompanied by declining BCG coverage in

the primary school subgroup by about 10 percentage points. In the measles indicator, absolute inequality (measured as the difference between the most- and least-educated subgroups) narrowed between 1999 and 2005 due to decreased coverage in the most-educated subgroup; in 2012, measles in all education subgroups increased, but by the highest margin in the most-educated subgroup, resulting in widening absolute inequality.

Place of residence inequality indicated that urban subgroups had higher immunization coverage than rural subgroups. For all indicators, absolute inequality was the largest in 1999 (around 20 percentage points or higher difference between urban and rural subgroups), and the narrowest in 2005 (less than 10 percentage points or lower in measles, DTP3, polio and full immunization indicators, and around 15 percentage points in the BCG indicator). The magnitude of absolute place of residence inequality across the five indicators in 2012 ranged from 10 percentage points in the polio indicator, to nearly 20 percentage points in the measles indicator.

The five immunization indicators demonstrated no – or very low levels of – absolute sex-related inequality in 1999 and 2005. In 2012, males had higher coverage than females for the DTP3, polio and full immunization indicators, with small differences between subgroups of just over 5 percentage points.

Indonesia

FIGURE 3.27. Disaggregated data for immunization coverage among one-year-olds in Indonesia (DHS 1994, 1997, 2002, 2007, 2012)
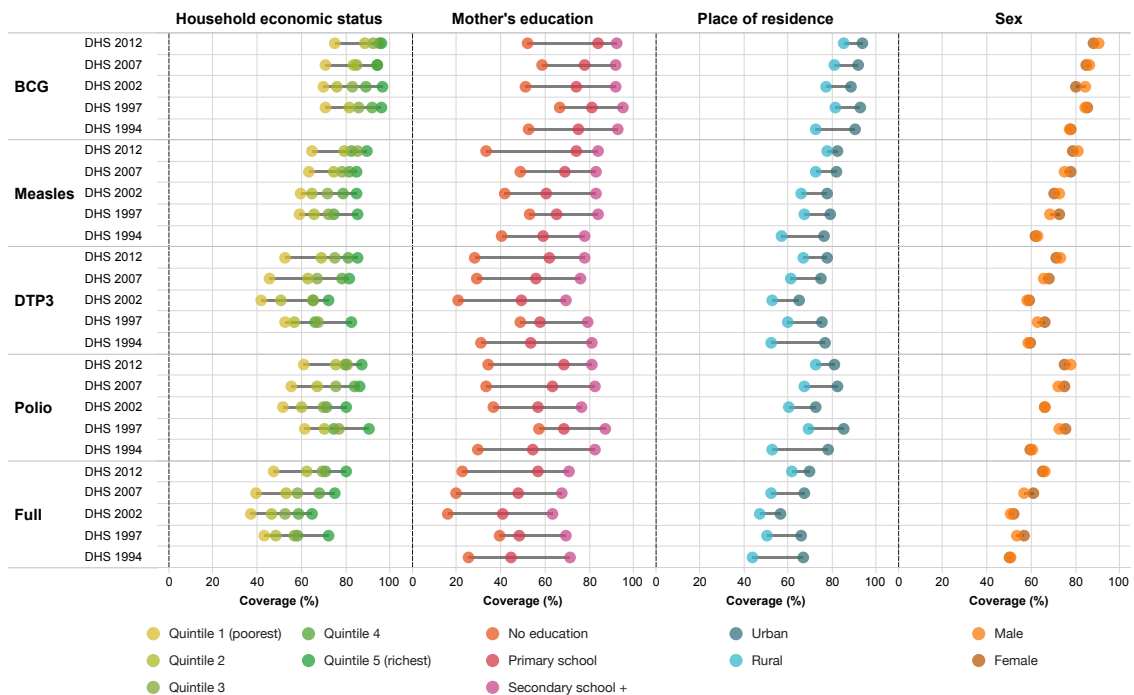
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Indonesia reported persistently high levels of absolute economic-related inequality in four surveys spanning from 1997 to 2012. In 2012, the difference in immunization coverage between quintiles 1 and 5 exceeded 20 percentage points for the BCG indicator, was around 25 percentage points for measles and polio indicators and was over 30 percentage points for DTP3 and full immunization indicators. For DTP3, polio and full immunization indicators, national coverage between 1997 and 2002 decreased, and coverage levels in all quintiles either decreased or stayed about the same. Subsequent surveys in 2007 and 2012 demonstrated improvements or no change in all quintiles for these three indicators. In the 2007 and 2012 surveys, all five indicators demonstrated a pattern of marginal exclusion, whereby coverage in quintile 1 was markedly lower than the other four quintiles.

Absolute education-related inequality in Indonesia was very high across all indicators and surveys, remaining around or above a 30 percentage point difference between the most- and least-educated subgroups. (For reference, note that the proportion of the population

of one-year-olds classified in the no education and primary school subgroups declined between 1994 and 2012, and the proportion with secondary school or higher increased.) All indicators realized a narrowing of inequality in 1997, followed by widening inequality in 2002, and dramatic decreases in coverage in the least-educated subgroup. In 2007 and 2012, all indicators had improvements in the primary school subgroup, narrowing the gap with the secondary school or higher subgroup.

For all five indicators, absolute inequality according to place of residence was lower in 2012 than in any of the four previous surveys. The difference between urban and rural coverage ranged from under 5 percentage points (for the measles indicator) to just over 10 percentage points (for the DTP3 indicator). In 1994, the difference between urban and rural subgroups was around 20 percentage points or higher for all indicators.

The latest 2012 data for all indicators indicated that absolute sex-related inequality was minimal.

Iraq

FIGURE 3.28. Disaggregated data for immunization coverage among one-year-olds in Iraq (MICS 2006, 2011)
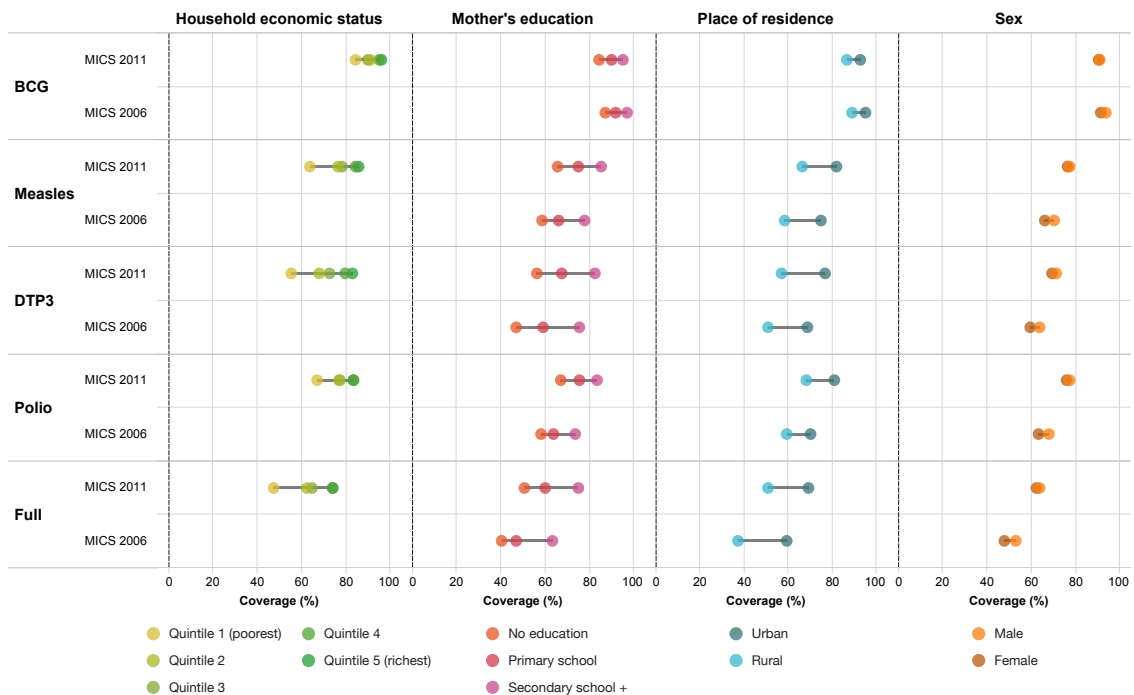
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Iraq reported data from 2011 about economic-related inequality in childhood immunization. The rich–poor difference was the most pronounced for the DTP3 indicator (almost 30 percentage points), followed by the full immunization, measles, polio and BCG indicators (just over 10 percentage points). Except for the BCG indicator, coverage across subgroups tended to display a marginal exclusion pattern, with quintile 1 lagging behind the other four richer quintiles. In all indicators, the level of coverage in quintile 1 was around 50% or higher. In the richest subgroup, coverage of at least three quarters of one-year-olds was reported for each indicator.

Education disaggregated data about the five childhood immunization indicators were available from surveys in 2006 and 2011. The magnitude of education-related absolute inequality (difference between the most- and least- educated subgroups) remained unchanged; the pattern of inequality across subgroups for each indicator also remained similar. For instance, the gap in full immunization coverage between the most and least educated was just under 25 percentage points in 2006 and 2011, with a greater

gap between the primary school and secondary school or higher subgroups than between the primary school and no education subgroups. The BCG indicator had the narrowest education-related absolute inequality, amounting to about 10 percentage points in 2006 and 2011.

The urban–rural difference in immunization coverage was most pronounced in the DTP3 and full immunization indicators (around 20 percentage points), and least pronounced in the BCG indicator (around 5 percentage points). In all indicators, coverage was higher in urban areas than rural areas. The magnitude of inequality remained similar in 2011 as in 2006.

According to the latest survey data from 2011, there was no sex-related absolute inequality in childhood immunization indicators in Iraq. In 2006, the measles, DTP3, polio and full immunization indicators reported higher coverage in males than females by a margin of about 5 percentage points.

Lao People's Democratic Republic

FIGURE 3.29. Disaggregated data for immunization coverage among one-year-olds in Lao People's Democratic Republic (MICS 2006, 2011)
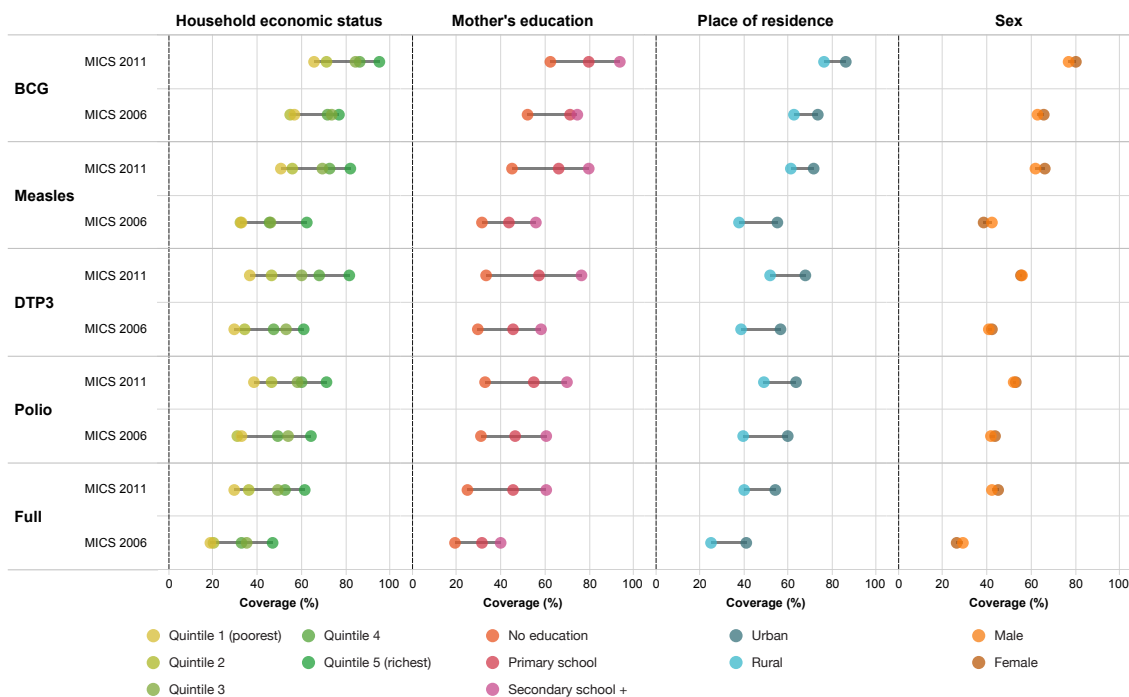
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Economic-related absolute inequality in childhood immunization indicators, measured as the gap between quintile 5 and quintile 1, tended to increase or stay the same between 2006 and 2011. Two indicators reported a sizable increase in inequality of about 10 percentage points (BCG) and nearly 15 percentage points (DTP3), and one indicator had a marginal increase of just under 5 percentage points (full immunization). Across all indicators, the level of coverage tended to be similar in quintiles 1 and 2, and in quintiles 3 and 4; this pattern was particularly apparent in the 2006 survey. In 2011 in the DTP3 indicator, coverage levels demonstrated a step-wise gradient across the five wealth quintiles.

