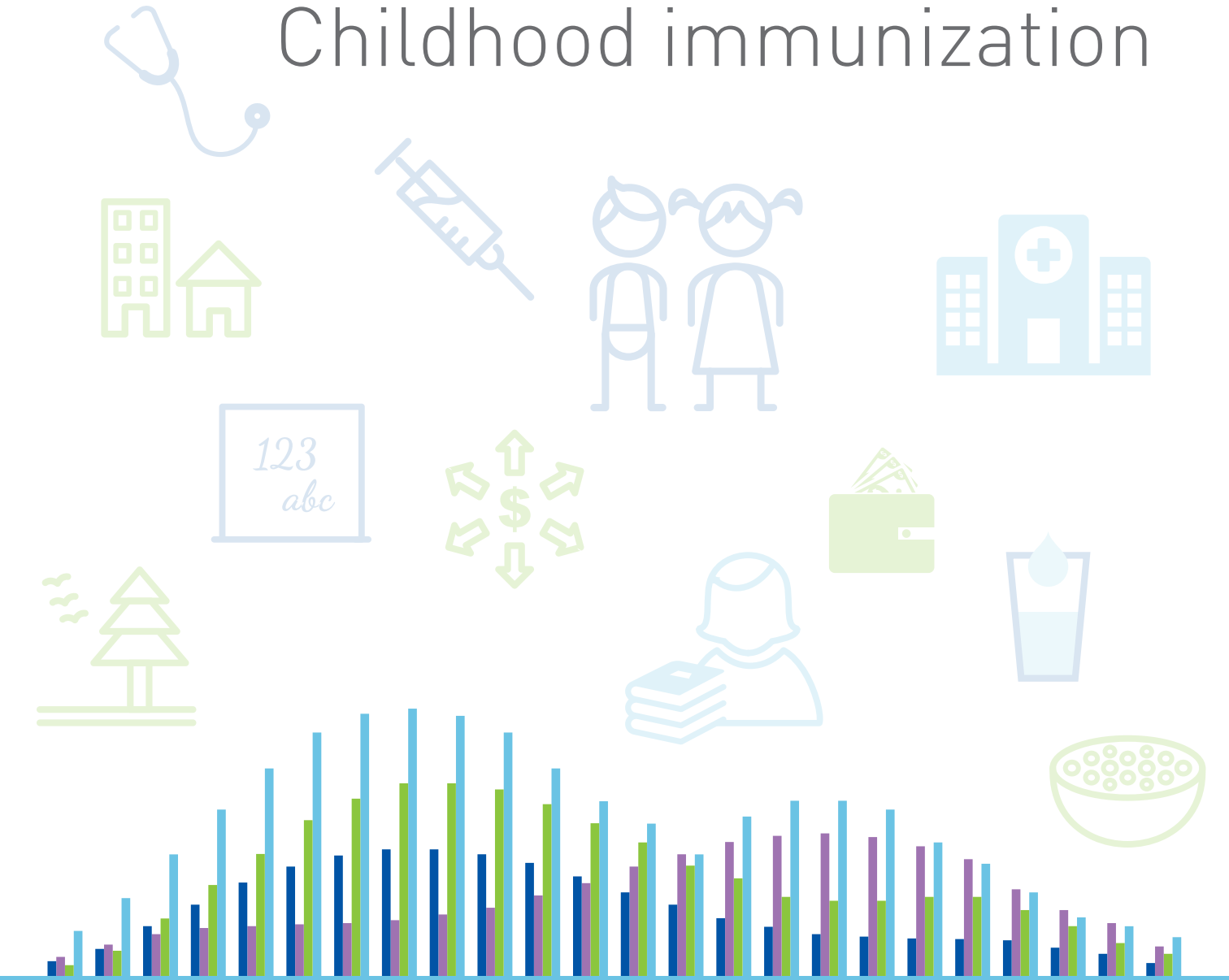
EXPLORATIONS OF INEQUALITY

Childhood immunization



INTERACTIVE VISUALIZATION OF HEALTH DATA

World Health Organization

EXPLORATIONS OF INEQUALITY

Childhood immunization

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Explorations of inequality: childhood immunization

ISBN 978-92-4-156561-5

Suggested citation. Explorations of inequality: childhood immunization. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.

Cataloguing-in-Publication (CIP) data. CIP data are available at http://apps.who.int/iris.

Design and layout by L'IV Com Sàrl, Villars-sous-Yens, Switzerland.
Printed by the WHO Document Production Services, Geneva, Switzerland.

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Foreword

The United Nations 2030 Agenda for Sustainable Development resolves to combat inequalities within and among countries. It endeavours to reach the furthest behind first, envisioning a world with universal and equitable access to education, health care and social protection, where no one is left behind. Health equity is a cross-cutting priority for the World Health Organization (WHO). Equity-oriented policies, programmes and practices help to ensure that health and the opportunities to attain health can be realized by everyone, everywhere and always.

I am now pleased to welcome the report *Explorations of inequality: childhood immunization* as an important extension of this work. This is a landmark report that goes beyond single stratification, illustrating how vulnerability and advantage can compound across multiple dimensions of inequality. The report offers a detailed analysis of national coverage and inequalities in childhood immunization across 10 priority countries, probing the factors that contribute to national coverage levels, as well as the inequalities that impede progress. Building on disaggregated data – the starting point of inequality measurements – the analyses employed in this report deepen our understanding of childhood immunization coverage. The report demonstrates how sophisticated approaches to health monitoring are relevant to decision-makers in health and other sectors.

Achieving the equity mandate of the Agenda for Sustainable Development requires concerted efforts, underpinned by reliable information systems that measure and monitor progress. This report is an important contribution to establishing that evidence base in childhood immunization. The type of exploration presented here serves as an example of what can be done across other health topics and settings.

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Foreword

Monitoring inequalities in health remains central to advancing health equity, signalling where gaps in health exist and encouraging innovative approaches to address them. To this end, national health information systems with the capability to collect, analyse and report on health inequality are a necessary investment for health inequality monitoring. WHO promotes the monitoring of health inequalities, globally and nationally. In recent years, publications such as the *Handbook on health inequality monitoring: with a special focus on low- and middle-income countries*, and the *National health inequality monitoring: a step-by-step manual* have outlined systematic approaches for monitoring; the *State of inequality* report series has shared the results of cross-country and national monitoring, enabled by tools such as the Health Equity Assessment Toolkit and the Health Equity Monitor database and theme page.

In this report, the 10 priority countries present unique case studies for childhood immunization, illustrating the value of health inequality monitoring in different contexts. In some countries, the rigorous analysis presented in the report was previously lacking; the findings in these settings will be particularly valuable as an evidence basis for childhood immunization initiatives to reach underserved populations, and to prompt health information system strengthening. In countries that reported low levels of inequality, ongoing assessment is vital to ensure that progress in childhood immunization continues to benefit all population groups. Within all 10 countries, the report called for heightened action to address geographical inequalities between subnational regions.

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Acknowledgements

Ahmad Reza Hosseinpoor (Health Equity Monitoring Lead, Department of Information, Evidence and Research, Health Metrics and Measurement Cluster, World Health Organization, Geneva, Switzerland) led the conceptualization and development of the report in close collaboration with Nicole Bergen (Faculty of Health Sciences, University of Ottawa, Ottawa, Canada), Anne Schlotheuber (Technical Officer, Department of Information, Evidence and Research, Health Metrics and Measurement Cluster, World Health Organization, Geneva, Switzerland) and Cecilia Vidal Fuertes (consultant). Ahmad Reza Hosseinpoor and Cecilia Vidal Fuertes defined the analytical framework. Cecilia Vidal Fuertes prepared the data and did the analyses; Nicole Bergen drafted the report text and provided technical editing support; and Anne Schlotheuber developed the graphics and interactive visuals.

The WHO Collaborating Center for Health Equity Monitoring (International Center for Equity in Health, Federal University of Pelotas, Brazil) provided guidance on the computation of the childhood immunization indicator used in this report. The report benefited from the contributions of numerous subject matter experts, who supported the development of the report across all stages of development. We acknowledge Owen O'Donnell (Erasmus University Rotterdam, Rotterdam, Netherlands), who made contributions to refining the analysis approach and reviewed the report. Aluisio JD Barros (Federal University of Pelotas, Pelotas, Brazil) and Adama Diop (consultant) reviewed the report. From Gavi, the Vaccine Alliance, Emmanuel Bor, Gustavo Correa, Samuel Muller, Antara Sinha and Carol Szeto reviewed early drafts of the report, and provided valuable comments.

Reviewers from the World Health Organization included: Jhilmil Bahl, Vinoid Bura, Somnath Chatterji, Kamal Fahmy, Tracey S Goodman, Quamrul Hasan, Annet Kisaye, Theadora Swift Koller, Wahyu Retno Mahanani, Helen Matzger, Alejandro Ramirez Gonzalez, Stephanie Shendale and Nadia Abd El-aziz Teleb Badr.

AvisAnne Julien provided copy-editing support and proofread the document, and Christine Boylan prepared the index.

Funding for the project was provided by Gavi, the Vaccine Alliance.

Frequent abbreviations and acronyms

DHS	Demographic and Health Surveys
DTP	combined diphtheria, tetanus toxoid and pertussis vaccine
ECI	Erreygers normalized concentration index
ICT	Islamabad: Islamabad Capital Territory
NFHS	National Family Health Survey
WHO	World Health Organization

Executive summary

Childhood immunization is a key intervention to promote the health, well-being and survival of children. Since the introduction of the Expanded Programme on Immunization in 1974 by the World Health Organization (WHO), global efforts have been in place to expand the benefits of vaccines across all countries and population groups. Despite marked success in many aspects of immunization programmes, inequalities in childhood immunization remain a challenge. Gavi, the Vaccine Alliance, established in 2000, is committed to accelerating the equitable uptake and coverage of vaccines, especially within poor countries and for populations that are underserved.

This report provides a closer look at the factors associated with childhood immunization. The report focuses on the 10 countries that Gavi, the Vaccine Alliance identified as the highest priority for childhood immunization. These countries face the most severe immunization challenges, and together account for more than 70% of children who do not get a full course of basic vaccines. Within each country, the report assessed: childhood immunization data disaggregated by child, mother, household and geographic characteristics; wealth- and education-related inequalities in childhood immunization, calculated as concentration curve and concentration index; and adjusted associations between immunization coverage and selected socioeconomic, demographic and geographic factors, through multiple regression analysis. The findings of the report are presented alongside details about the country context, followed by a multicountry assessment and discussion of the major implications of the findings.

Methods at a glance

Gavi, the Vaccine Alliance priority countries: Afghanistan, Chad, Democratic Republic of the Congo, Ethiopia, India, Indonesia, Kenya, Nigeria, Pakistan and Uganda.

Data sources: For each priority country, data were sourced from the latest publicly available Demographic and Health Surveys (DHS), ranging from 2012 to 2016. Surveys were conducted with a representative sample of women aged 15–49 years and included questions about childhood immunization and background characteristics.

Childhood immunization indicator: The childhood immunization indicator featured in this report is DTP3 immunization: the percentage of children aged 12–23 months who had received three doses of the combined diphtheria, tetanus toxoid and pertussis vaccine (DTP3) (or any DTP-containing vaccine, including pentavalent and tetravalent).

Descriptive analysis: Disaggregated data show childhood immunization coverage broken down by: child's sex, birth order, mother's age at birth, mother's education, mother's ethnicity or caste/tribe, sex of household head, household economic status, place of residence and subnational regions. Concentration curve and concentration index were used to measure how DTP3 coverage varied by socioeconomic status.

Multiple regression analysis: A logistic regression model was used to assess the associations between DTP3 immunization coverage and selected child, mother, household and geographic characteristics. Estimated associations are presented as odds ratios.

For more details about the methods, please refer to Chapter 2.

Major findings, by country

Afghanistan: Nationally, only three in five one-year-olds in Afghanistan received three doses of the DTP vaccine. Childhood immunization demonstrated no inequality by child sex, and low levels of inequality by birth order; however, coverage varied substantially according to mother's characteristics (age at birth, education and ethnicity), household economic status, place of residence and subnational region. Certain ethnic groups (especially the Nuristanis) and regions (including Nooristan and Urozgan) registered very low levels of coverage. When controlling for other background characteristics, immunization coverage was significantly associated with mother's age at birth, mother's education, household economic status and subnational region. Other things equal, the odds of coverage were 2.7 times larger for children in the richest quintile than in the poorest quintile, and almost twice as large among mothers aged 35–49 years (compared to those aged 15–19 years) and among mothers with secondary school or more (compared to those with no education).

In Afghanistan in 2015, a child of a teenaged mother with no education had one third the chance of being vaccinated as a child of a mother 20–49 years of age with secondary education or higher; if the child of the uneducated, teenaged mother belonged to the poorest 20%, this chance dropped to one ninth (compared to a child of a highly educated mother aged 20–49 years in the richest 20%).

Chad: Childhood immunization coverage in Chad was very low, with just one third of children reporting DTP3 immunization. DTP3 coverage showed no difference between boys and girls, but there was some inequality by birth order, mother's age at birth, sex of household head and place of residence. Coverage varied substantially according to mother's education level and subnational region. Coverage across wealth quintiles demonstrated a mass deprivation pattern, where coverage was uniformly low in quintiles 1 to 4, and increased sharply in quintile 5. When adjusted for other characteristics, the odds of immunization were 2.5 times higher in the richest than the poorest quintile and twice as high in mothers with secondary education or more as in mothers with no education. The regions of Mandoul and Mayo Kebbi Ouest had 27 and 19 times higher odds of coverage than Chari Baguirmi, respectively.

In Chad in 2014–2015, a child of a mother aged 20–34 years with secondary education or higher and belonging to the richest 20% had up to 7.2 times higher chance of receiving DTP3 immunization compared with a child of a teenaged mother with no education, from the poorest 20% household.

Democratic Republic of the Congo: Overall, the Democratic Republic of the Congo had national DTP3 immunization covering three out of five one-year-olds. Although there was no or little inequality by child's sex, birth order or mother's age at birth, coverage varied by other factors: mother's education, mother's ethnicity, household economic status, place of residence and subnational region. For instance, coverage across ethnic groups ranged from a minimum of 43% in the Uele Lac Albert and Cuvette Central subgroups to 83% in the Bakongo Nord & Sud subgroup. While coverage demonstrated a steep gradient across wealth quintiles, the urban–rural split spanned 20 percentage points, with higher coverage in urban areas. Controlling for other factors, immunization coverage was associated with mother's ethnicity, household economic status and subnational region. The odds of receiving the third dose of the DTP vaccine were 9 times higher for children in the Nord-Kivu province than children in the Katanga province, other things equal.