Childhood immunization data disaggregated according to mother's education demonstrated increasing inequality in all indicators between 2006 and 2011. This increase was due to larger gains in coverage in the most-educated than the least-educated subgroups. For instance, the BCG, measles, DTP3 and full immunization indicators reported improvements of around 20 percentage points or more in the most-educated subgroup, and polio reported a gain of about 10 percentage points. The improvement in the least-educated

subgroups was nearly 15 percentage points for the measles indicator, 10 percentage points for the BCG indicator, and around 5 percentage points or less for DTP3, polio and full immunization indicators. In each indicator, the gains in the primary school subgroup was at least as substantial as the gains in the no education subgroup, however, less pronounced than the gains in the secondary school or higher subgroup.

Inequality according to place of residence in 2011 demonstrated an urban–rural difference of about 10 percentage points (BCG and measles indicators) or 15 percentage points (DTP3, polio and full immunization indicators), favouring urban areas. Across indicators, place of residence absolute inequality either decreased slightly or stayed about the same between 2006 and 2011.

Sex-related absolute inequality (the difference in coverage between females and males) did not exceed 5 percentage points for any of the five childhood immunization indicators. Where small differences were reported, there was no consistent trend of higher coverage in one sex or the other.

Liberia

FIGURE 3.30. Disaggregated data for immunization coverage among one-year-olds in Liberia (DHS 2007, 2013)
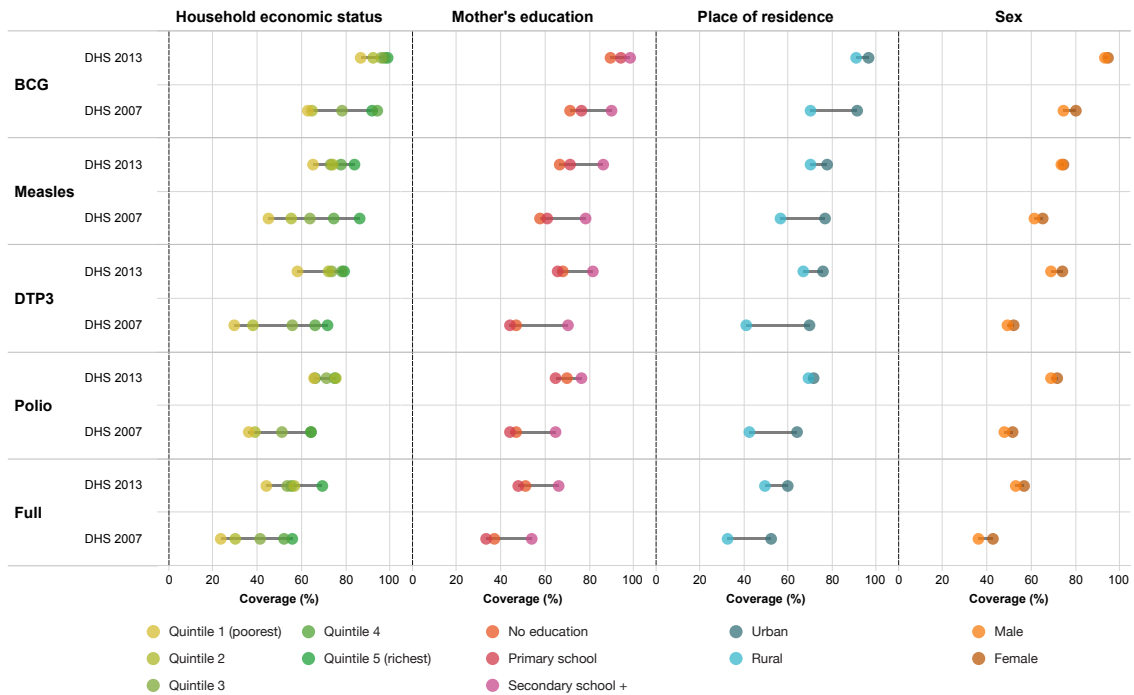
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Liberia, absolute economic-related inequality declined between 2007 and 2013 in all five immunization indicators, accompanied by improvements in national coverage. Coverage levels in poorer subgroups increased dramatically over this period. In 2013, absolute economic-related inequality remained high (difference of around 20 percentage points or higher between quintiles 1 and 5) in the measles, DTP3 and full immunization indicators. In the DTP3 indicator, coverage in quintile 1 increased by almost 30 percentage points between 2007 and 2013, and coverage in quintile 2 increased by nearly 35 percentage points; these gains outpaced the magnitude of improvement in quintiles 3–5, and absolute inequality narrowed. The polio indicator had a difference of nearly 30 percentage points between quintiles 1 and 5 in 2007, which shrunk to around 10 percentage points in 2013.

Inequality according to mother's education, measured as the difference in coverage between the most and least educated, decreased between 2007 and 2013 for the BCG, DTP3 and polio indicators. In these three indicators, improvements were reported

for each of the three subgroups, with more marked improvements in the no education and primary school subgroups than the secondary school or higher subgroup. Measles and full immunization indicators also had improvements in all subgroups, though absolute inequality remained unchanged.

For all five indicators, the difference in coverage between urban and rural subgroups decreased between 2007 and 2013, to a level around 10 percentage points or less. Narrowing absolute inequality was achieved through greater increases in coverage in rural than urban subgroups. The DTP3 indicator, for instance, had an increase of over 25 percentage points in the rural subgroup, and just over 5 percentage points in the urban subgroup.

Absolute sex-related inequality was low, demonstrating a difference of less than 5 percentage points across all indicators in 2013. Where small differences were reported, females had higher coverage than males.

Mali

FIGURE 3.31. Disaggregated data for immunization coverage among one-year-olds in Mali (DHS 1995, 2001, 2006, 2012)
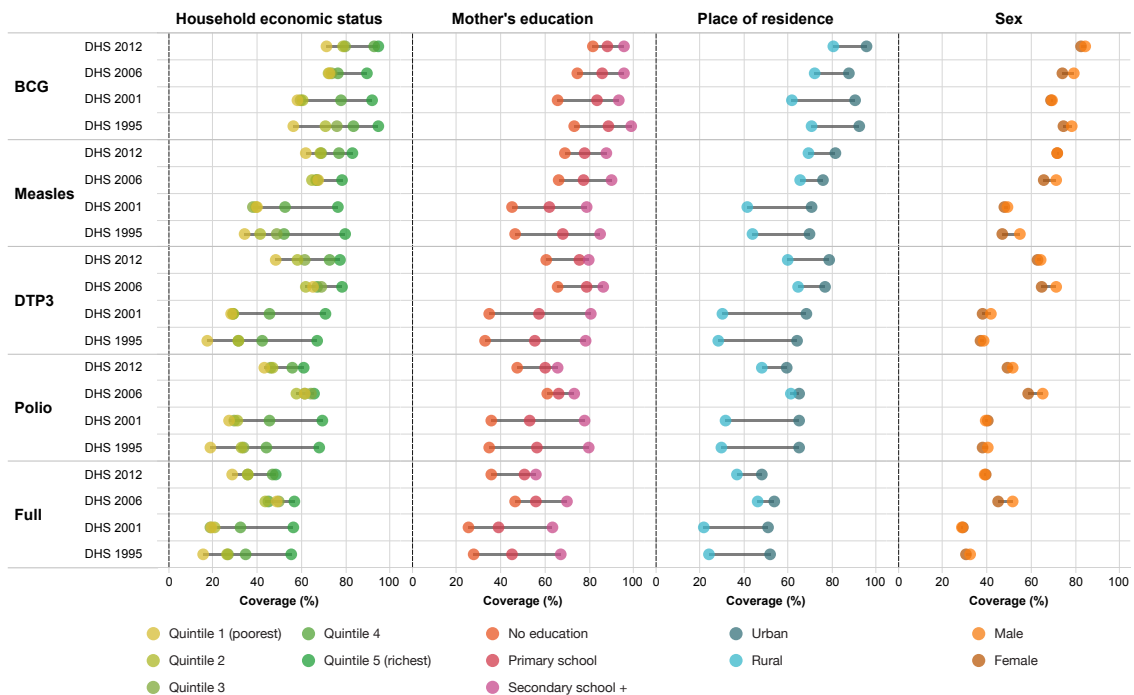
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

According to the latest available survey data in 2012, absolute economic-related inequality in Mali was high, at around 20 percentage points or more difference between quintiles 1 and 5, for all indicators. This marked a widening of absolute inequality when compared with survey data from 2006. In 2006, measles, DTP3, polio and full immunization indicators demonstrated remarkable improvements in quintiles 1–4, compared with coverage in 2001 and 1995; the BCG indicator had a similar pattern, though improvements were realized in quintiles 1–3. In all indicators, improvements in poorer quintiles in 2006 drove narrowing of absolute inequality alongside increased national coverage. For instance, the polio indicator had a difference of over 40 percentage points between quintiles 1 and 5 in 2001 and 1995, which dropped to under 5 percentage points in 2006. Over this time, national coverage of polio immunization increased by over 20 percentage points.

All indicators reported lower levels of absolute education-related inequality in 2006 and 2012 than in 1995 and 2001. Education-related inequality in Mali was consistently high in measles, DTP3 and full immunization indicators, with a difference of about 20 percentage points or higher between the most and least educated

in all four surveys. In the BCG indicator, the least-educated subgroup reported consistent improvements in coverage from 2001 to 2012, with very low increases in the two other subgroups. The polio indicator in 2006 showed a marked increase in coverage in no education and primary school subgroups, however, coverage in all subgroups decreased in 2012, but especially in the no education subgroup.

Inequality by place of residence demonstrated higher coverage in urban than rural subgroups. In all indicators, the gaps between urban and rural subgroups were substantially higher in 1995 and 2001 than in 2006 and 2012; this narrowing of absolute inequality was especially pronounced in the measles, DTP3, polio and full immunization indicators, and was attributable to marked improvements in rural areas.

All indicators tended to show very low levels of absolute sex-related inequality across the surveys. In 2006, however, all indicators had low levels of inequality that favoured males (around 5 percentage points difference between the two subgroups).