Ethiopia: About half of one-year-olds in Ethiopia were covered by DTP3 immunization. With the exception of child's sex, where coverage was the same in boys and girls, Ethiopia reported inequalities according to all other background characteristics featured in the report. Most notably,

coverage was higher among children of mothers with secondary school or more education, richer households, urban areas and certain subnational regions (especially Addis Ababa, Dire Dawa and Tigray, where coverage was over 80%). Ethnicity-related inequality demonstrated a substantial difference of 60 percentage points, from 22% in the Affar population to 82% in the Tigray population. Controlling for other factors, immunization coverage was associated with mother's age at birth, mother's education, sex of household head, household economic status and subnational region.

In Ethiopia in 2016, the chance of receiving the third dose of DTP vaccine was 6.7 times higher among a child whose mother is 20–49 years of age and primary school educated, and who lived in a male-headed household, compared with a child of a teenaged mother with no education in a female-headed household.

India: DTP3 immunization coverage in India reached nearly four out of five one-year-olds. Coverage was equal in boys and girls and female- and male-headed households, and there was little difference between coverage in urban and rural areas. Gradients in coverage were observed across birth order (higher order births showing lower coverage), mother's education level (less-educated subgroups showing lower coverage) and wealth quintiles (poorer quintiles showing lower coverage). DTP3 immunization coverage tended to be lower among children of mothers aged 35–49 years, children belonging to scheduled tribes and children in certain subnational regions (e.g. Nagaland and Arunachal Pradesh, where coverage was just over 50%). Adjusting for other factors, immunization coverage was associated with birth order, mother's education and economic status, and there was large variation in the odds of coverage across regions. There was a weak, although significant, association for mother's age at birth and mother's caste/tribe as well as for place of residence (demonstrating higher likelihood of coverage in rural areas).

In India in 2015–2016, children with highly educated mothers aged 20–49 years who belonged to the richest 20% of the population had a 5.3 times higher chance of being vaccinated, compared with children born to teenaged mothers with no education, in the poorest 20% of the population.

Indonesia: Indonesia reported 72% DTP3 immunization coverage among one-year-olds. Male and female children had similar levels of coverage, as did children of male- and female-headed households. Coverage dropped sharply with increasing birth order, and pronounced inequalities were observed by mother's education, household economic status and subnational region. Some inequality was observed by mother's age at birth (maximal coverage in the 20–34 years group) and place of residence (favouring urban areas). Controlling for other factors, immunization coverage was strongly associated with birth order, mother's education, household economic status and subnational region. Across provinces, the odds of childhood immunization demonstrated large variation: children in DI Yogyakarta, Bali, East Nusa Tenggara and North Sulawesi were more than 8 times as likely to be covered as those in Banten.

In Indonesia in 2012, a child who was part of a household in the richest 20%, and whose mother was aged 35–49 years, had a 6.4 times greater chance of being vaccinated compared to a child living in a household of the poorest 20%, and whose mother was a teenager.

Kenya: Nine out of 10 one-year-olds in Kenya were covered by DTP3 immunization. There was no inequality by child's sex, sex of household head or place of residence; some inequality was reported by mother's age at birth and household economic status. Coverage was lower for children born 6th or higher, for children of mothers with no education, and for children of Maasai and Somali ethnic groups. Across the eight subnational regions, the lowest coverage was reported by the North Eastern region (78%) and the highest coverage

was reported by the Central region (96%). After controlling for background characteristics, DTP3 immunization coverage was positively associated with mother's education and household economic status. The odds of reporting DTP3 coverage were over 2 times higher for 1st to 5th born children, compared to those 6th born or higher. Statistically significant associations with DTP3 immunization were also reported across subnational regions in Kenya.

In Kenya in 2014, children had a higher chance of being vaccinated if they belonged to the richest 40% of households and their mother had at least primary school education: compared to those who were part of the poorest 20% and whose mother had no education, their chances were 6.3 times higher.

Nigeria: In Nigeria, two in five one-year-olds received the third dose of DTP-containing vaccine. While females and males reported similar levels of coverage, substantial inequalities were observed by all other studied characteristics. Coverage among 1st born children was about twice as high as coverage among children 6th born or higher; coverage was 24 percentage points higher among female-headed households; and coverage by mother's age at birth spanned 20 percentage points, from 22% in 15–19-year-olds to 42% in 20–34-year-olds. DTP3 immunization demonstrated steep gradients by both mother's education and household economic status, and was about 2.5 times higher in urban than rural areas. Across the six subnational regions, coverage ranged from 14% in the North West region to 81% in the South East region. Overall, immunization was highly concentrated among children of richer households and more-educated mothers. After adjusting for other factors, immunization coverage was significantly associated with most background characteristics (birth order and place of residence were nearly significant and child's sex was not significant). Strong associations were evident for mother's education, household economic status and subnational regions.

In Nigeria in 2013, children of mothers aged 20–34 years who were highly educated, living in a rich household in the South South region were among the most advantaged in terms of childhood immunization: their chance of being vaccinated was 300 times higher than children with teenaged mothers with no education, living in poor households in the North West region.

Pakistan: Among one-year-olds in Pakistan, national DTP3 immunization coverage was 65%. Variable levels of inequality were reported across background characteristics, most prominently by mother's education, household economic status and subnational region. For both education and wealth, coverage was markedly lower in the most disadvantaged subgroups (the least-educated and the poorest). Across subnational regions, coverage spanned from 28% in Balochistan to 92% in ICT Islamabad. After controlling for other characteristics, immunization coverage was strongly associated with mother's education and especially household economic status, and subnational region. The odds of coverage differed greatly across regions, with ICT Islamabad having 7.8 times higher odds of coverage than Sindh.

In Pakistan in 2012–2013, a child of a mother aged 20–34 years with higher than secondary education and from the richest 20% of the population had a 28 times higher chance of being vaccinated, compared with a child of a teenaged mother with no education and from the poorest 20% of the population.

Uganda: Four out of five one-year-olds in Uganda were covered by DTP3 immunization. Little variation in coverage was reported across several studied background characteristics, except for mother's education and subnational region. Coverage was similar in boys and girls and differed by less than 4 percentage points across subgroups for mother's age at birth, sex of household head, household economic status and place of residence.

According to birth order, coverage was lower in 6th or higher order births, but similar across children of 1st to 5th birth order. By mother's education, coverage was higher among children of the most-educated subgroup (with more than secondary school) than other education subgroups, with a difference spanning 11 percentage points. Across subnational regions, coverage varied from 71% in Busoga to 91% in Teso. After adjusting for other characteristics, childhood immunization was significantly associated with birth order, mother's age at birth and subnational region. For instance, children of mothers with more than secondary school education had twice as high odds of receiving the DTP3 vaccine than children whose mothers had no education.

Key messages

Across the 10 priority countries, the national DTP3 immunization coverages ranged from 34% in Chad to 90% in Kenya. Evaluating performance based on national averages alone, however, masks the situation in population subgroups. The countries faced distinct patterns of inequality, from Uganda, where inequality tended to be very small for most of the featured characteristics, to Nigeria, where inequality was pronounced for most characteristics.

Despite the uniqueness of each country situation, some commonalities emerged. Inequalities by child's sex tended to be minimal or non-existent, and inequality by subnational region tended to be substantial. All countries reported variation by mother's education and subnational region and all (except Uganda) demonstrated inequality on the basis of household economic status. All 10 priority countries showed a positive association between mother's education level and childhood immunization coverage. Countries that reported low national coverage (e.g. Chad, Ethiopia and Nigeria) tended to demonstrate steep gradients and/or mass deprivation patterns across socioeconomic subgroups; the odds of immunization tended to be significantly higher in more advantaged subgroups in these countries. Countries with higher national coverage (e.g. India, Indonesia, Kenya and Uganda), more often demonstrated marginal exclusion or universal patterns across socioeconomic subgroups, and tended to have lower urban–rural inequality.

When considered alongside knowledge of the country context, the results of this report can be used to inform equity-oriented policies, programmes and practices to promote universal childhood immunization coverage. This report serves as a basis for more detailed explorations at the national and subnational levels, and a baseline for future health inequality monitoring efforts. Monitoring and exploring inequalities in health is essential as countries strive to "leave no one behind" on the path towards sustainable development.

1. Introduction

Immunization is a safe, effective and cost-effective health intervention across different life stages, including childhood *(1–4)*. Childhood immunization is a key strategy for the reduction of child morbidity and mortality: over the period from 2000 to 2015, the greatest decline in child mortality was attributable to reductions in vaccine-preventable diseases *(5)*. Immunization is considered an essential health service, and its coverage is monitored as part of Sustainable Development Goal 3: to ensure healthy lives and promote well-being for all at all ages *(6)*.

In 1974, the World Health Organization (WHO) established the Expanded Programme on Immunization to develop and promote routine immunization programmes in countries. Since this time, national immunization programmes have been introduced around the world, and subsequently shaped by new technologies, evolving vaccine delivery practices and innovative approaches to financing. Global campaigns and initiatives, past and present, have contributed to the expanded reach of vaccines and their benefits to diverse geographic settings and population groups *(7–11)*.

Still, not all children have equal opportunity to benefit from vaccines. While the success of immunization programmes is linked to aspects of health systems – such as accessibility of health facilities, health worker knowledge, vaccine supply and cost for vaccinations *(12)* – wider determinants of health also impact childhood immunization. In low-resource settings, childhood immunization programmes are affected by political stability, war and unrest, gender equality, living conditions, traditional or cultural practices, geographic characteristics, government spending on health, and receipt of external support for health *(13,14)*.

Within countries, gaps in immunization coverage exist between population subgroups. The report *State of inequality: childhood immunization* presents within-country inequalities in 69 countries, demonstrating large and persistent gaps on the basis of economic status and mother's education level in most countries *(15)*. Countries have demonstrated different patterns of inequality in childhood immunization, with variable levels of within-country inequality by wealth, education, gender, place of residence and other characteristics *(15–18)*.

Gavi, the Vaccine Alliance

Established in 2000, Gavi, the Vaccine Alliance was founded to address inequities in access to childhood vaccines, especially in poorer countries and among disadvantaged populations. Increasingly, guided by the framework of the WHO Global Vaccine Action Plan *(9)*, Gavi has adopted a more explicit focus on addressing within-country inequalities *(19)*. Through the 2016–2020 Gavi Strategic Action Plan, Gavi committed to the goal of accelerating equitable uptake and coverage of vaccines, and will monitor equity of coverage and barriers based on geography, wealth quintiles, mother's (or female caretaker's) education and fragile state status *(20)*.

By 2020, Gavi aspires to reach over 300 million children, and see a 10% reduction in under-5 mortality in Gavi-supported countries. Gavi currently engages with 72 countries, including 10 high-priority, tier-1 countries. These 10 countries face severe immunization challenges, and together account for more than 70% of children who do not get a full course of basic vaccines. Gavi's engagement with these countries is guided by Gavi's Partners Engagement Framework, based on four key principles: country-focused approach; differentiation; transparency; and accountability *(21)*.

Countries have employed numerous strategies to increase the coverage of childhood immunization among underserved populations, with varying success. Common ways of promoting childhood immunization include: providing education to parents and community members; issuing reminder cards; giving conditional cash transfers for parents who vaccinate their children; delivering regular vaccination outreach activities in villages; identifying unvaccinated children at home visits and referring them to clinics; and integrating vaccination services with other health services *(22)*. Further research is needed to determine how policies, programmes and practices can be designed for the highest impact in target populations.

This report aims to facilitate a better understanding of factors associated with childhood immunization coverage. Focusing on each of Gavi's 10 tier-1 countries, the in-depth analyses characterize the magnitude of inequality in childhood immunization across multiple dimensions of inequality and identify factors that are associated with immunization coverage. The main objectives of the report are:

- to present disaggregated childhood immunization data by child, mother, household and geographic characteristics in Gavi's 10 tier-1 countries (Afghanistan, Chad, Democratic Republic of the Congo, Ethiopia, India, Indonesia, Kenya, Nigeria, Pakistan and Uganda);
- to measure wealth- and education-related inequalities in those countries; and
- to assess the factors that underlie childhood immunization coverage in those countries.

The findings of this report serve to inform evidence-based and equity-oriented policies, programmes and practices; they also indicate areas for further research. The report was developed for an audience with some knowledge of statistics as well as health inequality measurements and their applications (especially staff of ministries of health, policy-makers, researchers and public health professionals).

The report is organized in 14 chapters. Chapter 2 outlines the methods, including data sources, priority country selection, the immunization indicator and analysis approaches. Chapters 3–12 present findings across the 10 featured countries. These chapters provide a brief overview of the country context, followed by the findings from the analyses. Chapter 13 presents a multicountry assessment of the findings across all 10 countries. Finally, Chapter 14 concludes with an overview of major findings and suggested directions for moving forward towards universal childhood immunization.

References

1. Ozawa S, Clark S, Portnoy A, Grewal S, Brenzel L, Walker DG. Return on investment from childhood immunization in low- and middle-income countries, 2011–2020. Health Aff (Millwood). 2016;35(2):199–207.
2. Andre F, Booy R, Bock H, Clemens J, Datta S, John T et al. Vaccination greatly reduces disease, disability, death and inequity worldwide. Bull World Health. 2008 February 1;86(2):140–6.
3. Bloom DE. The value of vaccination. In: Curtis N, Finn A, Pollard AJ, editors. Hot topics in infection and immunity in children VII. New York: Springer; 2011.
4. Clements CJ, Nshimirimanda D, Gasasira A. Using immunization delivery strategies to accelerate progress in Africa towards achieving the Millennium Development Goals. Vaccine. 2008 April;26(16):1926–33.
5. Countdown to 2030 Maternal, Newborn & Child Survival. Tracking progress towards universal coverage for reproductive, newborn and child health: the 2017 report. Report No.: Licence: CC BY-NC-SA 3.0 IGO. Washington (DC): United Nations Children's Fund (UNICEF) and the World Health Organization (WHO); 2017.
6. Resolution A/RES/70/1. Transforming our world: the 2030 agenda for sustainable development. Adopted by the United Nations General Assembly, New York, 25 September 2015.
7. WHO Department of Immunization, Vaccines and Biologicals, UNICEF Programme Division. Global Immunization Vision and Strategy 2006–2015. Geneva: World Health Organization; 2005.

8. Vandelaer J, Bilous J, Nshimirimana D. Reading Every District (RED) approach: a way to improve immunization performance. Bull World Health. 2008;86(3):A–B.
9. Global Vaccine Action Plan 2011–2020. Geneva: World Health Organization; 2013.
10. Immunization [Internet]. New York: UNICEF; 2018 (https://www.unicef.org/immunization/, accessed 20 April 2018).
11. Immunization policy and strategies [Internet]. Immunization, vaccines and biologicals. Geneva: World Health Organization (http://www.who.int/immunization/programmes_systems/policies_strategies/en/, accessed 20 April 2018).
12. Rainey JJ, Watkins M, Ryman TK, Sandhu P, Bo A, Banerjee K. Reasons related to non-vaccination and under-vaccination of children in low- and middle-income countries: findings from a systematic review of the published literature, 1999–2009. Vaccine. 2011 October;29(46):8215–21.
13. Arsenault C, Johri M, Nandi A, Mendoza Rodríguez JM, Hansen PM, Harper S. Country-level predictors of vaccination coverage and inequalities in Gavi-supported countries. Vaccine. 2017 April;35(18):2479–88.
14. Glatman-Freedman A, Nichols K. The effect of social determinants on immunization programs. Hum Vaccines Immunother. 2012 March 13;8(3):293–301.
15. State of inequality: childhood immunization. Geneva: World Health Organization; 2016.
16. 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. Lancet Glob Health. 2016 September;4(9):e617–e626.
17. Arsenault C, Harper S, Nandi A, Mendoza Rodríguez JM, Hansen PM, Johri M. Monitoring equity in vaccination coverage: a systematic analysis of demographic and health surveys from 45 Gavi-supported countries. Vaccine. 2017 February;35(6):951–9.
18. Restrepo-Méndez MC, Barros AJ, Wong KL, Johnson HL, Pariyo G, França GV et al. Inequalities in full immunization coverage: trends in low- and middle-income countries. Bull World Health. 2016 November 1;94(11):794–805A.
19. Gandhi G. Charting the evolution of approaches employed by the Global Alliance for Vaccines and Immunizations (GAVI) to address inequities in access to immunization: a systematic qualitative review of GAVI policies, strategies and resource allocation mechanisms through an equity lens (1999–2014). BMC Public Health [Internet]. 2015 December (http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-2521-8, accessed 16 April 2015).
20. Gavi, the Vaccine Alliance 2016–2020 Strategy [Internet]. Geneva: Gavi, the Vaccine Alliance; 2014 (https://www.gavi.org/about/strategy/, accessed 18 April 2018).
21. Engaging partners for success [Internet]. Geneva: Gavi, the Vaccine Alliance; 2018 (https://www.gavi.org/library/news/gavi-features/2017/engaging-partners-for-success/, accessed 24 April 2018).
22. Oyo-Ita A, Wiysonge CS, Oringanje C, Nwachukwu CE, Oduwole O, Meremikwu MM; Cochrane Effective Practice and Organisation of Care Group, editor. Interventions for improving coverage of childhood immunisation in low- and middle-income countries. Cochrane Database Syst Rev. 2016 July 10.

2. Methods

Data sources

This report used data from the Demographic and Health Surveys (DHS). The DHS are large-scale nationally representative household surveys that collect comparable information about population health indicators and their socioeconomic context *(1)*. The DHS use standardized questionnaires administered to a representative sample of women aged 15–49 years, focusing primarily on maternal and child health. The DHS use a multistage cluster design. In India, the DHS is referred to as the National Family Health Survey (NFHS), which follows the same general protocol and methodology.

Priority countries

This report provides an in-depth analysis for a set of 10 priority countries identified by Gavi, the Vaccine Alliance as tier-1 countries. These countries together account for more than 70% of children worldwide who do not get a full course of basic vaccines *(2)*. The countries featured in this report span three WHO regions: the African Region; the South-East Asia Region; and the Eastern Mediterranean Region. For each priority country, the latest publicly available DHS was used. Table 2.1 presents the list of countries included in this report, the year of DHS or NFHS fieldwork and the WHO region.

Childhood immunization indicator

The childhood immunization indicator featured in this report is receipt of the third dose of the combined diphtheria, tetanus toxoid and pertussis vaccine (DTP3). Coverage of DTP3 immunization was defined as: the percentage of children aged 12–23 months who had received three doses of the combined DTP vaccine at the time of the survey. DTP3 immunization coverage was calculated considering all DTP-containing vaccines, including pentavalent, tetravalent and/or DTP only. The lower limit of this age range is the youngest age by which children should have received three doses, and

TABLE 2.1. Priority countries included in this report

No.	Country	DHS/NFHS fieldwork year[a]	WHO region
1	Afghanistan	2015	Eastern Mediterranean
2	Chad	2014	African
3	Democratic Republic of the Congo	2013	African
4	Ethiopia	2016	African
5	India	2015	South-East Asia
6	Indonesia	2012	South-East Asia
7	Kenya	2014	African
8	Nigeria	2013	African
9	Pakistan	2012	Eastern Mediterranean
10	Uganda	2016	African

[a] In countries where the DHS or NFHS fieldwork spanned two years, this indicates the first year of fieldwork. These countries are: Chad (2014–2015), Democratic Republic of the Congo (2013–2014), India (2015–2016) and Pakistan (2012–2013).

the upper limit is the oldest age by which they should have received three doses. DTP3 coverage is considered a key indicator of immunization programme performance, and has been widely applied for national and global monitoring *(3)*.

The DTP3 coverage indicator was constructed based on the information on immunization collected from health cards as well as from mothers' reports. According to DHS protocols, if the immunization card was available, the interviewer copied the vaccination dates directly to the questionnaire. When there was no immunization card, or if the vaccine had not been recorded on the card, the respondent was asked to verbally report the vaccines administered to the child.

Analysis approaches

The report presents the results of two types of analyses: descriptive analysis of inequalities by background characteristics (including data disaggregation and calculation of socioeconomic inequality using summary measures of inequality); and multiple regression analysis to examine associations of DTP3 with each characteristic controlling for the others. For all analyses, survey sampling design, including sample weights and clustering effects, were taken into account when calculating point estimates and their confidence intervals.

For more information about the analysis approaches, please see the accompanying technical note and glossary: http://www.who.int/gho/health_equity/report_2018_immunization/technical_notes.pdf

Descriptive overview

Disaggregation by background characteristics

To assess inequality in DTP3 immunization coverage within each country, the report first presents the level of coverage among subgroups of the population. Data were disaggregated by characteristics of the child, the mother and the household, as well as geographic characteristics (Table 2.2). For most factors, subgroups were constructed using comparable definitions and categorizations across countries. For example, subgroups based on mother's age at birth were grouped as 15–19 years, 20–34 years and 35–49 years in all countries. Inequality according to household economic status was evaluated by comparing the level of coverage across five quintiles of a wealth index. (The wealth index was constructed using information on assets ownership, housing characteristics, and access to services *(4)*). For mother's education, subgroups reflected the highest level of education attended (a standard DHS variable). Due to small sample sizes in some countries, the two highest education categories were sometimes combined as "secondary school or more".

Country-specific subgroup categorizations were applied for mother's ethnicity, caste/tribe and subnational region. More information about these variables are included in the country context section of each chapter, and the DHS or NFHS final country reports *(5)*. In countries where information on mother's ethnicity or caste/tribe was available, the categorization defined by the DHS or NFHS survey was used. In the Democratic Republic of the Congo, Ethiopia and Kenya, specific categories were combined in one category defined as "other" and only larger ethnic groups were presented individually. For subnational regions, unless otherwise noted, the data presented in this report reflect the subnational administrative divisions that were current at the time of the survey and for which data were collected. In the Democratic Republic of the Congo and Indonesia, the subnational divisions have changed since the time of the survey. In Chad, Kenya and Uganda, some of the divisions were combined. In Pakistan, the DHS was not administered in two subnational regions, and therefore they were also not included in this report.

TABLE 2.2. Background characteristics and associated subgroups applied to describe within-country inequality

	Characteristics	Subgroups
Child characteristics	Child's sex	Female Male
	Birth order	1st born 2nd–3rd born 4th–5th born 6th born or higher
Mother characteristics	Mother's age at birth	15–19 years 20–34 years 35–49 years
	Mother's education[a]	No education Primary school Secondary school More than secondary school
	Mother's ethnicity or caste/tribe[b]	Country-specific – see each country chapter
Household characteristics	Sex of household head	Female Male
	Household economic status	Quintile 1 (poorest) Quintile 2 Quintile 3 Quintile 4 Quintile 5 (richest)
Geographic characteristics	Place of residence	Rural Urban
	Subnational region	Country-specific – see each country chapter

[a] In Afghanistan, Chad, the Democratic Republic of the Congo, Ethiopia and Kenya, the combined category of "secondary school or more" was applied due to small sample sizes of women with higher levels of education.
[b] Mother's ethnicity was applied in four countries: Afghanistan, Democratic Republic of the Congo, Ethiopia and Kenya; caste/tribe was applied in India.

Wealth- and education-related inequalities

To further assess within-country inequality in DTP3 immunization coverage, this report focused on two background characteristics: household economic status and mother's education. The report used the concentration index and concentration curve to provide a more complete analysis of how coverage varied across the full distribution of household wealth and mother's education *(6,7)*.

To quantify the magnitude of inequality in DTP3 immunization coverage in a single numerical value, the Erreygers normalized concentration index (ECI) was calculated. (In this report, both wealth-related and education-related ECI values were calculated.) The ECI is a summary measure of absolute inequality that indicates the extent to which DTP3 immunization coverage is concentrated among the rich (or the poor) or among the more educated (or less educated). The ECI is a variant of the generalized concentration index that shows a specific adjustment applicable for binary health indicators whose average is bounded between zero and one *(8–10)*. The ECI has a negative value when the health indicator is concentrated among the poor (or less educated); and it has a positive value when the health indicator is concentrated among the rich (or more educated). When there is no inequality, the ECI value is 0. ECI values have a possible range from -1 to +1.

The concentration curve is a graphical representation of how DTP3 coverage is distributed across subgroups with an inherent ordering, such as household economic status. In the case of household economic status, the concentration curve plots the cumulative share of DTP3 coverage against the cumulative share of children ranked from poorest to richest. In a situation of perfect equality, the concentration curve will be a 45-degree diagonal line (line of equality); that is, the share of immunization coverage exactly matches the share of children belonging to each wealth rank. If DTP3 coverage is lower among poorer children, the concentration curve will lie below the line of equality; if higher among poorer children, the curve will lie above the line of equality. The further the concentration curve lies from the equality line, the greater the inequality.

Multiple regression analysis

A logistic regression model was used to assess the adjusted associations between DTP3 immunization coverage and selected demographic, socioeconomic and geographic characteristics. The multiple regression framework establishes the association of each characteristic with DTP3 coverage, accounting for other characteristics. The development of the framework was guided by a literature review and subject to data availability.

Results of the regression analysis were reported using adjusted odds ratios. Odds ratios were used to compare the relative odds (that is, the chance) of DTP3 immunization of one subgroup against a reference subgroup (Table 2.3). An odds ratio equal to 1 means that the factor does not affect the odds of DTP3 immunization. An odds ratio greater than 1 indicates that the characteristic is associated with higher odds of immunization compared to

TABLE 2.3. Background characteristics included in the multiple regression analyses

Characteristics	Reference and other subgroups
Child's sex	Reference subgroup: male
Birth order	Reference subgroup: 6th born or higher Other subgroups included as dummy variables: 1st born; 2nd–3rd born; 4th–5th born
Mother's age at birth	Reference subgroup: 15–19 years Other subgroups included as dummy variables: 20–34 years; 35–49 years
Mother's education[a]	Reference subgroup: no education Other subgroups included as dummy variables: primary school; secondary school; more than secondary school
Mother's ethnicity or caste/tribe[b]	Reference subgroup: country-specific – see each country chapter Other subgroups included as dummy variables: country-specific – see each country chapter
Sex of household head[c]	Reference subgroup: male
Household economic status	Reference subgroup: quintile 1 Other subgroups included as dummy variables: quintiles 2–5
Place of residence	Reference subgroup: rural
Subnational region	Reference subgroup: country-specific – see each country chapter Other subgroups included as dummy variables: country-specific – see each country chapter

[a] In Afghanistan, Chad, the Democratic Republic of the Congo, Ethiopia and Kenya, the combined category of "secondary school or more" was applied due to small sample sizes of women with higher levels of education.
[b] Mother's ethnicity was applied in two countries: Democratic Republic of the Congo and Kenya; caste/tribe was applied in India.
[c] Sex of household head was not included for Afghanistan, because nearly all households (99%) were headed by males.

the reference subgroup; an odds ratio less than 1 indicates lower odds of immunization compared to the reference subgroup. For example, for place of residence, the reference subgroup was rural: if the odds ratio was more than 1, the chance of coverage was higher in urban areas, and if the odds ratio was less than 1, the chance of coverage was less likely in urban areas.

The statistical inference of the odds ratio was determined by the 95% confidence intervals and the p-value of the test of statistical significance. The significance level was considered as 0.05: if the p-value was below 0.05, the association was considered statistically significant. P-values between 0.05 and 0.10 were considered to be nearly significant. Joint hypothesis testing was also used to test whether the characteristics with multiple subgroups (e.g. regions, etc.), taken as a whole, were significantly associated with DTP3 immunization coverage.

In addition to exploring the adjusted associations between background characteristics and DTP3 coverage, the report analysed how the relationship between these variables and DTP3 coverage changed after accounting for interaction effects. For each country, interactions were individually tested between: mother's education and household wealth; mother's age at birth and household wealth; mother's age at birth and education; and place of residence and household wealth. For almost all combination cases, interactions were not statistically significant on whole.

Multicollinearity was also tested. This is the condition where a very high correlation exists between two or more variables included in the multiple regression model, resulting in unstable estimates (in our case, odds ratios). In Afghanistan and Ethiopia, ethnicity showed collinearity (with subnational region). The model including ethnicity in both countries demonstrated that the variable was not statistically significant and the associations between DTP3 and ethnicity were mainly explained through the regional variation in different ethnic subgroups. So, ethnicity was dropped from the logistic regressions in these countries, although ethnicity was used in the descriptive analysis.

Interactive visuals and tables

Interactive visuals and tables accompany this report, enabling further exploration of patterns in the data, and customized visual outputs. The interactive visuals and tables convey additional information about the underlying data to contextualize the interpretation of the report findings and make the results more transparent. Information included in the interactive visuals covers: national averages, disaggregated data, ECI values and odds ratios. 95% confidence intervals are reported for all estimates. For disaggregated data, the population share for each population subgroup and sample size limitations are presented. For odds ratios, the p-values as well as information about the logistic regression model (number of observations used in the model, pseudo R2 and Wald Chi2) are listed. To access the interactive visuals referenced in this report, see the QR codes and URLs that appear at the end of each country chapter. To access the interactive tables, see Appendix 1.

References

1. The DHS Program. Demographic and Health Surveys [Internet]. Washington (DC): US Agency for International Development; 2018 (dhsprogram.com, accessed 21 May 2018).
2. Targeted country assistance. [Internet]. Geneva: Gavi, the Vaccine Alliance; 2018 (https://www.gavi.org/support/pef/targeted-country-assistance/, accessed 21 May 2018).
3. Wallace AS, Ryman TK, Dietz V. Overview of global, regional, and national routine vaccination coverage trends and growth patterns from 1980 to 2009: implications for vaccine-preventable disease eradication and elimination initiatives. J Infect Dis. 2014 November;210(Suppl. 1):S514–S22.
4. Rutstein SO, Johnson K. The DHS wealth index. Calverton: ORC Macro; 2004.