Mozambique

FIGURE 3.32. Disaggregated data for immunization coverage among one-year-olds in Mozambique (DHS 1997, DHS 2003, MICS 2008, DHS 2011)
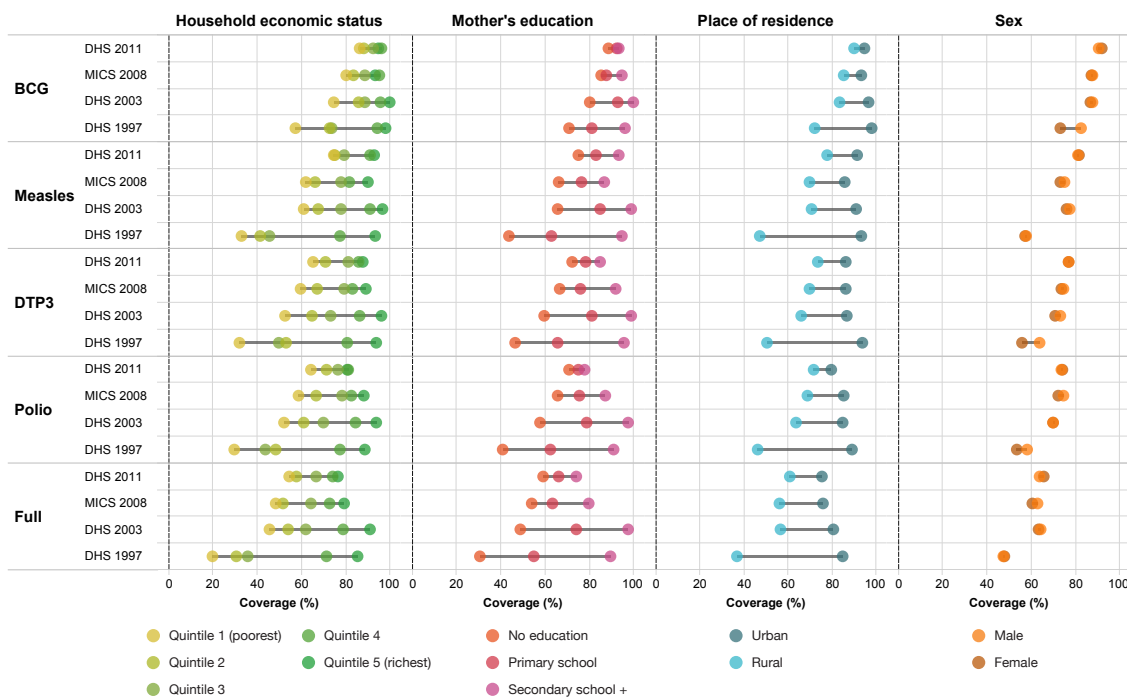
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Immunization data from Mozambique were available from 2011, 2008, 2003 and 1997. Economic-related absolute inequality – the difference between the richest and poorest – tended to narrow over time. According to the most recent 2011 data, economic-related absolute inequality was around 20 percentage points for measles, DTP3 and full immunization indicators, around 15 percentage points for polio and around 10 percentage points for BCG. By contrast, in 1997 economic-related absolute inequality was over 40 percentage points for all indicators. Improvements in inequality were largely driven by increased coverage in the poorer quintiles. In the polio and full immunization indicators, coverage in the richest quintile peaked in 2003 and declined by nearly 15 percentage points by 2011. Similar patterns were observed in BCG and DTP3, to a lesser extent.

In all five indicators, the absolute difference between the most- and least-educated subgroups decreased over time. Across indicators, the no education subgroup did not report a decrease in coverage at any time – in nearly all cases, the coverage improved. The primary school subgroup reported gains in coverage between 1997 and 2003 and then a decrease, by a smaller margin, between 2003 and 2008 (all indicators). In 2011, coverage in the primary school subgroup remained the same as in 2008 (DTP3, polio and full immunization indicators), or improved by over 5 percentage points (BCG and measles). The level of coverage in the secondary school or higher subgroup was around 75% or above for all indicators at all

time points. The BCG, DTP3, polio and full immunization indicators reported the minimum level of coverage in the most-educated subgroup in the most recent survey (2011).

In Mozambique, childhood immunization indicators demonstrated higher coverage in urban than rural areas at all time points. In 1997, BCG reported place of residence absolute inequality of over 25 percentage points, and in all other indicators this difference was over 40 percentage points. In 2011, BCG had an urban–rural difference of 5 percentage points, polio had a difference of less than 10 percentage points, and inequality in measles, DTP3 and full immunization was less than 15 percentage points. In all indicators, the increase in coverage in rural areas was most pronounced between 1997 and 2003. In 2008 and 2011, rural areas realized no change or small improvements in coverage. In urban areas, the level of coverage of each indicator remained within a 10 percentage point range at all time points.

Mozambique reported low levels of sex-related absolute inequality. In 2011, 2008 and 2003, there was almost no difference in coverage between females and males in all five immunization indicators. In 1997, BCG and DTP3 indicators showed higher coverage in males than females by a margin of less than 10 percentage points, and polio demonstrated a difference of 5 percentage points.

Niger

FIGURE 3.33. Disaggregated data for immunization coverage among one-year-olds in Niger (DHS 1998, 2006, 2012)
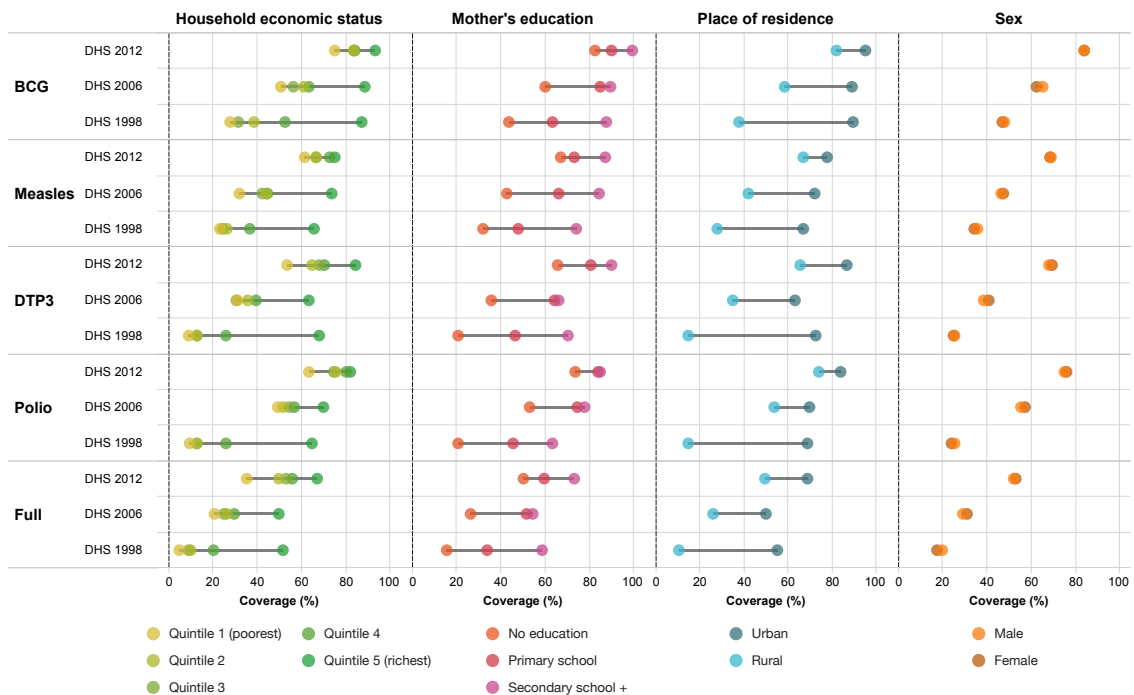
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Niger, absolute economic-related inequality demonstrated a distinct mass deprivation pattern in all indicators in 1998 and 2006: the coverage in quintile 5 was markedly higher than coverage in quintiles 1–4. In 2012, the BCG and polio indicators had a difference in coverage of less than 20 percentage points between the richest and poorest quintiles, and for the measles indicator, this difference was under 15 percentage points. For each of the DTP3 and full immunization indicators, coverage was around 30 percentage points higher in quintile 5 than quintile 1; the coverage levels in quintiles 2–4 were around the midpoints between quintiles 5 and 1. In all indicators, the national coverage increased at each subsequent time point. The BCG and measles indicators had lower absolute economic-related inequality in 2012 than in 2006, whereas for DTP3, polio and full immunization indicators, absolute inequality was about the same in 2012 as 2006.

Immunization coverage across education subgroups showed a characteristic pattern in all indicators over the three surveys. In 2006, coverage tended to increase most markedly in the primary school subgroup, and in 2012 coverage increased most markedly in the no education subgroup. Absolute education-related inequality, measured as the difference in coverage between the most- and least-educated subgroups, was 20–25 percentage points in measles, DTP3 and full immunization indicators in 2012; this difference was just over 15 percentage points in BCG. The polio indicator had a difference of just over 10 percentage points in 2012, with similar levels of coverage in the primary school and secondary school or higher subgroups.

Absolute place of residence inequality narrowed over the three surveys in all indicators. The rural subgroup, which accounted for around 80–85% of the population of one-year-olds, increased steadily over time. In the DTP3 and full immunization indicators, coverage in the urban subgroup declined by a margin of 5–10 percentage points between 1998 and 2006, followed by an increase of around 20–25 percentage points in 2012.

Absolute sex-related inequality was very low in all immunization indicators at all time points.

Nigeria

FIGURE 3.34. Disaggregated data for immunization coverage among one-year-olds in Nigeria (DHS 1999, DHS 2003, DHS 2008, MICS 2011, DHS 2013)
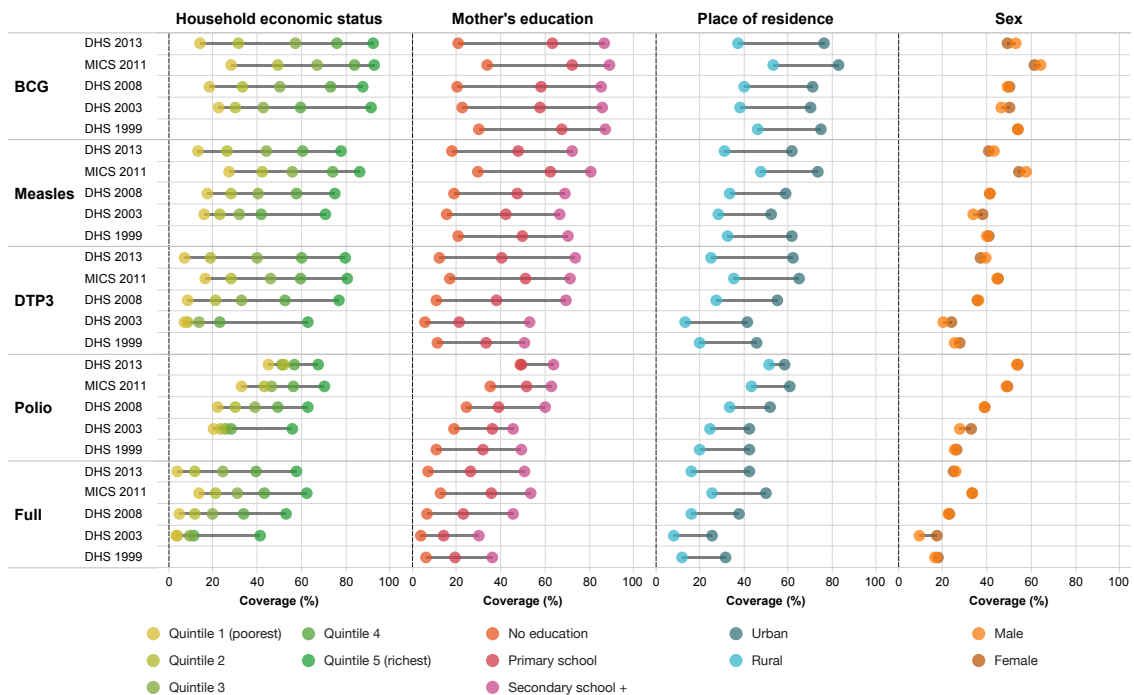
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

Wealth-disaggregated data about childhood immunization in Nigeria were illustrated using four surveys spanning from 2003 to 2013. Over this period, economic-related absolute inequality remained high in all five indicators, with the difference between quintile 1 and 5 spanning from a minimum of around 20 percentage points (polio indicator, 2013 data) to a maximum of almost 80 percentage points (BCG indicator, 2013 data). In the BCG, measles and DTP3 indicators, the level of absolute inequality remained at least 55 percentage points in all surveys. All indicators had a pattern of mass deprivation in 2003 (coverage in quintile 5 was substantially higher than coverage in quintiles 1–4), which progressively became more of a linear gradient by 2013. In all indicators, coverage in quintile 4 improved markedly between 2003 and 2008, by a margin of about 15 percentage points or higher.