5. The DHS Program. DHS Final Reports [Internet]. Washington (DC): US Agency for International Development; 2018 (https://dhsprogram.com/publications/publication-search.cfm?type=5, accessed 21 May 2018).
6. O'Donnell O, van Doorslaer E, Wagstaff A, Lindelow M. Analyzing health equity using household survey data. A guide to techniques and their implementation. Washington (DC): World Bank; 2008.
7. Handbook on health inequality monitoring: with a special focus on low- and middle-income countries. Geneva: World Health Organization; 2013:126.
8. Erreygers G. Correcting the concentration index. J Health Econ. 2009 March;28(2):504–15.
9. Erreygers G, Van Ourti T. Measuring socioeconomic inequality in health, health care and health financing by means of rank-dependent indices: a recipe for good practice. J Health Econ. 2011 July;30(4):685–94.
10. O'Donnell O, O'Neill S, Van Ourti T, Walsh B. conindex: estimation of concentration indices. Stata J. 2016;16(1):112.

3. Afghanistan

Country context

Afghanistan has a population of 34 million, with 15.5% under 5 years of age *(1)*. The country consists of 34 provinces, and major ethnic groups include Nuristani, Pashtun, Tajik, Hazara, Uzbek, Turkmen, Baloch and Pashai. The under-5 mortality rate in Afghanistan has improved over the past decades, from 177.3 deaths per 1000 live births in 1990 to 70.4 deaths per 1000 live births in 2016 *(2)*; however, despite progress, the country has not yet achieved the Millennium Development Goal target of 59 *(3)*. Key risk factors for child health include poverty, underemployment, natural disasters, conflict migration, compromised security situation, urbanization and certain social norms *(4)*.

The Expanded Programme on Immunization began operating in Afghanistan in 1978 *(5)*. Expanded Programme on Immunization activities have been implemented in the majority of districts, and are managed through a three-tier system with responsibilities coordinated across national, provincial and district levels *(6)*. The National Immunization Program in Afghanistan delivers services through facility-based, outreach and mobile approaches *(6)*. Routine immunization is a core component of the Basic Package of Health Services, a strategy to bolster access to health services in rural populations *(7)*. While the introduction of this package has benefited vaccine delivery, challenges and service delivery gaps persist *(8)*.

Childhood immunization in the country remains low overall, with national estimates falling well below coverage goals of 90% *(6)*. Inequality is a concern in Afghanistan, as childhood immunization is variable across geographic and demographic subgroups. For instance, immunization coverage is lower in areas with security concerns *(5)*, and among the poorest *(9)* and those living farther from health facilities *(4,10)*.

The improvement of immunization services, including revising the Expanded Programme on Immunization policy and strengthened monitoring mechanisms, is a strategic area of action for child health in Afghanistan *(4)*. Expanding coverage and addressing inequity are addressed in immunization forums and country plans.

Descriptive overview

Disaggregation by background characteristics

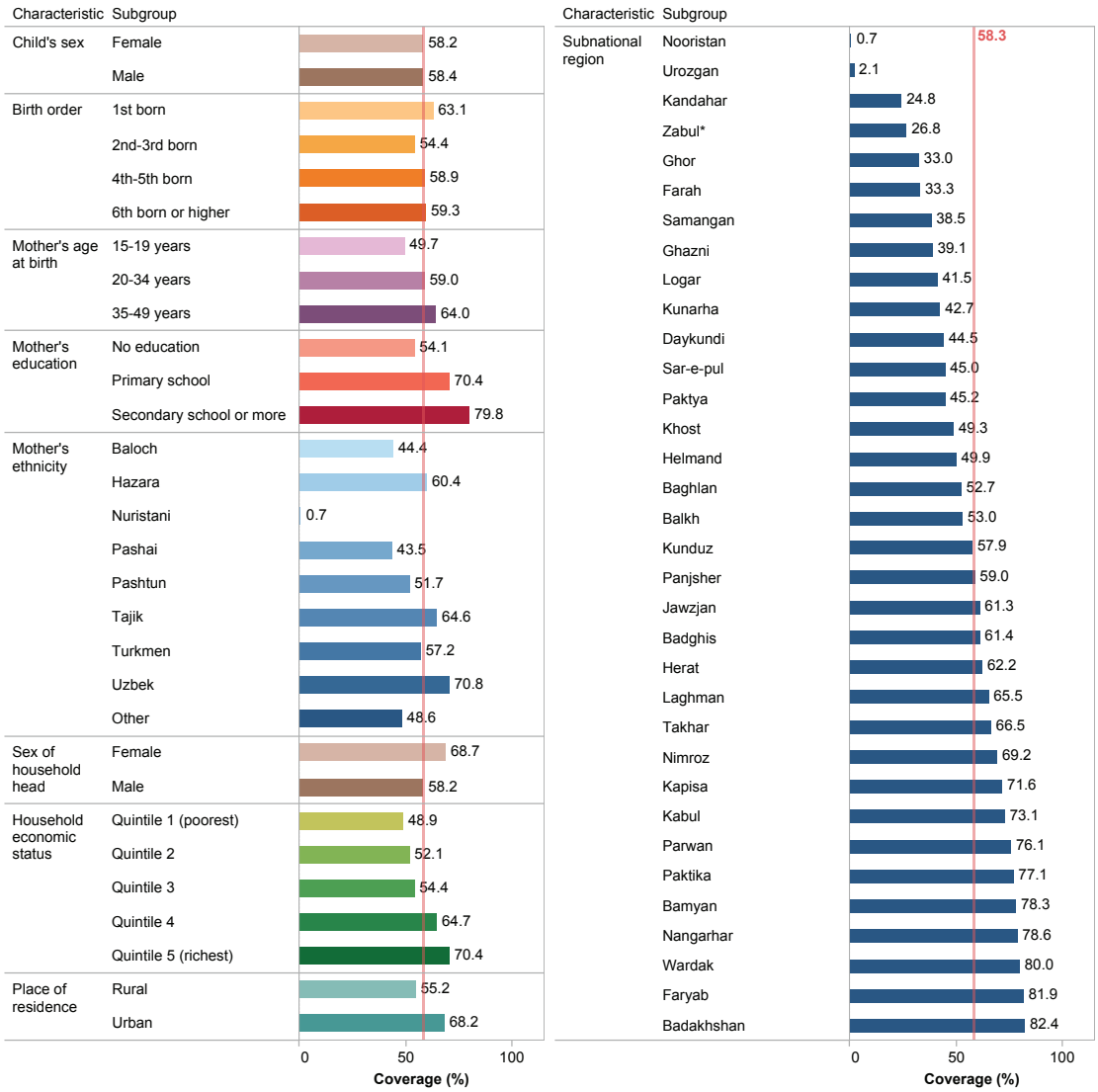
Nationally, the coverage of DTP3 immunization was 58% among one-year-olds. Figure 3.1 shows the coverage of DTP3 immunization in Afghanistan by population subgroups.

There was no variation in coverage according to child sex. Coverage varied somewhat according to birth order, ranging from 54% among 2nd–3rd born children to a maximum of 63% among 1st born children.

DTP3 coverage showed a substantial gradient by mothers' characteristics. Compared to the 15–19 years subgroup, coverage increased by 9 percentage points (from 50% to 59%) in the 20–34 years subgroup, and an additional 5 percentage points in the 35–49 years subgroup (64%). DTP3 coverage also increased consistently with mother's education, whereby coverage was notably lower for the no education subgroup (54%) compared to the secondary school or more subgroup (80%). There was a substantial difference in immunization coverage across ethnic subgroups: coverage ranged from 1% in Nuristani populations to 71% in Uzbek populations.

Female-headed households reported higher immunization coverage (69%) than male-headed households (58%). Afghanistan demonstrated a

FIGURE 3.1. DTP3 immunization coverage among one-year-olds in Afghanistan, disaggregated by background characteristics (DHS 2015)



Note: The red vertical line shows the national average.
*Estimate was based on 25–49 cases.

gradient of increasing coverage across household wealth quintiles. Coverage increased moderately in the three poorest quintiles (from 49% in quintile 1 to 54% in quintile 3) and demonstrated larger increases in the two richest quintiles (65% in quintile 4 and 70% in quintile 5).

The immunization coverage of children from urban areas (68%) was 13 percentage points higher than children from rural areas (55%). Coverage across regions varied substantially. Notably, the gap between the regions with lowest coverage (Nooristan and Urozgan, 1% and 2%, respectively) and those with the highest coverage (Badakhshan and Faryab, 82%) was over 80 percentage points.

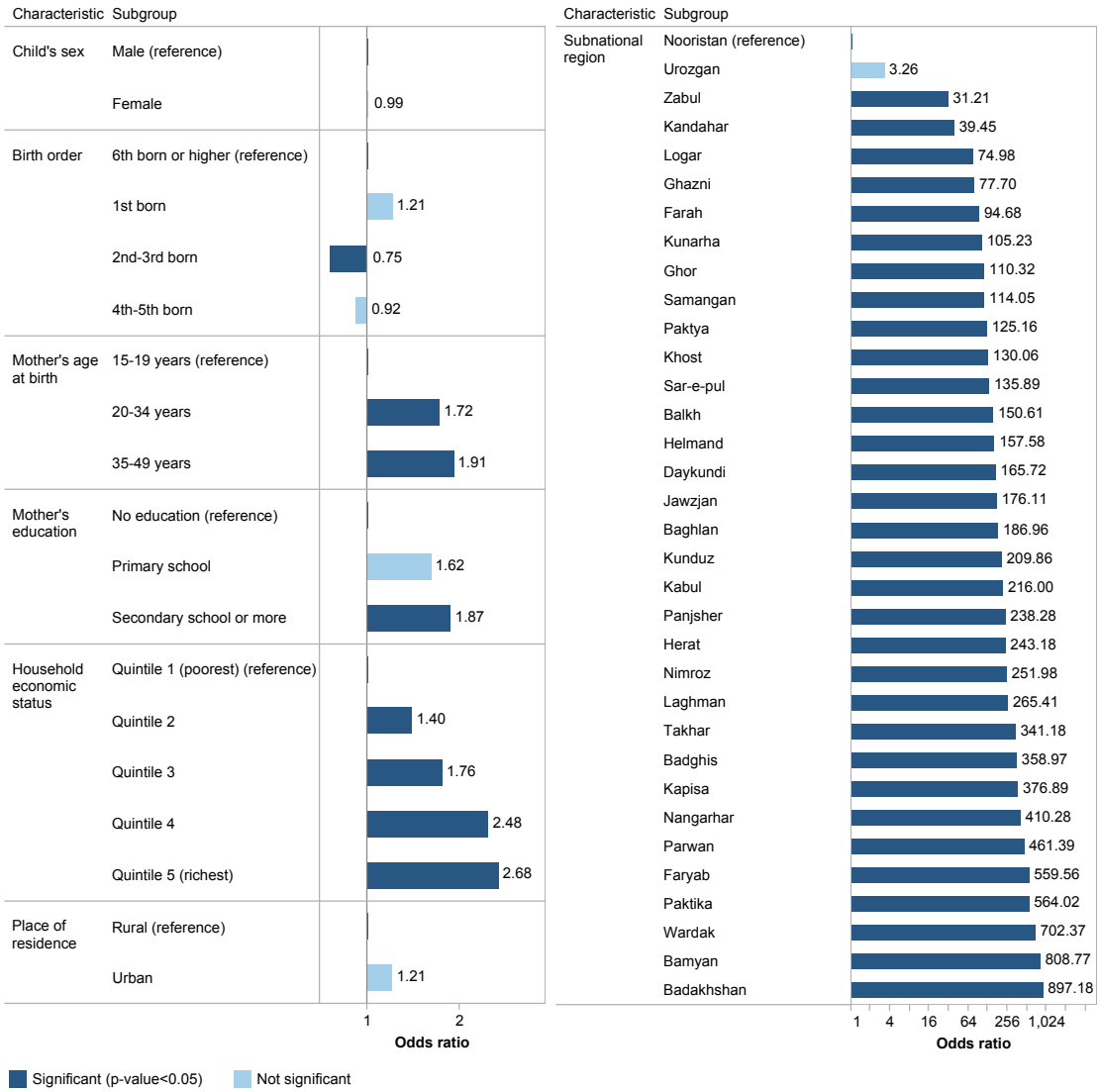
Wealth- and education-related inequalities

In Afghanistan, the wealth-related ECI for DTP3 immunization coverage had a positive value of 0.191, indicating that coverage was more concentrated among richer households. The education-related ECI was 0.135, suggesting that coverage was higher among those with more education. In both cases, the ECIs were statistically significant. The wealth-related concentration curve for DTP3 immunization coverage in Afghanistan is available in Chapter 13.

Multiple regression analysis

Figure 3.2 presents the adjusted associations between DTP3 immunization coverage and selected socioeconomic, demographic and geographic

FIGURE 3.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in Afghanistan, calculated as odds ratio (DHS 2015)



Note: Sex of household head was not included in this analysis because nearly all households (99%) were headed by males.

factors. There was large variation in the odds of childhood immunization across regions, adjusting for other characteristics. For example, compared to Nooristan, the region with the lowest odds of coverage, children living in Wardak, Bamyan or Badakhshan were more than 700 times as likely to be covered.

Immunization coverage was significantly associated with household economic status. For instance, the odds of DTP3 immunization for a one-year-old child in either of the two richest quintiles were around 2.5 times higher than those of a child in the poorest quintile. Mother's age at birth was associated with childhood immunization: children of mothers aged 35–49 years and 20–34 years had a probability 1.9 and 1.7 times higher, respectively, of being covered than children of mothers aged 15–19 years. Taken as a whole, the education variable was statistically significant, indicating variation in DTP3 coverage across mother's education: children whose mothers had secondary school or more education were 1.9 times more likely to be covered than those in the no education subgroup. On whole, the birth order variable was also statistically significant.

The remaining factors presented non-significant associations with DTP3 coverage. For instance, other things equal, child's sex and place of residence were not associated with immunization coverage.

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
3. Akseer N, Salehi AS, Hossain SM, Mashal MT, Rasooly MH, Bhatti Z et al. Achieving maternal and child health gains in Afghanistan: a Countdown to 2015 country case study. Lancet Glob Health. 2016;4(6):e395–e413.
4. Children and women in Afghanistan: a situation analysis 2014. Kabul: UNICEF; 2014.
5. Mashal T, Nakamura K, Kizuki M, Seino K, Takano T. Impact of conflict on infant immunisation coverage in Afghanistan: a countrywide study 2000–2003. Int J Health Geogr. 2007;6(1):23.
6. Islamic Republic of Afghanistan Ministry of Public Health. Comprehensive Multi-Year Plan for National Immunization Program 2011–2015. Kabul: Government of Afghanistan; 2012.
7. Islamic Republic of Afghanistan Ministry of Public Health. A basic package of health services for Afghanistan, 2005/1384. Kabul: USAID Afghanistan; 2005.
8. Mbaeyi C, Kamawal NS, Porter KA, Azizi AK, Sadaat I, Hadler S et al. Routine immunization service delivery through the basic package of health services program in Afghanistan: gaps, challenges, and opportunities. J Infect Dis. 2017 July 1;216(Suppl. 1):S273–S279.
9. Akseer N, Bhatti Z, Rizvi A, Salehi AS, Mashal T, Bhutta ZA. Coverage and inequalities in maternal and child health interventions in Afghanistan. BMC Public Health [Internet]. 2016 September;16(S2) (http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-3406-1, accessed 4 April 2018).
10. Hemat S, Takano T, Kizuki M, Mashal T. Health-care provision factors associated with child immunization coverage in a city centre and a rural area in Kabul, Afghanistan. Vaccine. 2009 May;27(21):2823–9.