Nigeria reported education-disaggregated data from five surveys (1999–2013). Education-related absolute inequality in Nigeria was pronounced, exceeding a 60 percentage point difference between the most- and least-educated subgroups for the BCG and DTP3 indicators (several time points, including the most recent). The minimal level of inequality was reported for the polio indicator, at 15 percentage points in 2013. The no education subgroup reported very low levels of coverage across all indicators, with coverage of less than 35% for BCG, measles, DTP3 and full immunization at all time points. In the BCG indicator, coverage in the most-educated subgroup was consistently over 85%, while in the full immunization indicator, coverage in the most-educated subgroup did not exceed 55%. For BCG, measles,

DTP3 and full immunization indicators, the coverage of the primary school subgroup fell midway between the more- and less-educated subgroups. In polio, coverage in the no education subgroup increased rapidly between 2008 and 2013, reaching about 50% coverage by 2013 (the same level of coverage as in the primary school subgroup).

Place of residence inequality was reported across five surveys, revealing consistently higher immunization coverage in urban than rural areas. In 2013, the largest urban–rural difference was reported in the BCG indicator (about 40 percentage points), and the smallest difference was in the polio indicator (over 5 percentage points). The BCG, measles and DTP3 indicators reported differences of around 25 percentage points or more at all time points, with coverage in rural areas never exceeding 55%, and coverage in urban areas reaching a maximum of about 85%. In the polio indicator, the urban-rural difference decreased by a margin of about 10 percentage points between 2011 and 2013. In the full immunization indicator, incremental increases in both subgroups were reported between 2003 and 2011; in 2013, coverage in urban and rural areas each decreased, amounting to around 15% coverage in rural areas and nearly 45% coverage in urban areas.

The sex-related absolute inequality in Nigeria was small across the five indicators. According to the latest data from 2013, the female–male difference was less than 5 percentage points in all indicators. Where small differences in coverage were reported, there was no pattern of one sex having a persistent advantage over the other.

Pakistan

FIGURE 3.35. Disaggregated data for immunization coverage among one-year-olds in Pakistan (DHS 2006, 2012)
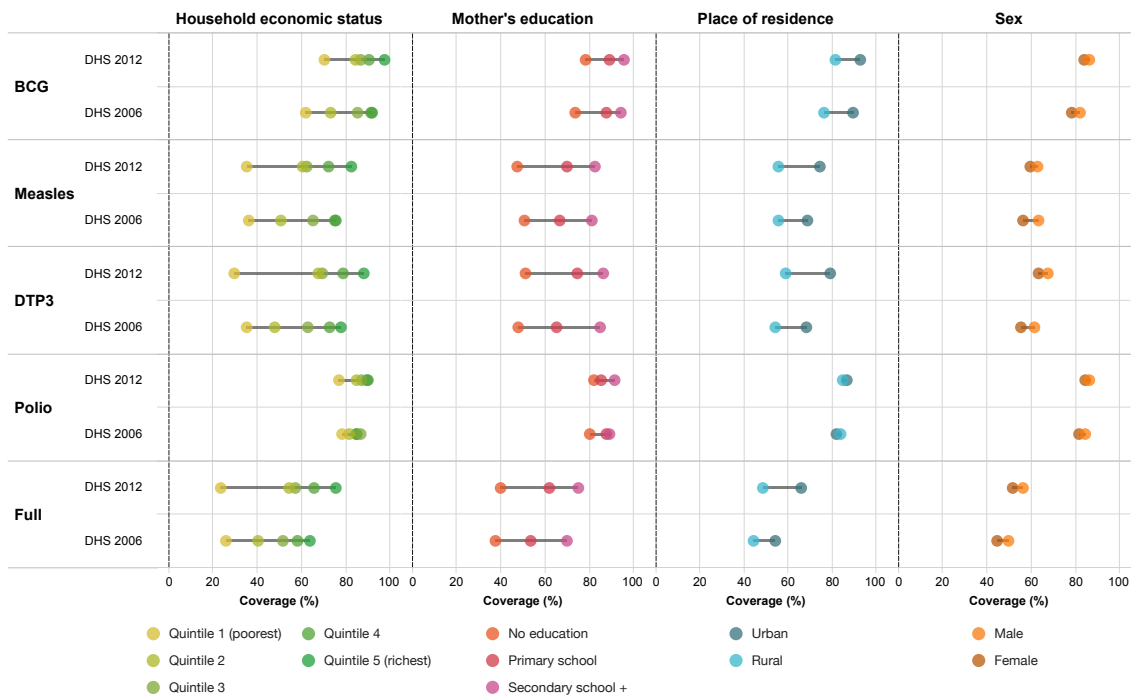
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Pakistan, absolute economic-related inequality was substantial for four of the five immunization indicators: BCG; measles; DTP3; and full immunization. In 2012, the measles, DTP3 and full immunization indicators had a difference of 50–60 percentage points or higher between quintiles 1 and 5, and the BCG indicator had a difference of just over 25 percentage points. All four indicators had increased levels of absolute inequality in 2012, compared with 2006. The polio indicator had lower levels of absolute economic-related inequality with a difference between quintiles 1 and 5 of almost 15 percentage points. Across all indicators, the gap between quintiles 1 and 2 increased between 2006 and 2012, resulting in a marginal exclusion pattern of inequality.

Pakistan demonstrated a gradient of increasing coverage across subgroups with higher levels of education. In the BCG indicator, absolute education-related inequality remained around 15–20 percentage points in 2006 and 2012, and inequality for the polio indicator remained just below 10 percentage points. Measles, DTP3 and full immunization indicators had a gap in coverage between the most- and least-educated subgroups of over 30 percentage points. In DTP3, polio and full immunization indicators, the difference between the most- and least-educated subgroups remained about the same between 2006 and 2012. In 2012 in the measles, DTP3,

and full immunization indicators, the coverage in the primary school subgroup shifted closer to the level of coverage in the secondary school or higher subgroup. In measles, DTP3 and full immunization indicators, the size of the gap between the no education and primary school subgroups increased between 2006 and 2012. Across all indicators, there was very little change in the level of coverage in the no education subgroup between 2006 and 2012.

In 2012, absolute place of residence inequality, measured as the difference in coverage between urban and rural subgroups, ranged between 10 and 20 percentage points for BCG, measles, DTP3 and full immunization indicators. For measles, DTP3 and full immunization indicators, absolute inequality increased between 2006 and 2012 due to larger gains in the urban subgroup. Very low levels of absolute place of residence inequality were reported for the polio indicator at both time points.

In 2012, the difference in immunization coverage between females and males was under 5 percentage points in all indicators; BCG and polio indicators had similar coverage in both subgroups. Where marginal levels of absolute inequality existed, coverage was higher in males than females.

South Sudan

FIGURE 3.36. Disaggregated data for immunization coverage among one-year-olds in South Sudan (MICS 2010)
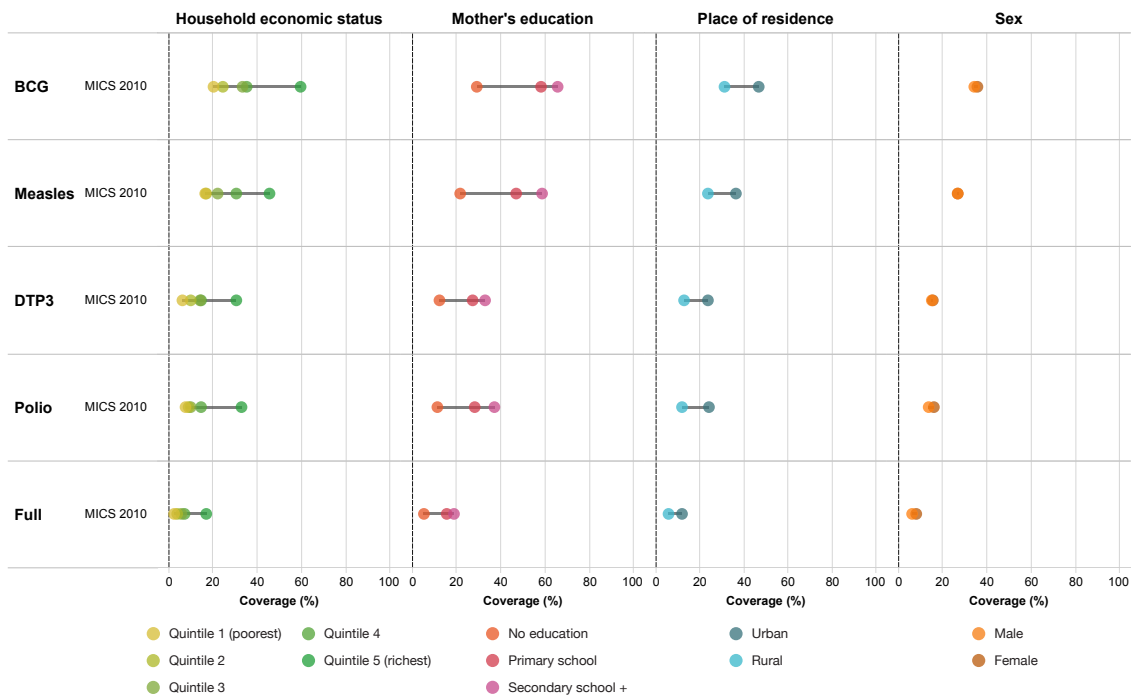
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In South Sudan, the level of economic-related absolute inequality, as reported in MICS 2010, varied across indicators. The level of inequality tended to be higher in indicators with a higher national average. For instance, the rich–poor difference reached a maximum of nearly 40 percentage points in the BCG indicator (national coverage of 35%), and a minimum of about 15 percentage points in the full immunization indicator (national coverage of less than 10%). All indicators demonstrated a pattern of mass deprivation, whereby coverage in quintile 5 was substantially higher than coverage in quintiles 1–4. In the BCG indicator, the gap between quintiles 4 and 5 was about 25 percentage points; measles, DTP3 and polio indicators reported gaps of about 15–20 percentage points, and the full immunization indicator reported a gap of 10 percentage points.