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in Afghanistan.

To access interactive visuals:

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http://apps.who.int/gho/data/view.wrapper.HE-VIZ21?lang=en&menu=hide

To access interactive tables, see Appendix 1.

4. Chad

Country context

Chad has a population of 14 million, with 18.6% under 5 years of age *(1)*. The country consists of 23 subnational regions. In this report, as per the protocol followed in the DHS, the regions of Borkou and Tibesti were grouped as one, as were the regions of Ennedi-Est and Ennedi-Ouest; thus, data are presented for 21 subnational regions. In 1990, the under-5 mortality rate was 210.8 deaths per 1000 live births, which dropped to 127.3 deaths per 1000 live births in 2016 *(2)*. The poor state of child health in Chad has been attributed to widespread poverty, multifaceted inequalities, geopolitical instability and weak institutional capabilities *(3)*.

Chad's national Inter-Agency Coordinating Committee (ICC), chaired by the Minister of Health and supported by other government ministries and United Nations partner organizations, is the high-level decision-making body for matters concerning childhood immunization *(4)*. While the country has a technical advisory group for polio, an independent national advisory committee on immunization has not yet been established *(4)*.

The immunization coverage among one-year-olds in Chad is very low *(5)*. The expansion of the Reaching Every District (RED) strategy to 54 out of 90 health districts in recent years has made some headway in improving immunization coverage; intensified efforts to reach nomadic populations, and the movement of people to more secure areas such as camps, have also contributed to coverage increases *(4)*. Operational difficulties in the health sector, as well as programme implementation challenges and security issues have impeded progress in childhood immunization *(4)*. Factors that predict non-use of maternal health services or childhood immunization include: rural residence; low level of parental education; and having multiple children under 5 years of age in the family *(6)*.

Descriptive overview

Disaggregation by background characteristics

National DTP3 immunization coverage was 34% among one-year-olds in Chad. Figure 4.1 presents coverage of DTP3 immunization disaggregated by child, mother and household characteristics, as well as geographical characteristics.

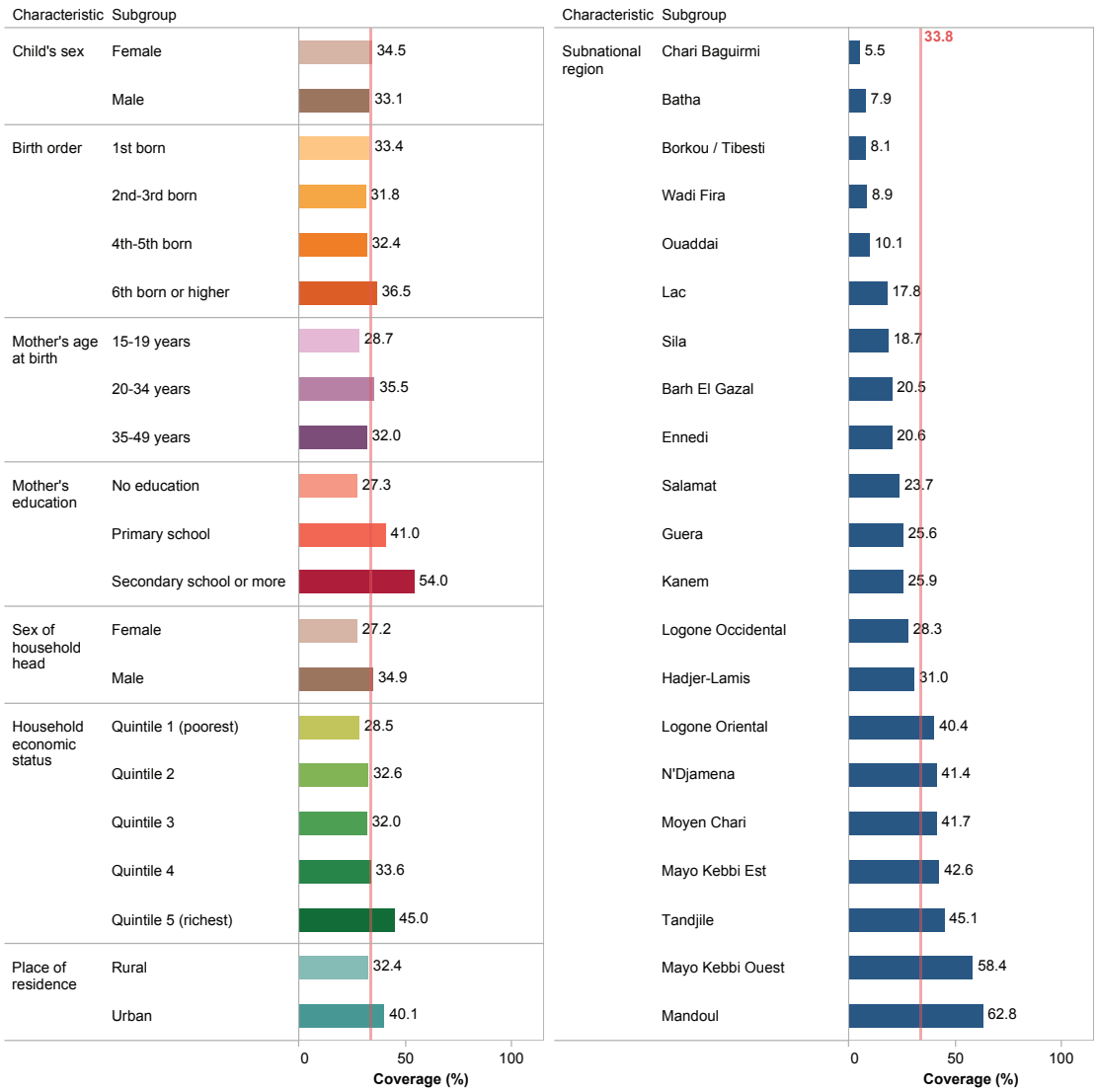
Immunization coverage was not different between boys and girls, and varied only slightly by birth order, with 6th or higher order births reporting 3 percentage points higher coverage than 1st order births.

The level of coverage across subgroups of mother's age at birth demonstrated a reverse U-shape, where coverage peaked in the 20–34 years subgroup (36%) and was lower for the 15–19 and 35–49 years subgroups (7 and 4 percentage points, respectively). Chad presented a linear gradient in DTP3 coverage across education subgroups, with a pattern of equivalent increases in coverage between the three education subgroups. Coverage in the secondary education or higher subgroup was double that of the no education subgroup (54% versus 27%, respectively).

Looking at household characteristics, coverage in the subgroup with female household heads was 8 percentage points lower than those with male household heads. Inequality according to economic status showed little variation in coverage between quintiles 1 to 4, and a sharp increase of more than 10 percentage points between quintiles 4 and 5.

Children in urban areas had 8 percentage points higher coverage than children in rural areas (32% versus 40%). Regions also showed substantial variation in coverage, which fall into four groupings:

FIGURE 4.1. DTP3 immunization coverage among one-year-olds in Chad, disaggregated by background characteristics (DHS 2014)



Note: The red vertical line shows the national average.

the first group contains five regions with coverage levels up to 10%; the second group contains nine regions with coverage between 18% (Lac) and 31% (Hadjer-Lamis); the third group contains five regions with coverage between 40% (Logone Oriental) and 45% (Tandjile); and, finally, the fourth group contains the two regions with levels of coverage around 60% (Mayo Kebbi Ouest and Mandoul).

Wealth- and education-related inequalities

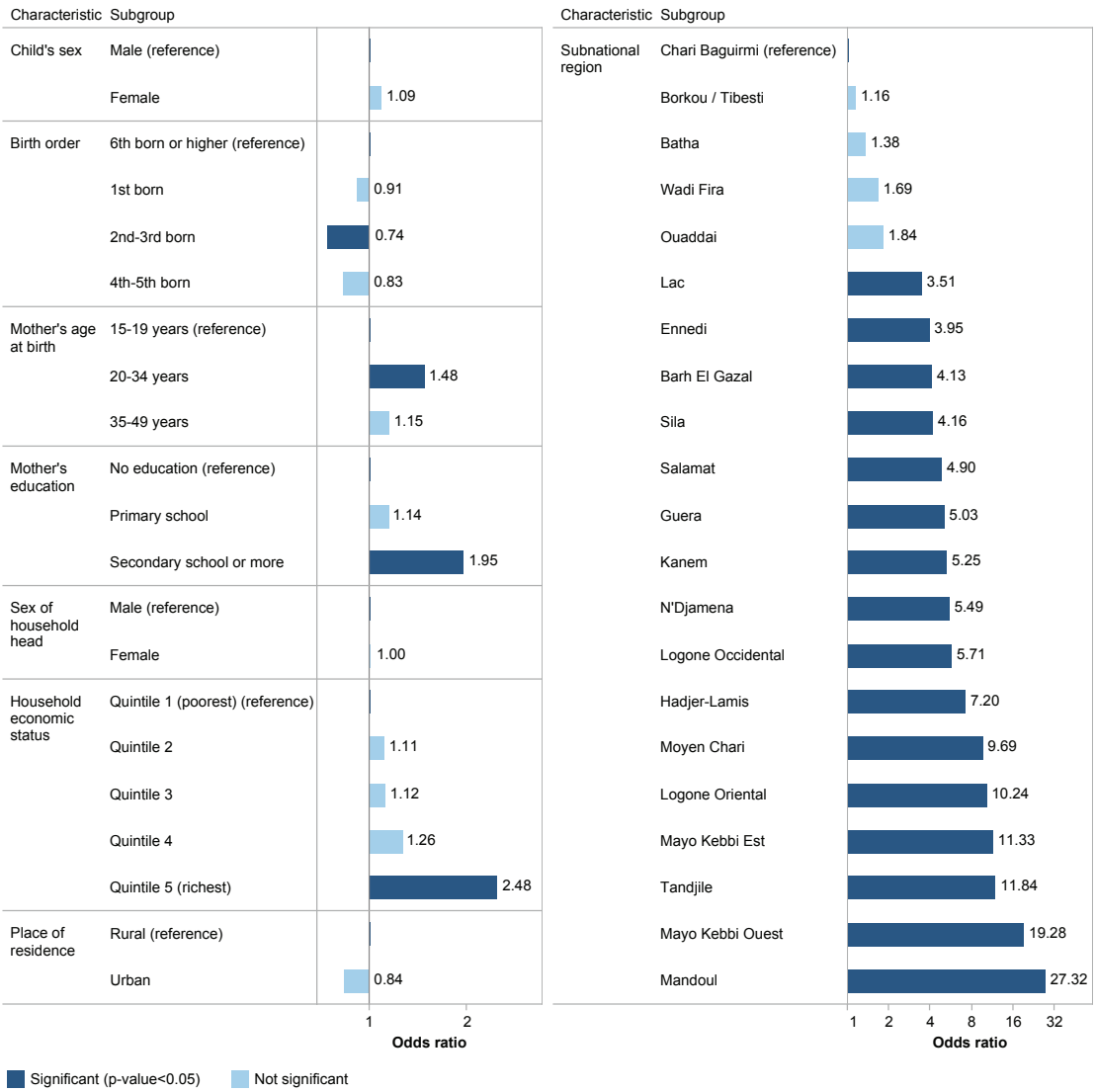
The wealth-related inequality of DTP3 immunization coverage, measured using the ECI, had a positive value of 0.100, indicating that coverage was concentrated among wealthier households, but only to a limited extent. The education-related ECI in Chad was 0.184, demonstrating a concentration of coverage among the children of mothers with higher education. Both ECI values were statistically

significant. The wealth-related concentration curve for DTP3 immunization coverage in Chad is available in Chapter 13.

Multiple regression analysis

Figure 4.2 presents estimated odds ratios and confidence intervals for the adjusted associations between DTP3 immunization coverage and selected socioeconomic, demographic and geographic factors. The odds of DTP3 coverage differed greatly across regions in Chad, with most regions presenting substantial and statistically significant higher odds of coverage than the reference region of Chari Baguirmi. Notably, Mandoul and Mayo Kebbi Ouest had 27 and 19 times higher odds of coverage than Chari Baguirmi, respectively.

FIGURE 4.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in Chad, calculated as odds ratio (DHS 2014)



After controlling for other characteristics, the odds of immunization for children in the richest quintile was 2.5 times higher than for children in the poorest quintile. There was no evidence, however, of significant variation between coverage in quintile 1 and coverage in quintiles 2 to 4. Mother's education was associated with DTP3 coverage, as the subgroup with secondary education or more was twice as likely to be covered as the no education subgroup. Compared to mothers aged 15–19 years, the odds of coverage were 1.5 times higher in the 20–34 years subgroup.

Other factors including child sex, sex of household head, place of residence and birth order demonstrated no associations with DTP3 immunization coverage, after controlling for background characteristics.

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
3. Chad country programme document 2012–2016 [Internet]. Report No.: E/ICEF/2011/P/L.22. New York: UNICEF; 2011 (https://www.unicef.org/about/execboard/files/Chad_final_approved_2012-2016_20_Oct_2011.pdf, accessed 6 April 2018).
4. Global Vaccine Action Plan: priority country reports on progress towards GVAP-RVAP goals. Annex to the GVAP Secretariat Annual Report 2016. Geneva; World Health Organization; 2016.
5. Global Health Observatory. Health Equity Monitor [Internet]. Geneva: World Health Organization; 2018 (http://www.who.int/gho/health_equity/en/, accessed 4 April 2018).
6. Carlson M, Paintain LS, Bruce J, Webster J, Lines J. Who attends antenatal care and expanded programme on immunization services in Chad, Mali and Niger? The implications for insecticide-treated net delivery. Malar J. 2011;10(1):341.

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in Chad.

To access interactive visuals:

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

http://apps.who.int/gho/data/view.wrapper.HE-VIZ21?lang=en&menu=hide

To access interactive tables, see Appendix 1.