Education-related inequality, calculated as the absolute difference between coverage in the most- and least-educated subgroups, was over 35 percentage points in BCG and measles indicators. These two indicators each reported gaps of over 25 percentage points between the no education and primary school or higher subgroups. Education-related absolute inequality was around 25 percentage points for the polio indicator, around 20 percentage points for DTP3, and almost 15 percentage points for full immunization. For reference, note that about 80% of the population of one-year-olds belonged to the no education subgroup.

Place of residence absolute inequality was observed in all five indicators, ranging from a 15 percentage point difference between urban and rural subgroups in the BCG indicator, to a difference of just over 5 percentage points in full immunization. Across all indicators, coverage was higher in urban than rural areas.

South Sudan demonstrated no inequality according to sex across the five indicators. In all indicators, there was almost no difference in coverage between females and males.

Sudan

FIGURE 3.37. Disaggregated data for immunization coverage among one-year-olds in Sudan (MICS 2010)
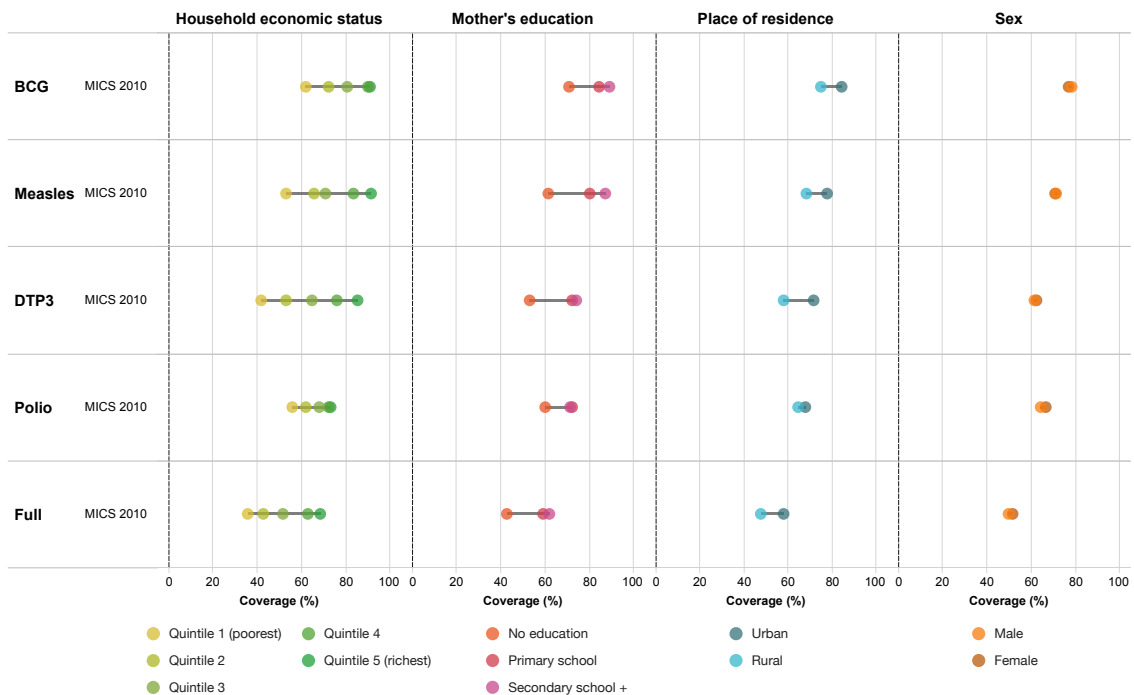
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In 2010, the economic-related absolute inequality in childhood immunization demonstrated a gap between the richest and poorest quintiles of around 30 percentage points or higher for the BCG, measles, DTP3 and full immunization indicators; in the polio indicator, this difference was just over 15 percentage points. The maximum economic-related absolute inequality was reported for the DTP3 indicator, where the rich–poor difference was nearly 45 percentage points, spanning from just over 40% coverage in quintile 1 to about 85% coverage in quintile 5. In general, there was a step-wise pattern of increasing coverage between quintile 1 and 5, with a few exceptions: the coverage of the BCG indicator was the same in quintiles 4 and 5, and the coverage of the polio indicator was the same in quintiles 4 and 5.

Sudan reported inequality according to mother's education level, which consisted of three subgroups: no education; primary school; and secondary school or higher. Across all indicators, the gaps between the no education and the primary school subgroups were much larger than the gaps between the primary school and

secondary school or higher subgroups. In the DTP3 indicator, for instance, the level of coverage among the primary school and secondary school or higher subgroups was around 70–75%, whereas coverage in the no education subgroup fell below 55%. The indicator with the lowest level of education-related absolute inequality was polio, where the difference between the most- and least-educated subgroups was about 10 percentage points. For reference, note that about half of the one-year-old population belonged to the no education subgroup.

Inequality by place of residence, measured as the difference in coverage in urban–rural areas, was around 15 percentage points in the DTP3 indicator, around 10 percentage points in the BCG, measles and full immunization indicators, and less than 5 percentage points for the polio indicator.

There was no difference in the coverage of childhood immunization indicators between females and males in Sudan.

Yemen

FIGURE 3.38. Disaggregated data for immunization coverage among one-year-olds in Yemen (MICS 2006, DHS 2013)
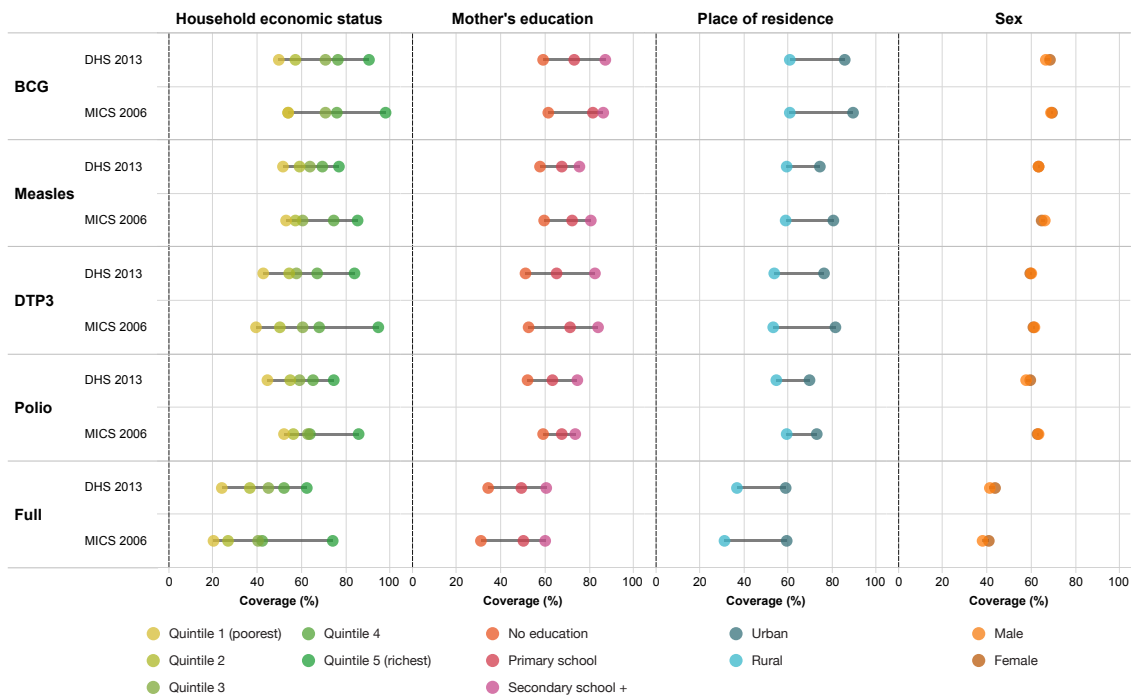
Notes: Dots represent coverage estimates for subgroups within each dimension of inequality. The length of the horizontal lines shows the difference between minimum and maximum coverage.

In Yemen, economic-related absolute inequality in childhood immunization indicators decreased between 2006 and 2013, though the magnitude of decrease varied. Most notably, for the DTP3 and full immunization indicators, the difference between the richest and poorest quintiles was about 15 percentage points narrower in 2013 than in 2006. All indicators reported decreased coverage in quintile 5, with less pronounced changes in quintile 1. The level of coverage of full immunization in the intermediary subgroups (quintiles 2–4) increased over time; other indicators reported minimal changes in the levels of coverage in quintiles 2–4, by a margin of 5 percentage points or less.

Education-related absolute inequality, reported as the difference in coverage between the most- and least-educated subgroups, remained similar in 2013 and 2006 for the BCG, measles, DTP3 and full immunization indicators. The polio indicator reported an increase

in absolute inequality, from 15 percentage points in 2006 to just over 20 percentage points in 2013.

Place of residence absolute inequality was reported in all five indicators, favouring urban areas. According to data from 2013, the urban–rural gap was about 20–25 percentage points for BCG, DTP3 and full immunization indicators. The measles and polio indicators had a 2013 urban–rural difference of 15 percentage points. For all indicators, place of residence absolute inequality did not worsen between 2006 and 2013: BCG; measles; DTP3; and full immunization indicators reported a small narrowing of inequality by about 5 percentage points.

In Yemen, absolute inequality according to sex was very low for all indicators.

4. Discussion and conclusions

Understanding and improving the state of inequality in childhood immunization

Monitoring inequality in five childhood immunization indicators revealed that gaps in coverage persist across many low- and middle-income countries. In particular, inequalities according to household economic status and mother's education level were prevalent across study countries, while certain countries reported wide gaps between urban and rural areas. Globally, certain patterns emerged across the study countries. Gradients across wealth quintiles and education subgroups were evident in the median values of disaggregated data. Where place of residence inequality was reported, coverage tended to be higher in urban areas. Sex-related inequality in childhood immunization did not exist or was minimal. Analyses of priority countries further demonstrated that every country faces a unique situation with regard to childhood immunization, and that all countries have room for improvement.

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FOLLOWING THE LEAD OF GVAP THE INTEGRATION OF EQUITY CONSIDERATIONS INTO INDICATORS AND TARGETS FOR GLOBAL INITIATIVES IS KEY TO DRIVE EXPANDED HEALTH INEQUALITY MONITORING IN CHILDHOOD IMMUNIZATION AND ACROSS OTHER HEALTH TOPICS.

GVAP has adopted equity-sensitive indicators and targets, which routinize the practice of inequality monitoring, and draw attention to economic-related inequality. Twenty-three priority countries were identified in this report on the basis of GVAP indicator criteria (reporting a gap in DTP3 immunization whereby coverage levels were more than 20 percentage points higher in the richest than the poorest wealth quintile). An exploration of data from these countries helps to better understand the nuances of economic-related inequality in DTP3 coverage – for example, how inequality has changed over time and how intermediary subgroups are performing. In addition, the situation in other childhood immunization indicators and other dimensions of inequality further illustrate which children are at a higher risk of not receiving vaccines.

Exploring the root causes of inequality

A deep understanding of the country context and its immunization practices is necessary to gain insight into the root causes of inequalities observed in this report. Additional context-specific quantitative and qualitative studies are required to understand the existing barriers and opportunities for improving equity in childhood immunization.

Expanding inequality monitoring can inform how to improve coverage in unvaccinated and under-vaccinated children through policies, programmes and practices. While economic status, education, place of residence and sex – the dimensions included in this report – have global applicability, health inequality monitoring should also reflect needs and characteristics at a national level. For instance, inequalities by subnational region should be explored. Countries with rapid rates of urbanization should ensure that inequality monitoring efforts cover the urban poor. Countries that are affected by migration, vulnerable labour sectors, war and conflict, etc. should design inequality monitoring to capture vulnerable populations.

Vaccinations are primarily given as either part of campaigns or routine delivery. Learning more about effective ways to deliver vaccines, especially in low-resource settings, can help countries to improve services for difficult-to-reach populations.

Tools and resources for health inequality monitoring

The WHO **Health Equity Monitor data repository and theme page** contain comparable, disaggregated data on the topic of reproductive, maternal, newborn and child health (RMNCH). Aiming to serve as a platform for global- and national-level health inequality monitoring, the Health Equity Monitor data repository covers over 30 RMNCH indicators, with data from more than 280 DHS and MICS across 102 countries. The theme page supports the analysis and interpretation of disaggregated data through highlighting key messages and demonstrating innovative reporting approaches.

- The theme page can be accessed at: www.who.int/gho/health_equity/en/
- The data repository can be accessed at: apps.who.int/gho/data/node.main.HE-1540?lang_en

The WHO *Handbook on health inequality monitoring: with a special focus on low- and middle-income countries* is a resource designed to support the development and strengthening of health inequality monitoring systems at a national level. The handbook provides an introduction to health inequality monitoring concepts, and describes a step-wise approach to monitoring, drawing from examples from low- and middle-income countries.

- The handbook is available from: www.who.int/gho/health_equity/handbook/en/

The WHO **Health inequality monitoring eLearning module** is based on the content and organization of the *Handbook on health inequality monitoring: with a special focus on low- and middle-income countries*. The eLearning module allows the learner to build a theoretical understanding of health inequality monitoring by progressing through the material in a self-directed manner. Learner engagement is encouraged through discussion points, application exercises, quiz questions and suggested readings.

- The eLearning module is available from: extranet.who.int/elearn/course/category.php?id_15

The WHO **Health Equity Assessment Toolkit (HEAT)** was developed as an online tool to for health inequality analysis. HEAT enables users to perform health inequality summary measure calculations using an existing database of disaggregated data, and to create customized visuals based on disaggregated data or summary measures. A new edition of the software package, **HEAT Plus**, is currently under development. HEAT Plus will allow users to upload and work with their own database.

- HEAT can be accessed at: http://www.who.int/gho/health_equity/assessment_toolkit/en/

Notes: For more information on WHO work on health inequality monitoring, see: Hosseinpoor AR, Bergen N, Schlotheuber A. Promoting health equity: WHO health inequality monitoring at global and national levels. Global health action. 2015;8.
For more information about the Health Equity Monitor, see: Hosseinpoor AR, Bergen N, Schlotheuber A, Victora C, Boerma T, Barros AJ. Data Resource Profile: WHO Health Equity Monitor (HEM). Int J Epidemiol. 2016 September 30:dyw176.
For more information on HEAT, see: Hosseinpoor AR, Nambiar D, Schlotheuber A, Reidpath D, Ross Z. Health Equity Assessment Toolkit (HEAT): software for exploring and comparing health inequalities in countries. BMC Med Res Methodol. 2016 October 19;16(1):141.

For instance, expanded national analyses of inequality by subnational region is a practical way to identify concrete points for intervention. In many cases, the organizational structure of a national health system facilitates resource allocation on the basis of geographical location (such as districts) rather than social groupings (such as education levels).

GVAP, along with WHO, recognize the importance of operational research on issues related to the delivery, logistics and demand for vaccination.[1] Optimally, immunization services should be integrated with health system strengthening (including supply chain management) and the implementation of universal health coverage. Stakeholders should look beyond "silo" approaches to find creative solutions to promote equity in immunization coverage.

With a better understanding of the patterns of inequality, national and international stakeholders can more effectively design and roll out appropriately-targeted initiatives. For instance, through the Reaching Every District strategy, WHO and UNICEF promote planning and monitoring activities to support gains in immunization coverage, including identifying and targeting

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[1] For more information, refer to: SAGE concept note (http://www.who.int/immunization/sage/meetings/2016/april/Concept_note_HSS-UHC_SAGE_12_14_April_2016.pdf)

those who are under-vaccinated or unvaccinated. Rooted in a bottom-up approach, the Reaching Every District strategy aims to operationalize the results of health inequality monitoring at the district level through activities such as mapping, creating workplans, determining resource allocations, conducting regular monitoring and evaluating progress.[1] The WHO Innov8 approach for reviewing national health programmes to leave no one behind offers a systematic process for integrating the results of health inequality monitoring to support equity-oriented programmatic planning.[2]

Strengthening health information systems

A movement for equity-oriented sustainable development, including universal health coverage, relies on the timely availability of high-quality data. Data that can be disaggregated according to multiple, relevant dimensions of inequality enable evidence-based decision-making. They also serve as the basis upon which to measure progress. GVAP identified the improvement of surveillance capacity and data quality and use as one of nine key global recommendations for accelerated progress towards its action plan. This recommendation underscored the importance of routine analysis, strong data reporting systems and the availability of up-to-date data to guide programmatic decisions.[3]

The data in this report were derived from household-level population surveys, which enabled the use of comparable data from a large set of low- and middle-income countries. A major limitation of this approach is the exclusion of countries that did not participate in DHS and MICS, rendering invisible certain countries with insufficient data availability

at the national level. Unfortunately, countries with fragmented health service provision, such as countries experiencing conflict or widespread instability, are less likely to have functional data collection systems. Thus, the state of inequality in excluded countries may be reasonably expected to be worse than in the countries included in this report. The global trends presented in this report may demonstrate a better-than-actual scenario.

In addition to household surveys, other data sources may be available for inequality monitoring at the national level. Routine data gathered through activities delivered by the health system, such as immunization cards and medical records, contain valuable information about individuals who have contact with the health system. Therefore, in addition to surveys, administrative records may provide complementary information to enable health inequality monitoring, especially if data can be linked between data sources on the basis of individual or small-area identifiers.[4]

Developing strong national health information systems is an investment that leads to improved data collection, analysis and reporting about health inequalities.[5] The functionality of health information systems depends on: political will; adequacy of funding and resources; level of technical expertise; high-level support (e.g. through policies and programmes); and community-level support (e.g. through participation and leadership). Strong health information systems are the product of collaborations between diverse stakeholders from national governments (e.g. ministries of health, national statistics offices, and others), United Nations agencies, funding agencies, academic institutions, nongovernmental organizations, bilateral partners, civil society organizations and the private sector.

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1. For more information about the Reaching Every District strategy, refer to: http://www.who.int/immunization/programmes_systems/service_delivery/red/en/

2. For more information about the WHO Innov8 approach, refer to: http://www.who.int/life-course/partners/innov8/en/

3. For more information, refer to page 22 of the 2016 Midterm Review of the Global Vaccine Action Plan: http://www.who.int/immunization/global_vaccine_action_plan/SAGE_GVAP_Assessment_Report_2016_EN.pdf

4. See: Hosseinpoor AR, Bergen N. Area-based units of analysis for strengthening health inequality monitoring. Bull World Health Organ. 2016 November;94(11):856–58.

5. See: Hosseinpoor AR, Bergen N, Magar V. Monitoring inequality: an emerging priority for health post-2015. Bull World Health Organ. 2015 September;93(9):591–591A.

Conclusions

Overall, the *State of inequality: childhood immunization* report highlights areas for improvement across low- and middle-income countries, especially among children in the poorest households and children of mothers with low levels of education. Monitoring inequalities in childhood immunization is a crucial step in making vaccines equitably available to all children. Through its equity indicators, GVAP has drawn attention to certain immunization inequalities. Inequality monitoring should be expanded and integrated across other initiatives to capture diverse dimensions of inequality and health indicators. Health information system strengthening, including enhancing the quality and comprehensiveness of data sources, will enable countries to improve health inequality monitoring.

Appendix 1. Data specifications

Data sources

The data used in this report were derived from household health surveys: Demographic and Health Survey (DHS), administered by the United States Agency for International Development (USAID); and Multiple Indicator Cluster Surveys MICS), administered by the United Nations Children's Fund (UNICEF). The DHS data included in this report were sourced from data collection rounds three to seven, and MICS data were sourced from data collection rounds three to five. The design of DHS and MICS aims to collect data that can be harmonized for the purpose of creating global databases; thus, for this report, data from DHS and MICS are assumed to be sufficiently comparable between settings and over time.

The limitations of using these data sources include: several countries do not participate in DHS or MICS, or do not conduct surveys on a regular basis; data about the complete set of vaccinations recommended by the World Health Organization (WHO) are not available from DHS and MICS; and the data reported here may be slightly different from other reports (including WHO reports) due to small discrepancies in the time span and/or calculation of indicators. For more information about the design and comparability of DHS and MICS, refer to:

- Hancioglu A, Arnold F. Measuring coverage in MNCH: tracking progress in health for women and children using DHS and MICS household surveys. PLoS Med 2013;10:e1001391.

- Corsi DJ, Neuman M, Finlay JE, Subramanian SV. Demographic and health surveys: a profile. Int J Epidemiol 2012;41:1602–13.

Data preparation

Micro-data from DHS and MICS were reanalysed by the International Center for Equity in Health (ICEH) to generate the disaggregated data used in this report. (ICEH is based in the Federal University of Pelotas, Brazil. For more on ICEH, refer to: www.equidade.org) Briefly, an analysis platform was developed to conduct batch analysis of DHS and MICS surveys using a single standard code, assuring that estimates are derived on the basis of standard definitions. The estimates and corresponding 95% confidence intervals were thoroughly screened for correctness. The childhood immunization data contained in this report are publicly available in the Health Equity Monitor database on the WHO Global Health Observatory. (The WHO Health Equity Monitor can be accessed at: apps.who.int/gho/data/node.main.HE-1540?lang_en) The reanalysis process has been previously applied to generate data for other initiatives, such as Countdown to 2015. For more information about the details of data reanalysis, refer to:

- Hosseinpoor AR, Bergen N, Schlotheuber A, Victora C, Boerma T, Barros AJ. Data Resource Profile: WHO Health Equity Monitor (HEM). Int J Epidemiol. 2016 September 30:dyw176.

- Requejo J, Victora C, Bryce J. Data Resource Profile: Countdown to 2015: maternal, newborn and child survival. Int J of Epidemiol. 2014 March 16:dyu034.

Childhood immunization indicators

The precise criteria for the calculation of childhood immunization indicators vary according to country-specific considerations. For instance, countries have different recommendations for the timing of vaccines, and thus align childhood immunization indicators to reflect national vaccination schedules. (For a list of vaccination schedules by country, refer to: http://apps.who.int/immunization_monitoring/globalsummary/schedules)

Vaccine programmes are not uniform across countries. In most countries, the national schedules cover fewer vaccines than are recommended by WHO. For instance, Suriname does not currently recommend the Bacille Calmette-Guérin (BCG) vaccine, and thus did not report data about this indicator. Additionally, vaccines are sometimes delivered in combination with other vaccines. Several countries administer DTP vaccines in combination with other vaccines, such as Haemophilus influenzae type b (Hib), and several countries deliver measles vaccination through measles-mumps-rubella (MMR) vaccines.

The definition of the full immunization indicator adopted for this report included one dose of BCG vaccine, three doses of polio vaccine, three doses of DTP and one dose of measles vaccine. Alternate definitions, based on the inclusion of different types of vaccines, are possible. For example, the United Nations Sustainable Development Solutions Network described an approach to defining the full immunization indicator based on country-specific criteria, allowing for the inclusion of vaccines recommended by national vaccination schedules, plus additional vaccinations at the discretion of the country. (For more information, refer to: http://indicators.report/indicators/i-19/)

Country selection

Countries were selected for inclusion in this report based on the availability of relevant data from a DHS or MICS that was conducted between 2010 and 2014. If a survey was conducted over more than one calendar year, then the year was assigned based on the first year of data collection. If a country had more than one DHS or MICS from this period, data were obtained from the most recent survey. The 69 countries included in this report were grouped as low- or middle-income based on World Bank classification from July 2016.