5. Democratic Republic of the Congo

Country context

The Democratic Republic of the Congo has a population of 76 million, with 18.5% under 5 years of age *(1)*. Prior to the adoption of their new Constitution in 2006, the country consisted of 11 provinces; in 2015, the country was further divided into 26 subnational regions – 25 provinces and 1 capital city region *(2)*. (Note that this report contains data from the 2013 DHS, covering 11 provinces.) The under-5 mortality rate in the Democratic Republic of the Congo has improved from 183.6 deaths per 1000 live births in 1990 to 94.3 deaths per 1000 live births in 2016 *(3)*.

The Comprehensive Multi-Year Plan 2015–2019 outlines the current 5-year strategy for the Expanded Programme on Immunization in the Democratic Republic of the Congo, including benchmarks and priorities to enhance vaccine delivery throughout the country. The Expanded Programme on Immunization is supported by an extensive and well-trained team of staff, and most vaccines are delivered by nurses at government hospitals or health centres *(4)*. Health workers work with community volunteers, who inform the community about immunization services, and contribute to planning and implementing immunization-related activities *(4)*.

While the country has sufficient numbers of health facilities, the delivery of immunization services suffers from a widespread lack of refrigerators at health centres, frequent vaccine shortages and stockouts, and financial and administrative delays *(4,5)*. Additionally, low population demand for childhood immunization, inadequate health worker remuneration and a lack of supervision have contributed to many missed opportunities for immunization *(4)*. Coverage has been reported to be higher among children in urban areas, children with more-educated mothers and children from wealthier families *(6,7)*. The likelihood of incomplete or untimely immunization has been associated with clinic characteristics, which may be linked to whether user fees are charged and, if so, how they are structured *(8)*.

Descriptive overview

Disaggregation by background characteristics

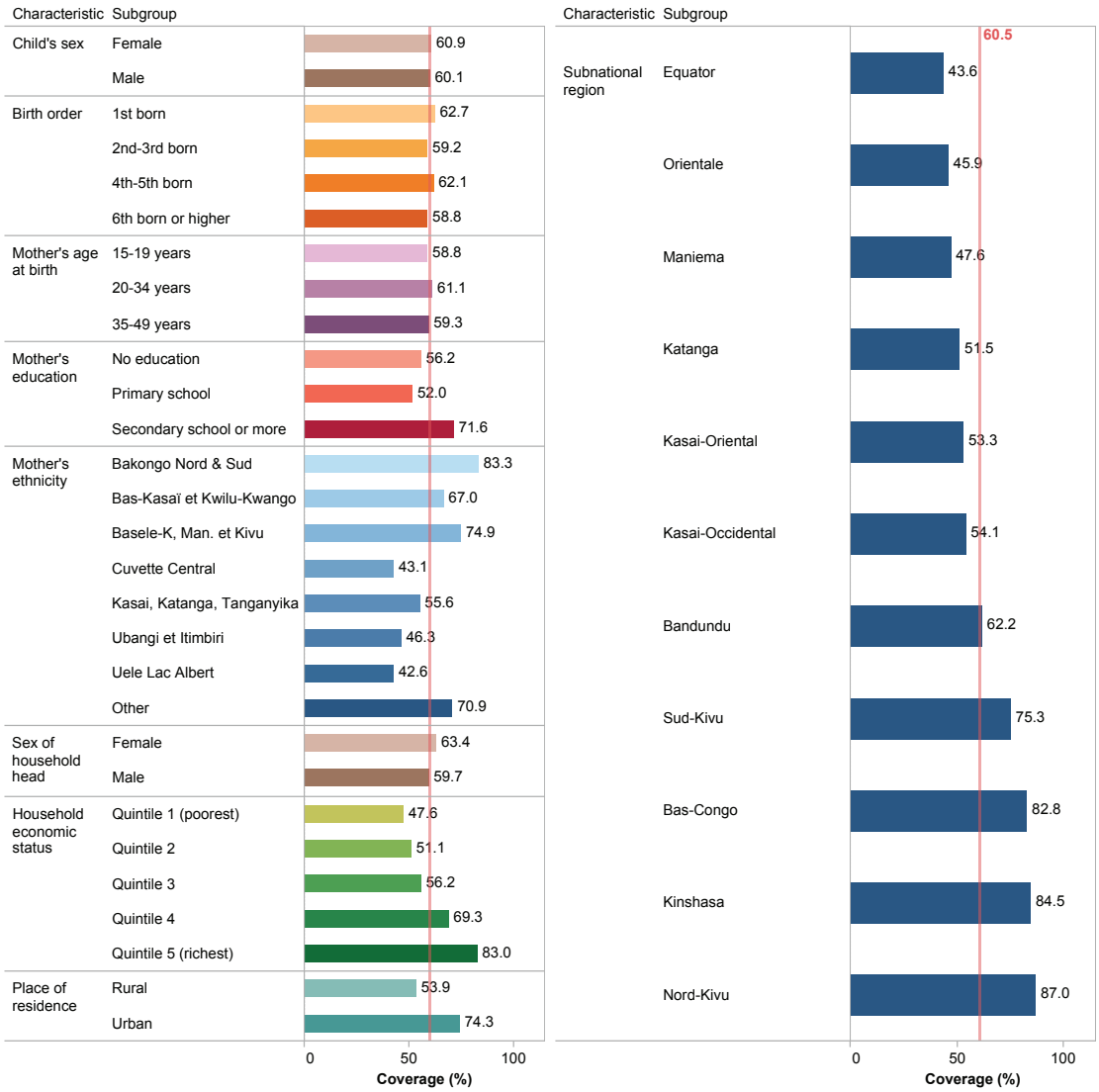
National coverage of DTP3 immunization among one-year-olds was 61% in the Democratic Republic of the Congo. Figure 5.1 presents DTP3 immunization coverage disaggregated by background characteristics.

Low levels of inequality in coverage were reported by child sex, birth order or mother's age at birth; however, coverage did vary by mother's education, mother's ethnicity and wealth quintile. For education subgroups, those in the secondary education or higher subgroup had substantially higher coverage (72%) than those in the less-educated subgroups, where coverage was 56% and 52% in the no education and primary education subgroups, respectively. DTP3 immunization coverage varied by mother's ethnicity, with coverage ranging from 43% in the Uele Lac Albert and Cuvette Central subgroups to 83% in the Bakongo Nord & Sud subgroup.

Across wealth quintiles, there was a sharp gradient in DTP3 immunization coverage: coverage showed gradually larger step-wise increases across quintiles, spanning from 48% in the poorest to 83% in the richest. The difference in coverage based on the sex of the household head was low.

Coverage among children in urban areas (74%) was 20 percentage points higher than for children in rural areas (54%). There was variation in coverage

FIGURE 5.1. DTP3 immunization coverage among one-year-olds in the Democratic Republic of the Congo, disaggregated by background characteristics (DHS 2013)



Note: The red vertical line shows the national average.

across provinces, spanning 43 percentages points from Equator (44%) to Nord-Kivu (87%).

Wealth- and education-related inequalities

The wealth-related inequality of DTP3 immunization coverage in the Democratic Republic of the Congo showed a positive ECI value of 0.287, indicating that coverage was more concentrated among the better-off. The education-related ECI summarized inequality across mother's education and demonstrated a value of 0.200. This result indicates that DTP3 coverage was higher among children with more-educated mothers. Wealth-related and education-related ECIs in the Democratic Republic of the Congo were statistically significant. The wealth-related concentration curve for DTP3

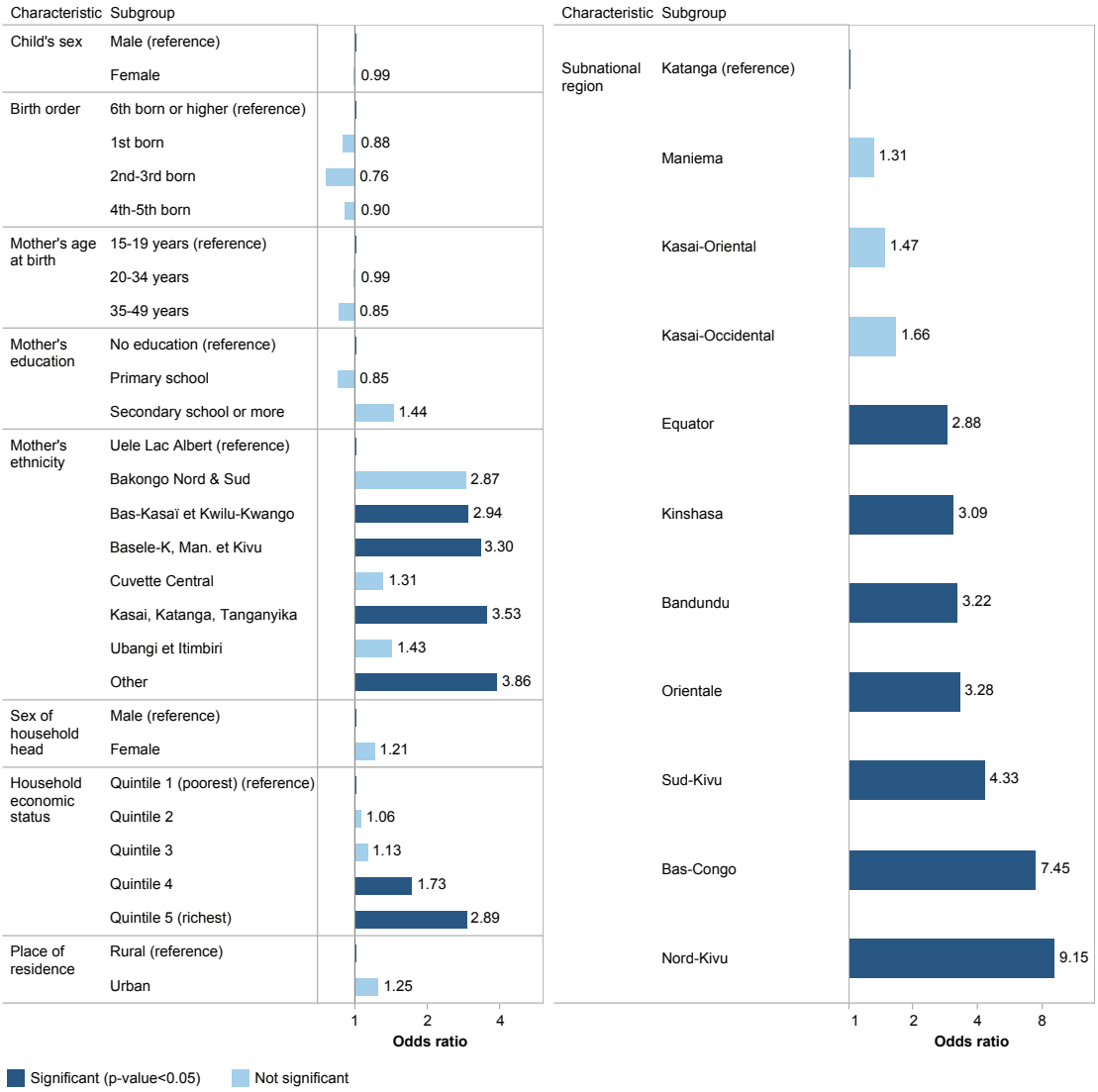
immunization coverage in the Democratic Republic of the Congo is available in Chapter 13.

Multiple regression analysis

Figure 5.2 shows the adjusted associations between DTP3 immunization coverage among one-year-olds and selected socioeconomic, demographic and geographic factors. Across provinces, the odds of coverage differed, with the majority of provinces showing significantly higher odds of DTP3 immunization than Katanga. Notably, children in Nord-Kivu and Bas-Congo were more than 9 and 7 times more likely to be covered than children in Katanga, respectively.

Controlling for other factors, immunization coverage was strongly associated with economic status and mother's ethnicity. The odds of receiving the third dose of the DTP vaccine were nearly 3 times higher

FIGURE 5.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in the Democratic Republic of the Congo, calculated as odds ratio (DHS 2013)



for children in the richest quintile than for children in the poorest quintile. Mother's ethnicity was a relevant factor associated with DTP3 immunization coverage. Compared to children in the Uele Lac Albert subgroup, the following ethnicity subgroups were three or more times as likely to be covered: Bas-Kasaï et Kwilu-Kwango; Basele-K, Man. and Kivu; and Kasai, Katanga, Tanganyika. After controlling for other factors, children in the secondary education or higher subgroup were 1.4 times more likely to be covered than those in the no education subgroup (the association was near significant).

The other factors demonstrated non-significant associations with DTP3 immunization coverage. After controlling for other characteristics, child's sex, birth order, mother's age at birth, sex of the household head and place of residence were not significantly associated with coverage.

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. The Constitution of the Democratic Republic of the Congo, 2005. Kinshasa: Democratic Republic of the Congo; 2005.
3. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
4. Global Vaccine Action Plan: priority country reports on progress towards GVAP-RVAP goals. Annex to the GVAP Secretariat Annual Report 2016. Geneva; World Health Organization, 2016.
5. Gerard SP, Kyrousis E, Zachariah R. Measles in the Democratic Republic of the Congo: an urgent wake-up call to adapt vaccination implementation strategies. Public Health Action. 2014 March 21;4(1):6–8.
6. Ashbaugh HR, Hoff NA, Doshi RH, Alfonso VH, Gadoth A, Mukadi P et al. Predictors of measles vaccination coverage among children 6–59 months of age in the Democratic Republic of the Congo. Vaccine. 2018 January;36(4):587–93.
7. State of inequality: childhood immunization. Geneva: World Health Organization; 2016.
8. Zivich PN, Kiketa L, Kawende B, Lapika B, Yotebieng M. Vaccination coverage and timelines among children 0–6 months in Kinshasa, the Democratic Republic of the Congo: a prospective cohort study. Matern Child Health J. 2017 May;21(5):1055–64.

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in the Democratic Republic of the Congo.

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To access interactive tables, see Appendix 1.

6. Ethiopia

Country context

Ethiopia has a population of about 100 million, with 14.9% under 5 years of age *(1)*. The country is comprised of 11 subnational regions, including nine regional states and two chartered cities. Between 1990 and 2016, the rate of under-5 mortality in Ethiopia reduced by more than two thirds, from 203.2 deaths per 1000 live births in 1990 to 58.4 deaths per 1000 live births in 2016 *(2)*. Ethiopia surpassed the child health Millennium Development Goal 4, largely due to the rapid development of community-level primary health care and the scale-up of high-impact interventions across health, nutrition and other development sectors *(3)*.

The Expanded Programme on Immunization was first launched in Ethiopia in 1980 with six antigens, followed by the progressive introduction of new and underutilized vaccines; currently, over 10 antigens are included in routine immunization programme. Ethiopia's national immunization programme Comprehensive Multi-Year Plan 2016–2020 aims to achieve coverage levels of at least 90% nationally and 80% in every district by 2020 *(4)*. The regional governments are the primary implementers of immunization programmes, with financial, technical and material support from international and local partners, and operational support from health officers (nurses), and community-based health extension workers. The Routine Immunization Improvement Plan, developed following a large national survey in 2012, has been successful in increasing immunization coverage in the 51 poorest-performing zones *(5)*.