A subset of 28 countries was selected on the basis of having a DHS or MICS from 2000 to 2004. If a country had more than one DHS or MICS from 2000 to 2004, then the survey that fell closest to 10 years prior to the most recent survey was selected. On average, countries reported a 10-year gap between survey periods, though this gap ranged from 6 to 14 years (Table A1.1).

TABLE A1.1. Number of years between surveys of the 28 countries included in change-over-time analyses

Years between surveys	Number of countries	Countries
6	2	Chad, United Republic of Tanzania
7	2	Burkina Faso, Cameroon
8	2	Mozambique, Peru
9	1	Malawi
10	8	Armenia, Benin, Colombia, Indonesia, Jordan, Nigeria, Philippines, Rwanda
11	6	Dominican Republic, Ethiopia, Ghana, Mali, Uganda, Viet Nam
12	3	Gabon, Haiti, Zambia
13	2	Namibia, Nepal
14	2	Cambodia, Egypt

The number of countries that reported data varied by each indicator-dimension of inequality combination, as per data availability. For inclusion in the set of countries for a particular indicator, a country must have data across all subgroups; if a country lacked data from one or more subgroups, then it was dropped from analysis for that indicator. (The interactive reference table contains complete data from all available countries, indicators and dimensions, noting the reasons for cases where data were limited – see Appendix 3.) This methodological choice ensured a constant number of countries across subgroups for a given indicator-dimension of inequality combination. The reasons for a country to be excluded were: the estimate was based on a sample size that was too low (that is, fewer than 25 cases in one or more subgroup); our criteria for creating education subgroups were incompatible with education classifications at the country level; or no data were available. Disaggregated data estimates for mother's education was not shown in the visuals in the following countries: Armenia, Belize, Bosnia and Herzegovina, Costa Rica, Cuba, Dominican Republic, Jamaica, Kyrgyzstan, Montenegro, Republic of Moldova, Serbia, The former Yugoslav Republic of Macedonia (because the estimate was based on fewer than 25 cases in one or more subgroups); and Kazakhstan, Mauritania and Ukraine (because education subgroups were incompatible with country classification). Disaggregated data estimates for household economic status were not available from Cuba. Data were not available for BCG and full immunization indicators in Suriname, and were not available for measles and full immunization indicators in Cuba.

Appendix 2. Analysis approaches and interpretation

General guidelines for assessing and reporting the state of inequality

- Disaggregated data and summary measures should be reported together:
  – disaggregated data give a sense of the underlying level of health; and
  – summary measures enhance interpretation and reporting by expressing inequality in a single number.

- Both relative and absolute summary measures should be considered and/or reported to give a more complementary and complete representation of the inequality between two subgroups:
  – absolute inequality measures such as difference are useful in demonstrating the magnitude of the gap between two subgroups, retaining the unit of measurement of the indicator (percentage points, in the case of childhood immunization coverage); and
  – relative measures such as ratio show the relational nature of inequality through a comparison that is unitless.

- National average should be provided alongside inequality estimates to provide a more complete assessment of the situation.

- Accounting for population share when reporting inequality provides a more nuanced indication of how inequalities exist within populations.

- When assessing change over time, it is important to consider the baseline level of coverage, as there is greater room for improvement in situations of poor performance at baseline. This is often the case when comparing the progress in disadvantaged and advantaged subgroups, as the disadvantaged often have lower levels of coverage at baseline and therefore a larger margin of improvement is possible.

- When interpreting estimates that approach lower and upper limits it is important to consider:
  – as the overall immunization coverage approaches 100%, the difference and ratio values typically decrease; and
  – if the coverage in the disadvantaged group is very low, then the resulting ratio (between disadvantaged and advantaged subgroups) may be very high.
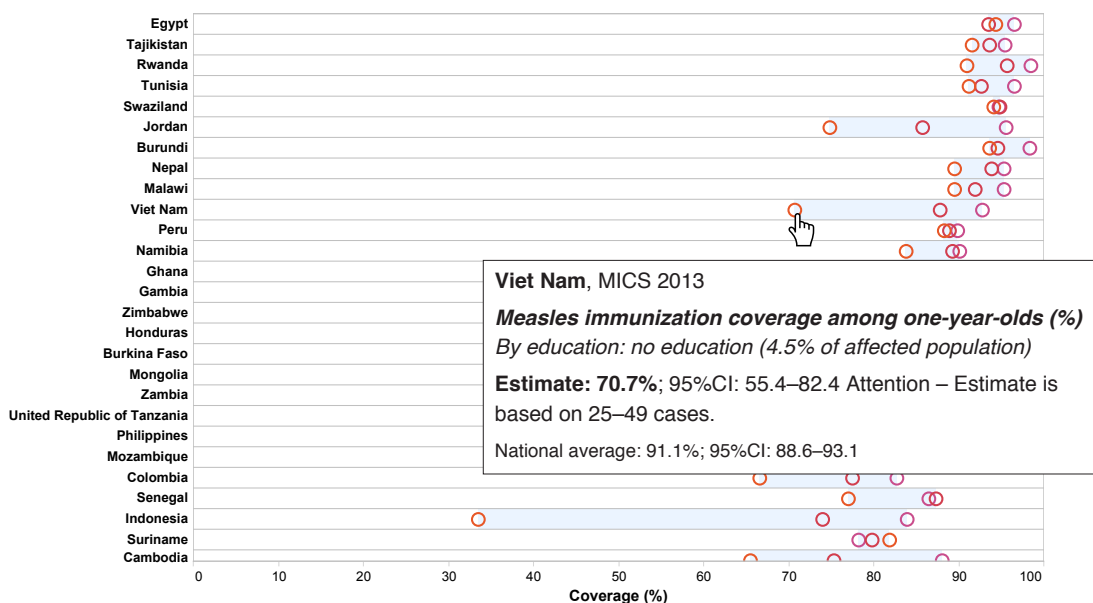
Note: Text adapted from page 72 of the *State of inequality: reproductive, maternal, newborn and child health* report (WHO 2015), available from: http://www.who.int/gho/health_equity/report_2015/en/

Population share, sample size and confidence intervals

Information pertaining to population share, low sample sizes and confidence intervals are available in the interactive visuals tooltip feature. (Tooltip allows users to access additional information about an estimate in an interactive visual. The tooltip dialogue box can be viewed by hovering over the estimate on the interactive visual.) Figure A2.1 displays the tooltip for measles immunization in Multiple Indicator Cluster Survey (MICS) 2013 in Viet Nam for the no education subgroup. This tooltip shows that the subgroup represents 4.5% of the population of one-year-olds, and the estimate is based on a low sample size of 25–49 cases. The 95% confidence interval of the estimated coverage (70.7%) is 55.4–82.4%.

FIGURE A2.1. Example of a tooltip, showing measles immunization coverage among one-year-olds in the no education subgroup in Viet Nam (MICS 2013)

> **Viet Nam**, MICS 2013
>
> ***Measles immunization coverage among one-year-olds (%)***
> *By education: no education (4.5% of affected population)*
>
> **Estimate: 70.7%**; 95%CI: 55.4–82.4 Attention – Estimate is based on 25–49 cases.
>
> National average: 91.1%; 95%CI: 88.6–93.1

The population share provides information about the proportion of one-year-olds that belong to a given subgroup, which allows for a more thorough understanding of inequality, and how change in inequality over time may be interpreted. The concept of population shift becomes pertinent when the population share in each subgroup changes over time. In the case of Viet Nam, the share of the population that belonged to the no education subgroup was around 5% in both Demographic and Health Survey (DHS) 2002 and MICS 2013 (no population shift); however, the share of the population that belonged to the secondary school or higher increased by 15 percentage points between the two surveys, from just under 70% in DHS 2002 to nearly 85% in MICS 2013, and the population share in the primary school subgroup decreased: a population shift from the primary school subgroup to the secondary school or higher subgroup.

An awareness of population shift can help to interpret disaggregated data. It can also help to understand the strengths and limitations of different summary measures of inequality. The summary measure calculations in this report (difference, ratio and excess change) do not account for population share across subgroups. Certain other measures, such as the slope index of inequality and the concentration index, take population share into account. For more information about the implications of populations shift and summary measures that account for population share, refer to the World Health Organization (WHO) *Handbook on health inequality monitoring: with a special focus on low-and middle-income countries*, available from: www.who.int/gho/health_equity/handbook/en/

The threshold for estimates based on low sample size in this report was 25–49 cases; that is, any subgroup that had an estimate based on 25–49 cases was flagged in the tooltip. (Samples of less than 25 cases resulted in the exclusion of the country for that indicator-dimension of inequality combination – see Appendix 1.) Estimates that are based on a low sample size should be interpreted with caution.

This report features 95% confidence intervals for all estimates. Based on the underlying sample size, 95% confidence intervals are a statistical measure that helps users to understand the precision of the estimate. They can be used to determine whether there are statistical differences between subgroups. Note, however, that statistical significance may not necessarily be meaningful in the context of public health decision-making. Thus, statistical significance should be considered alongside what is practical and relevant within policy environments.

Data presentation protocols

While this report does not put forth a recommended threshold for assigning practical significance, a difference between estimates of 2 percentage points or less was considered to be not practically relevant for public health purposes; for change over time, this threshold was 0.1 percentage point per year or less. Note that all estimates and their 95% confidence intervals are available for users to explore through the interactive visuals, and that alternate practices for assigning practical relevance may be adopted.

In general, the estimates presented in the text were rounded to the nearest 1% or 1 percentage point, and estimates for annual excess change were rounded to the nearest 0.1 percentage point. Refer to interactive visuals for more precise estimates, as well as related detailed information, as required.

The presentation of the results section according to dimensions of inequality emphasizes comparisons of inequality between childhood immunization indicators for a given dimension of inequality (including comparing inequality across countries). For instance, economic-related absolute inequality may be compared in the Bacille Calmette-Guérin (BCG) indicator and the measles indicator. This comparison is valid, as inequality is determined on the basis of a consistent number of subgroups (five quintiles). Alternate forms of comparison that involve comparing dimensions of inequality with different numbers of subgroups, such as economic-related inequality (five subgroups) versus education-related inequality (three subgroups), should be undertaken with caution.

For the priority country profiles, reporting generally discussed results by intervals of 5 to enhance the readability of the text. More precise estimates are available in the accompanying interactive visuals.

Population attributable risk (PAR)

PAR is a population impact measure that takes into account population share. PAR demonstrates the improvement in national average possible by eliminating within-country inequality by raising the national average to the level of the most-advantaged subgroup. For household economic status, mother's education and place of residence, the most-advantaged subgroup was uniformly assigned as follows: the richest 20% of households; mothers with secondary school or higher; or residents of urban areas. In the majority of cases, these subgroups reported a higher level of coverage compared to the national average, and thus PAR yielded a positive value. The few cases where the PAR value was negative stemmed from lower coverage in the assigned "most-advantaged" subgroup than the national average; for this report, these negative values were reassigned to zero, indicating that the national average would not be improved. For sex, the most-advantaged subgroup was assigned at the country level, according to the sex with the higher coverage; thus, unlike the other three dimensions of inequality, there was no fixed subgroup assigned as the most advantaged.

As a population impact measure, PAR demonstrates the potential gains in coverage through improvement of the national average to the level of the most-advantaged subgroup; in some cases, the desired gain in coverage in the population may be greater than the value of PAR. That is, eliminating inequality to the level of the most-advantaged subgroup may not be enough. For instance, the WHO Global Vaccine Action Plan (GVAP) has 90% coverage targets for national coverage; when coverage in the most-advantaged subgroup is less than 90%, PAR underestimates the desired overall improvement, though remains a useful summary measure for tracking inequality.

Appendix 3. Supplementary interactive visuals

Story points

The story point data visual is a series of eight interactive dashboards, demonstrating the state of inequality in childhood immunization across study countries. The story point format guides the user through data about the latest situation and change over time, allowing for independent data exploration and benchmarking.

Interactive visual A1: story points

To access the story point visual:

SCAN HERE:	or	VISIT:
		http://apps.who.int/gho/data/view.wrapper.HE-VIZ18?lang=en&menu=hide

Interactive reference table

The interactive reference table contains the complete set of data from all 69 low- and middle-income countries covered in this report. All data contained in the report are included in the interactive reference table, including national average, disaggregated data estimates, 95% confidence intervals and population share; situations of limited data availability are noted.

Interactive visual A2: reference table

To access the interactive reference table:

SCAN HERE:	or	VISIT:
		http://apps.who.int/gho/data/view.wrapper.HE-VIZ19?lang=en&menu=hide

Supplementary tables

TABLE S1. Study countries: survey source(s) and year(s), WHO region and country income group

Country	Survey source(s) and year(s)	WHO region	Country income group
Afghanistan[a]	MICS 2010–2011	Eastern Mediterranean	Low-income
Armenia[b]	DHS 2010, DHS 2000	European	Middle-income
Belize	MICS 2011	Americas	Middle-income
Benin[a,b]	DHS 2011–2012, DHS 2006, DHS 2001, DHS 1996	African	Low-income
Bosnia and Herzegovina	MICS 2011–2012	European	Middle-income
Burkina Faso[b]	DHS 2010, DHS 2003	African	Low-income
Burundi	DHS 2010	African	Low-income
Cambodia[a,b]	DHS 2014, DHS 2010, DHS 2005, DHS 2000	Western Pacific	Middle-income
Cameroon[a,b]	DHS 2011, MICS 2006, DHS 2004, DHS 1998	African	Middle-income
Central African Republic[a]	MICS 2010, MICS 2006, DHS 1994–1995	African	Low-income
Chad[b]	MICS 2010, DHS 2004	African	Low-income
Colombia[b]	DHS 2010, DHS 2000	Americas	Middle-income
Comoros[a]	DHS 2012, DHS 1996	African	Low-income
Congo[a]	DHS 2011–2012, DHS 2005	African	Middle-income
Costa Rica	MICS 2011	Americas	Middle-income
Côte d'Ivoire[a]	DHS 2011–2012, MICS 2006, DHS 1998–1999, DHS 1994	African	Middle-income
Cuba	MICS 2014	Americas	Middle-income
Democratic Republic of the Congo[a]	DHS 2013–2014, MICS 2010, DHS 2007	African	Low-income
Dominican Republic[b]	DHS 2013, DHS 2002	Americas	Middle-income
Egypt[b]	DHS 2014, DHS 2000	Eastern Mediterranean	Middle-income
Ethiopia[a,b]	DHS 2011, DHS 2005, DHS 2000	African	Low-income
Gabon[b]	DHS 2012, DHS 2000	African	Middle-income
Gambia	DHS 2013	African	Low-income
Ghana[b]	DHS 2014, DHS 2003	African	Middle-income
Guinea[a]	DHS 2012, DHS 2005, DHS 1999	African	Low-income
Haiti[b]	DHS 2012, DHS 2000	Americas	Low-income
Honduras	DHS 2011–2012	Americas	Middle-income

Country	Survey source(s) and year(s)	WHO region	Country income group
Indonesia[a,b]	DHS 2012, DHS 2007, DHS 2002–2003, DHS 1997, DHS 1994	South-East Asia	Middle-income
Iraq[a]	MICS 2011, MICS 2006	Eastern Mediterranean	Middle-income
Jamaica	MICS 2011	Americas	Middle-income
Jordan[b]	DHS 2012, DHS 2002	Eastern Mediterranean	Middle-income
Kazakhstan	MICS 2010–2011	European	Middle-income
Kyrgyzstan	MICS 2014	European	Middle-income
Lao People's Democratic Republic[a]	MICS 2011–2012, MICS 2006	Western Pacific	Middle-income
Liberia[a]	DHS 2013, DHS 2007	African	Low-income
Malawi[b]	MICS 2013–2014, DHS 2004	African	Low-income
Mali[a,b]	DHS 2012–2013, DHS 2006, DHS 2001, DHS 1995–1996	African	Low-income
Mauritania	MICS 2011	African	Middle-income
Mongolia	MICS 2010	Western Pacific	Middle-income
Montenegro	MICS 2013	European	Middle-income
Mozambique[a,b]	DHS 2011, MICS 2008, DHS 2003, DHS 1997	African	Low-income
Namibia[b]	DHS 2013, DHS 2000	African	Middle-income
Nepal[b]	MICS 2014, DHS 2001	South-East Asia	Low-income
Niger[a]	DHS 2012, DHS 2006, DHS 1998	African	Low-income
Nigeria[a,b]	DHS 2013, MICS 2011, DHS 2008, DHS 2003, DHS 1999	African	Middle-income
Pakistan[a]	DHS 2012–2013, DHS 2006–2007	Eastern Mediterranean	Middle-income
Panama	MICS 2013	Americas	Middle-income
Peru[b]	DHS 2012, DHS 2004	Americas	Middle-income
Philippines[b]	DHS 2013, DHS 2003	Western Pacific	Middle-income
Republic of Moldova	MICS 2012	European	Middle-income
Rwanda[b]	DHS 2010, DHS 2000	African	Low-income
Senegal	DHS 2014	African	Low-income
Serbia	MICS 2014	European	Middle-income
Sierra Leone	DHS 2013	African	Low-income
South Sudan[a]	MICS 2010	African	Low-income
Sudan[a]	MICS 2010	Eastern Mediterranean	Middle-income
Suriname	MICS 2010	Americas	Middle-income
Swaziland	MICS 2010	African	Middle-income
Tajikistan	DHS 2012	European	Middle-income
The former Yugoslav Republic of Macedonia	MICS 2011	European	Middle-income
Togo	DHS 2013–2014	African	Low-income
Tunisia	MICS 2011–2012	Eastern Mediterranean	Middle-income

Country	Survey source(s) and year(s)	WHO region	Country income group
Uganda[b]	DHS 2011, DHS 2000–2001	African	Low-income
Ukraine	MICS 2012	European	Middle-income
United Republic of Tanzania[b]	DHS 2010, DHS 2004–2005	African	Low-income
Viet Nam[b]	MICS 2013–2014, DHS 2002	Western Pacific	Middle-income
Yemen[a]	DHS 2013, MICS 2006	Eastern Mediterranean	Middle-income
Zambia[b]	DHS 2013–2014, DHS 2001–2002	African	Middle-income
Zimbabwe	MICS 2014	African	Low-income

[a] Priority country (as determined by criteria of the GVAP equity indicator, whereby the country reported DTP3 coverage that was 20 percentage points higher in the richest than the poorest wealth quintile).
[b] Country included in change-over-time analyses.

TABLE S2. Summary estimates for immunization indicators: national average and absolute and relative inequality by four dimensions of inequality (DHS and MICS 2010–2014)

		Immunization coverage among one-year-olds[a]				
		BCG	Measles	DTP3	Polio	Full
National average	Median	95.3	80.0	83.7	81.9	68.4
	Minimum	35.1	26.8	15.3	15.0	7.3
	Maximum	100.0	97.6	98.4	98.5	94.1
Absolute inequality (difference)						
Household economic status (richest quintile − poorest quintile)	Median	5.1	6.5	9.0	6.6	8.4
	Minimum	-3.8	-16.8	-20.2	-17.0	-25.0
	Maximum	78.3	64.7	72.3	33.1	54.1
Mother's education (secondary school or higher − no education)	Median	7.5	18.1	13.9	10.3	14.8
	Minimum	-0.6	-6.2	-10.4	-8.6	-10.8
	Maximum	66.2	54.4	61.7	53.5	49.1
Place of residence (urban − rural)	Median	2.6	3.6	2.9	1.4	2.4
	Minimum	-4.7	-13.0	-12.2	-15.2	-20.5
	Maximum	39.2	30.8	37.3	25.6	27.6
Sex (female − male)	Median	0.0	-0.2	-0.4	-0.3	-0.5
	Minimum	-3.7	-3.9	-5.8	-6.7	-9.0
	Maximum	6.5	6.5	8.3	10.3	10.3
Relative inequality (ratio)						
Household economic status (richest quintile / poorest quintile)	Median	1.05	1.08	1.11	1.10	1.10
	Minimum	0.96	0.80	0.69	0.64	0.39
	Maximum	6.60	5.90	10.82	4.22	15.42
Mother's education (secondary school or higher / no education)	Median	1.08	1.26	1.20	1.15	1.31
	Minimum	0.99	0.93	0.84	0.89	0.87
	Maximum	4.20	4.02	6.06	3.22	7.14
Place of residence (urban / rural)	Median	1.03	1.04	1.03	1.01	1.04
	Minimum	0.95	0.85	0.81	0.77	0.68
	Maximum	2.05	1.99	2.48	2.05	2.66
Sex (female / male)	Median	1.00	1.00	0.99	1.00	0.99
	Minimum	0.93	0.94	0.89	0.88	0.85
	Maximum	1.08	1.09	1.12	1.17	1.30

[a] Estimates are based on 67–69 countries, except for mother's education, for which estimates are based on 53–54 countries. National average estimates are expressed as percentages. Difference estimates are expressed as percentage points.

TABLE S3. Summary estimates for immunization indicators: annual absolute change in national average and annual absolute excess change by four dimensions of inequality (DHS and MICS 2000–2004 and 2010–2014)

		Immunization coverage among one-year-olds[a]				
		BCG	Measles	DTP3	Polio	Full
Annual absolute change						
National average	Median	0.49	0.82	1.13	0.59	1.12
	Minimum	-0.16	-0.77	-0.41	-1.33	-1.15
	Maximum	6.95	4.50	4.64	4.47	6.52
Annual absolute excess change						
Household economic status (annual change in the poorest quintile – annual change in the richest quintile)	Median	0.63	0.65	1.10	1.09	1.05
	Minimum	-2.32	-0.99	-2.55	-1.74	-1.89
	Maximum	3.06	4.08	3.63	3.87	3.74
Mother's education (annual change in no education – annual change in secondary school or higher)	Median	0.82	0.46	0.35	0.29	0.19
	Minimum	-1.51	-1.26	-1.43	-1.75	-1.79
	Maximum	1.98	2.26	3.83	4.16	4.24
Place of residence (annual change in rural areas – annual change in urban areas)	Median	0.37	0.49	0.45	0.48	0.41
	Minimum	-0.75	-0.95	-0.93	-0.36	-0.92
	Maximum	2.72	2.22	2.76	2.23	2.92
Sex (annual change in males – annual change in females)	Median	-0.01	0.00	0.05	0.09	0.04
	Minimum	-0.88	-0.47	-0.70	-0.67	-0.77
	Maximum	0.74	0.67	1.05	0.88	0.86

[a] Estimates are based on 28 countries, except for mother's education, for which estimates are based on 26 countries. All estimates are expressed as percentage points per year.

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Everyone Everywhere Always

http://www.who.int/gho/health_equity/report_2016_immunization/en/