Immunization coverage among one-year-olds in Ethiopia varies across population subgroups *(6)*. Immunization coverage was found to be higher among those children from wealthier households and communities, those with higher levels of parental education, and those residing in certain geographic areas *(7–9)*. Sustained and accelerated improvements in coverage are impeded by: difficulties reaching nomadic and remote communities; vaccine supply chain and cold-chain issues; irregular or infrequent availability of immunization services at health facilities; and low monitoring and supervision capacity *(10)*. Ethiopia is prone to natural and human-induced disasters (including droughts, floods, earthquakes, etc.) which may interrupt health services including immunization.

Descriptive overview

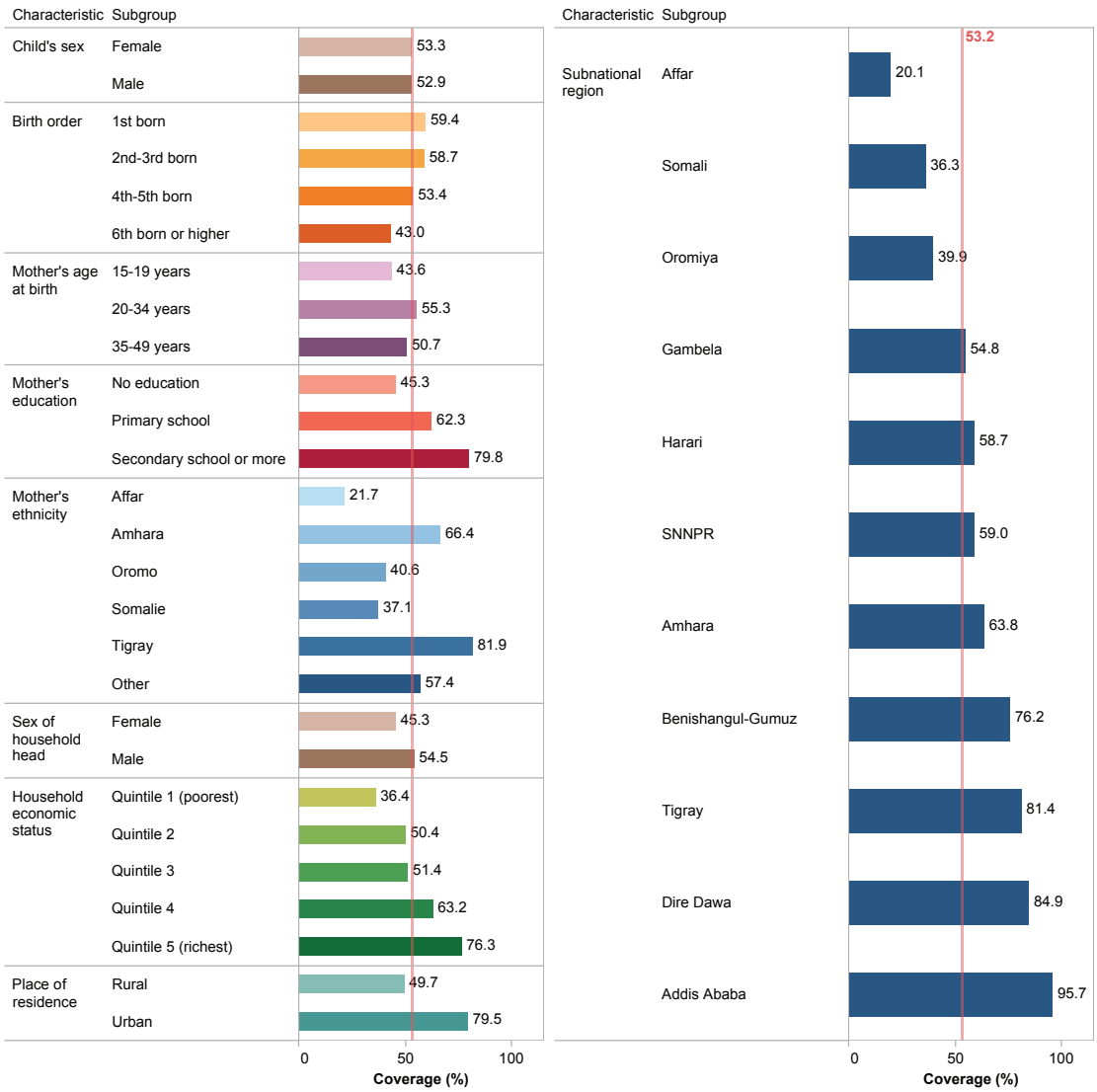
Disaggregation by background characteristics

In 2016, DTP3 immunization coverage among one-year-olds in Ethiopia was 53%. Figure 6.1 presents coverage of DTP3 immunization in Ethiopia disaggregated by socioeconomic, demographic and geographic characteristics.

There was no difference in coverage between females and males (53%), or between 1st and 2nd–3rd born children (59%). Children of higher birth orders, however, demonstrated lower levels of coverage, with just 43% coverage among 6th born or higher children.

Considering mothers' characteristics, coverage was lowest in the 15–19 years subgroup (44%) and was highest among the 20–34 years subgroup (55%); for mothers aged 35–49 years, coverage was 51%. There was a 17 percentage point increase in DTP3 immunization coverage moving from the no education (45%) to the primary school (62%) subgroups, and an 18 percentage point increase moving from the primary to the secondary school or more (80%) subgroups. The ethnicity-related inequality demonstrated a substantial difference

FIGURE 6.1. DTP3 immunization coverage among one-year-olds in Ethiopia, disaggregated by background characteristics (DHS 2016)



Note: The red vertical line shows the national average.

of 60 percentage points, from 22% in the Affar population to 82% in the Tigray population.

In Ethiopia, inequality according to household economic status presented a gradient pattern, with higher levels of coverage in wealthier households. Coverage in the richest quintile (76%) was more than double the level of coverage in the poorest quintile (36%).

Immunization coverage was 30 percentage points higher among children in urban areas (80%) than children in rural areas (50%). Across regions, coverage varied markedly: while less than half of one-year-olds received three doses of DTP in Affar (20%), Somali (36%) and Oromiya (40%), the DTP immunization coverage was more than 80% in Tigray (81%), Dire Dawa (85%) and Addis Ababa (96%).

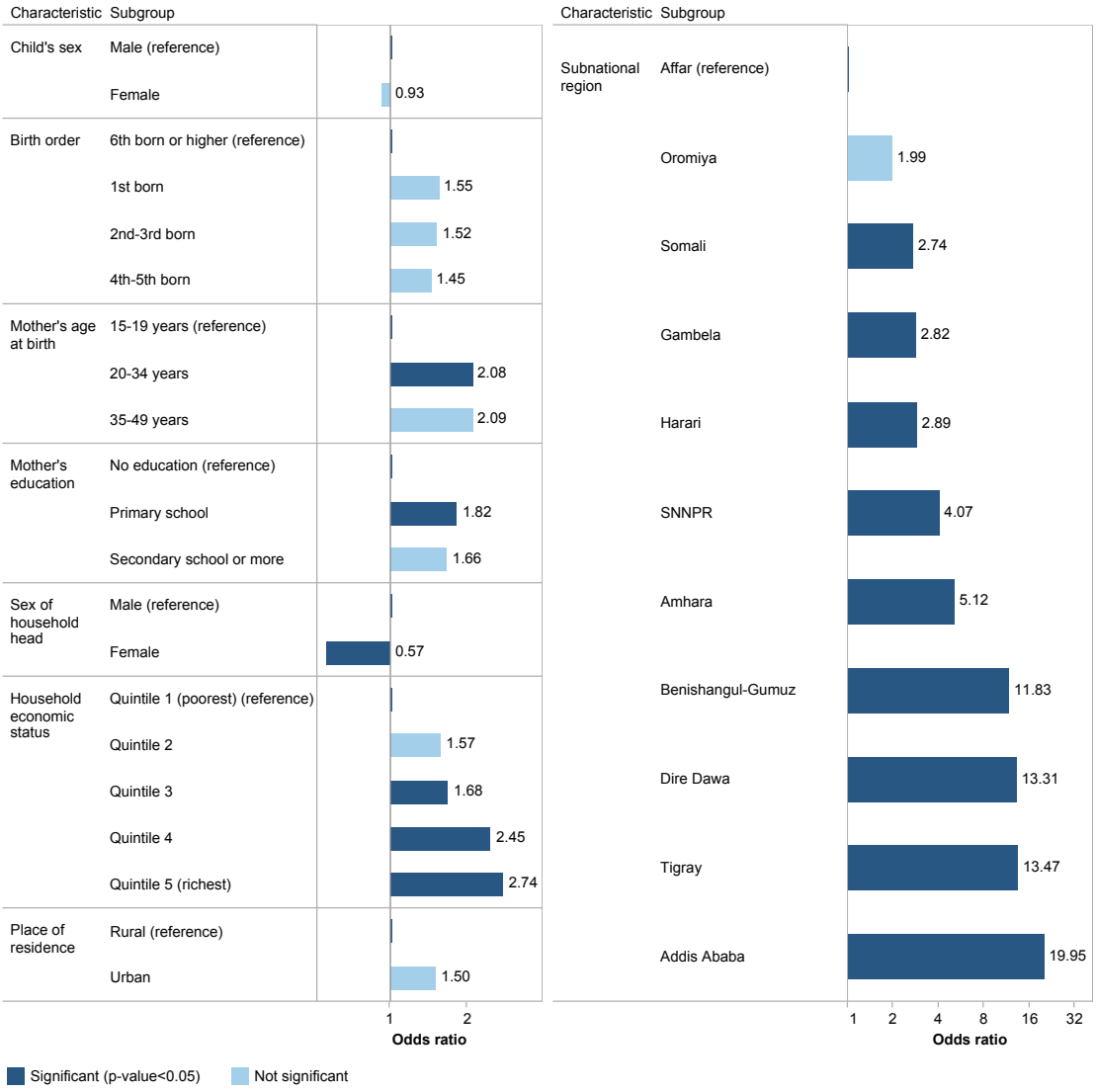
Wealth- and education-related inequalities

The ECI for Ethiopia showed a positive value of 0.296, indicating that coverage was largely concentrated among wealthier households. The ECI for education-related inequality in Ethiopia showed a positive value of 0.220, indicating that DTP3 immunization coverage was higher among children with more-highly educated mothers. Both wealth-related and education-related ECIs were statistically significant. The wealth-related concentration curve for DTP3 immunization coverage in Ethiopia is available in Chapter 13.

Multiple regression analysis

Figure 6.2 shows the adjusted associations between DTP3 immunization coverage among one-year-olds and socioeconomic, demographic and geographic factors. The association between subnational regions and DTP3 immunization coverage was

FIGURE 6.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in Ethiopia, calculated as odds ratio (DHS 2016)



strong and statistically significant. Compared to Affar, the odds of coverage were more than 10 times higher in four regions (Addis Ababa, Tigray, Dire Dawa and Benishangul-Gumuz).

Immunization coverage was associated with economic status and mother's education, after controlling for other characteristics. Compared to children in the poorest quintile, the odds of receiving the DTP3 vaccine were 2.5 times higher in quintile 4, and 2.7 times higher in quintile 5. Children in the primary education subgroup were 1.8 times more likely to be covered than children in the no education subgroup.

There was a positive relationship between immunization coverage and mother's age at birth: compared to the 15–19 years subgroup, the odds of coverage were twice as high among both the 20–34 years and the 35–49 years subgroups (though only nearly significant in the 35–49 years subgroup). One-year-olds belonging to households headed by a female had a significantly lower chance (0.6 times) of being covered.

Once background characteristics were accounted for, child's sex, birth order and place of residence showed no significant association with DTP3 immunization coverage in Ethiopia.

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
3. Ruducha J, Mann C, Singh NS, Gemebo TD, Tessema NS, Baschieri A et al. How Ethiopia achieved Millennium Development Goal 4 through multisectoral interventions: a Countdown to 2015 case study. Lancet Glob Health. 2017;5(11):e1142–e1151.
4. Ethiopia National Expanded Programme on Immunization: Comprehensive Multi-Year Plan 2016–2020. Addis Ababa: Ethiopia Federal Ministry of Health; 2015.
5. Thematic briefing note: immunization [Internet]. UNICEF Ethiopia Country Office; 2016 (https://www.unicef.org/ethiopia/ECO_Thematic_Briefing_Note_Immunization.pdf, accessed 5 April 2018).
6. Global Health Observatory. Health Equity Monitor [Internet]. Geneva: World Health Organization; 2018 (http://www.who.int/gho/health_equity/en/, accessed 4 April 2018).
7. Abadura SA, Lerebo WT, Kulkarni U, Mekonnen ZA. Individual and community level determinants of childhood full immunization in Ethiopia: a multilevel analysis. BMC Public Health [Internet]. 2015 December (http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-2315-z, accessed 5 April 2018).
8. Lakew Y, Bekele A, Biadgilign S. Factors influencing full immunization coverage among 12–23 months of age children in Ethiopia: evidence from the national demographic and health survey in 2011. BMC Public Health [Internet]. 2015 December (http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-2078-6, accessed 5 April 2018).
9. Skaftun EK, Ali M, Norheim OF; Thorne C, editor. Understanding inequalities in child health in Ethiopia: health achievements are improving in the period 2000–2011. PLoS ONE. 2014 August 28;9(8):e106460.
10. Global Vaccine Action Plan: priority country reports on progress towards GVAP-RVAP goals. Annex to the GVAP Secretariat Annual Report 2016. Geneva: World Health Organization; 2016.

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in Ethiopia.

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7. India

Country context

India has a population of 1.309 billion, with 9.3% under 5 years of age *(1)*. The country consists of 29 states and 7 union territories, including the National Capital Territory of Delhi. The under-5 mortality rate in India has fallen from 125.9 deaths per 1000 live births in 1990 to 43.0 deaths per 1000 live births in 2016 *(2)*. The high burden of childhood mortality and morbidity in India reflects the poor quality of public health care in India, with uneven progress between subnational regions, and on the basis of socioeconomic status and sex *(3)*.

In 1978, India launched its Expanded Programme on Immunization, which was renamed as the Universal Immunization Program in 1985. The Universal Immunization Program is embedded as part of India's National Health Policy, and the National Vaccine Policy of 2011 provides broad policy guidelines and frameworks to guide decision-making in areas such as research and development, vaccine quality assessment, institutional processes, vaccine introduction issues and regulatory issues *(4)*. The Government of India launched Mission Indradhanush in 2014 as a campaign to accelerate progress towards achieving 90% full immunization coverage by 2020 *(5)*. Initially targeting 201 low-performing districts, the campaign has subsequently been expanded to over 350 districts, and has been successful in improving coverage in underserved areas *(6)*.

Immunization coverage in India demonstrates multidimensional types of inequality, with variation across subgroups defined by social class, parental education, religion, wealth status, place of residence, and other individual and family characteristics *(7–9)*. Key challenges related to immunization activities include: weak health information systems and low capacity for monitoring and evaluation (resulting in a lack of evidence for planning and research activities); and human resource shortages in management, research and operations at all levels *(4)*.

In India, the National Family Health Survey (NFHS) is equivalent to the DHS conducted in other countries.

Descriptive overview

Disaggregation by background characteristics

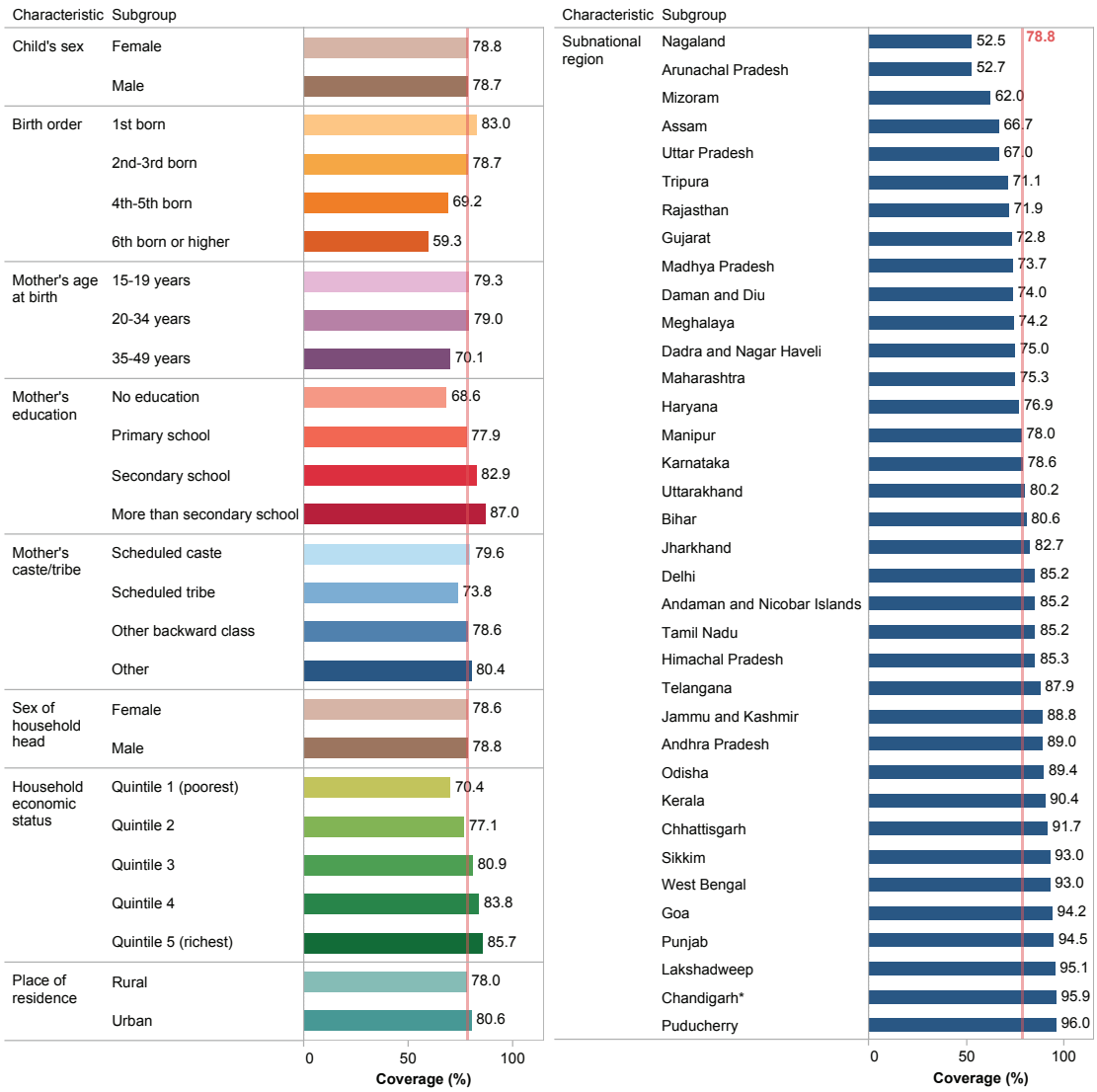
According to the 2015 NFHS, the DTP3 immunization coverage among one-year-olds in India was 79%. Figure 7.1 presents DTP3 immunization coverage in India by population subgroups.

Sex-related inequality was non-existent, as male and female children presented the same level of coverage (79%). There was a gradient in coverage according to birth order, with higher order births showing lower coverage.

Looking at mother's characteristics, the coverage of DTP3 immunization was the same for the 15–19 years and 20–34 years subgroups (79%), while coverage was lower in the 35–49 years subgroup (70%). A gradient in immunization coverage was observed across mother's education level, with increasing coverage in more-educated subgroups. The gap between the no education subgroup and the subgroup with more than secondary education was 18 percentage points. There were small differentials in DTP3 coverage by mother's caste/tribe: coverage was higher among those in the scheduled caste, other backward class or other subgroups (coverage around 80%), whereas coverage was lower in the scheduled tribe subgroup (74%).

There was no difference in coverage on the basis of the sex of the household head. A gradient was

FIGURE 7.1. DTP3 immunization coverage among one-year-olds in India, disaggregated by background characteristics (NFHS 2015)



Note: The red vertical line shows the national average.
*Estimate was based on 25–49 cases.

observed across wealth quintiles, with the gap in coverage between the richest and poorest quintiles amounting to 16 percentage points (86% and 70%, respectively).

Inequality by place of residence in India was minimal, with a 3 percentage point difference between coverage in urban (81%) and rural areas (78%). Coverage across subnational regions varied markedly. Nagaland and Arunachal Pradesh had the lowest coverage at 53%, whereas 9 out of the 36 regions reported coverage of 90% or higher.

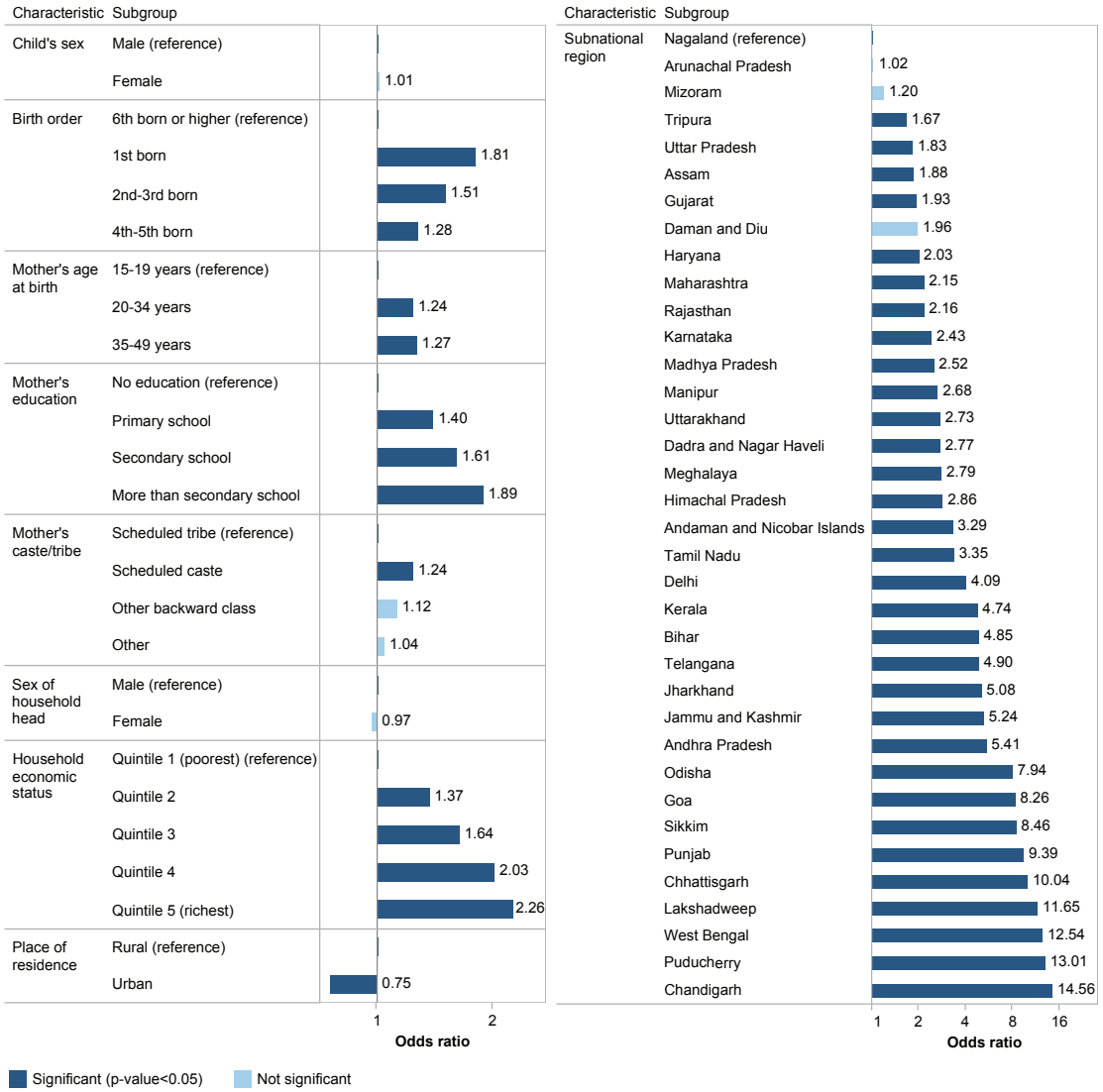
Wealth- and education-related inequalities

The wealth-related inequality in DTP3 immunization coverage in India amounted to a positive ECI value of 0.130. While small, this value indicates that coverage is more concentrated among wealthier households. The education-related ECI in India had a value of 0.150, suggesting that coverage was more concentrated in children with more-educated mothers. Both ECIs were largely statistically significant. The wealth-related concentration curve for DTP3 immunization coverage in India is available in Chapter 13.

Multiple regression analysis

Figure 7.2 shows odds ratios for the adjusted associations between DTP3 immunization coverage and selected socioeconomic, demographic and geographic factors. There was large variation in the odds of childhood immunization coverage

FIGURE 7.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in India, calculated as odds ratio (NFHS 2015)



across regions. Compared to the reference region of Nagaland, which had the lowest DTP3 immunization coverage in the country, several states/union territories demonstrated more than 10 times higher odds of coverage, including Chandigarh, Chhattisgarh, Lakshadweep, Puducherry and West Bengal.

Immunization coverage was positively associated with economic status and mother's education, adjusting for other factors. A one-year-old child in the richest quintile had a 2.3 times higher chance of being covered than a child in the poorest quintile. Compared to the no education subgroup, the odds of DTP3 immunization coverage were 1.4 times higher in the primary school subgroup, 1.6 times higher in the secondary school subgroup, and almost double in the more than secondary school subgroup.

There was a weak, although statistically significant, association between mother's age at birth and childhood immunization: the 20–34 years subgroup and the 35–49 years subgroup were 1.2 and 1.3 times more likely, respectively, of being covered than the 15–19 years subgroup. Birth order had a negative association with DTP3 immunization coverage: relative to children 6th born or higher, the odds of coverage were significantly higher in all lower order birth subgroups. The chance of being covered by DTP3 immunization among 1st born children was nearly twice as large. Compared to those of mothers in the scheduled tribe subgroup, those in the scheduled caste subgroup had 1.2 times higher chance of being covered. Place of residence also demonstrated a significant association, as children living in urban areas had a lower chance (0.75) of being covered than those in rural areas.

The sex of the child and the sex of the household head showed non-significant associations with DTP3 immunization coverage after adjusting for other factors.

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
3. Patel V, Parikh R, Nandraj S, Balasubramaniam P, Narayan K, Paul VK et al. Assuring health coverage for all in India. Lancet. 2015;386(10011):2422–35.
4. Ministry of Health & Family Welfare. National Vaccine Policy 2011. New Delhi: Government of India; 2011.
5. Mission Indradhanush [Internet]. (http://www.missionindradhanush.in/index.html, accessed 13 April 2018).
6. Bashar MA. Success story of mission Indradhanush: a road to achieve universal immunization. Natl J Community Med. 2016;7:455–6.
7. Shrivastwa N, Gillespie BW, Kolenic GE, Lepkowski JM, Boulton ML. Predictors of vaccination in India for children aged 12–36 months. Vaccine. 2015 Nov;33:D99–105.
8. Debnath A, Bhattacharjee N. Wealth-based inequality in child immunization in India: a decomposition approach. J Biosoc Sci. 2017 August 14;1–14.
9. Francis MR, Nohynek H, Larson H, Balraj V, Mohan VR, Kang G et al. Factors associated with routine childhood vaccine uptake and reasons for non-vaccination in India: 1998–2008. Vaccine [Internet]. 2017 August (http://linkinghub.elsevier.com/retrieve/pii/S0264410X17310939, accessed 13 April 2018).

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in India.

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8. Indonesia

Country context

Indonesia has a population of 258 million, with 9.5% under 5 years of age *(1)*. The under-5 mortality rate in Indonesia has decreased from 84.3 deaths per 1000 live births in 1990, to 26.4 deaths per 1000 live births in 2016 *(2)*, with inequalities that favour population subgroups that are richer, more educated or urban *(3)*. The country is currently comprised of 34 provinces, which span five main islands and four archipelagos. (Note that the data in this report are from the 2012 DHS, conducted before the creation of the province of North Kalimantan, and thus covering 33 provinces.)

The immunization programme in Indonesia is guided by a comprehensive multi-year plan for immunization (2015–2019), and the country has a fully functional Independent National Technical Advisory Group on immunization. Vaccines are primarily delivered by government health centres at the subdistrict level and private providers. The Indonesian Ministry of Health has launched a number of national activities to promote immunization, including: Backlog Fighting; National Immunization Week; catch-up campaigns; Sustained Outreach Strategy for drop-out and follow-up in targeted districts; Strengthening Technical Assistance for Routine Immunization (START) projects; and outbreak response *(4)*. Social assistance programmes such as Programme Keluarga Harapan encourage the use of immunization services through conditional cash transfers to poor families *(5)*.

Immunization coverage in Indonesia varies by household economic status, mother's education level, place of residence and province *(4)*; other factors correlated with immunization status include birth order, family size, parental occupation, health insurance and distance to a health facility *(6,7)*. The country faces a rapidly urbanizing population, posing challenges in reaching children in migrant and urban poor families with limited access to health care. Other challenges in delivering immunizations stem from supply-side issues such as geographic disparity, topography, cold-chain maintenance and reluctance to implement multi-dose vial policy; demand-side issues include an increasing trend of vaccine hesitancy, such as negative perceptions of immunization side-effects and suspicion of haram ingredients *(5)*.

Descriptive overview

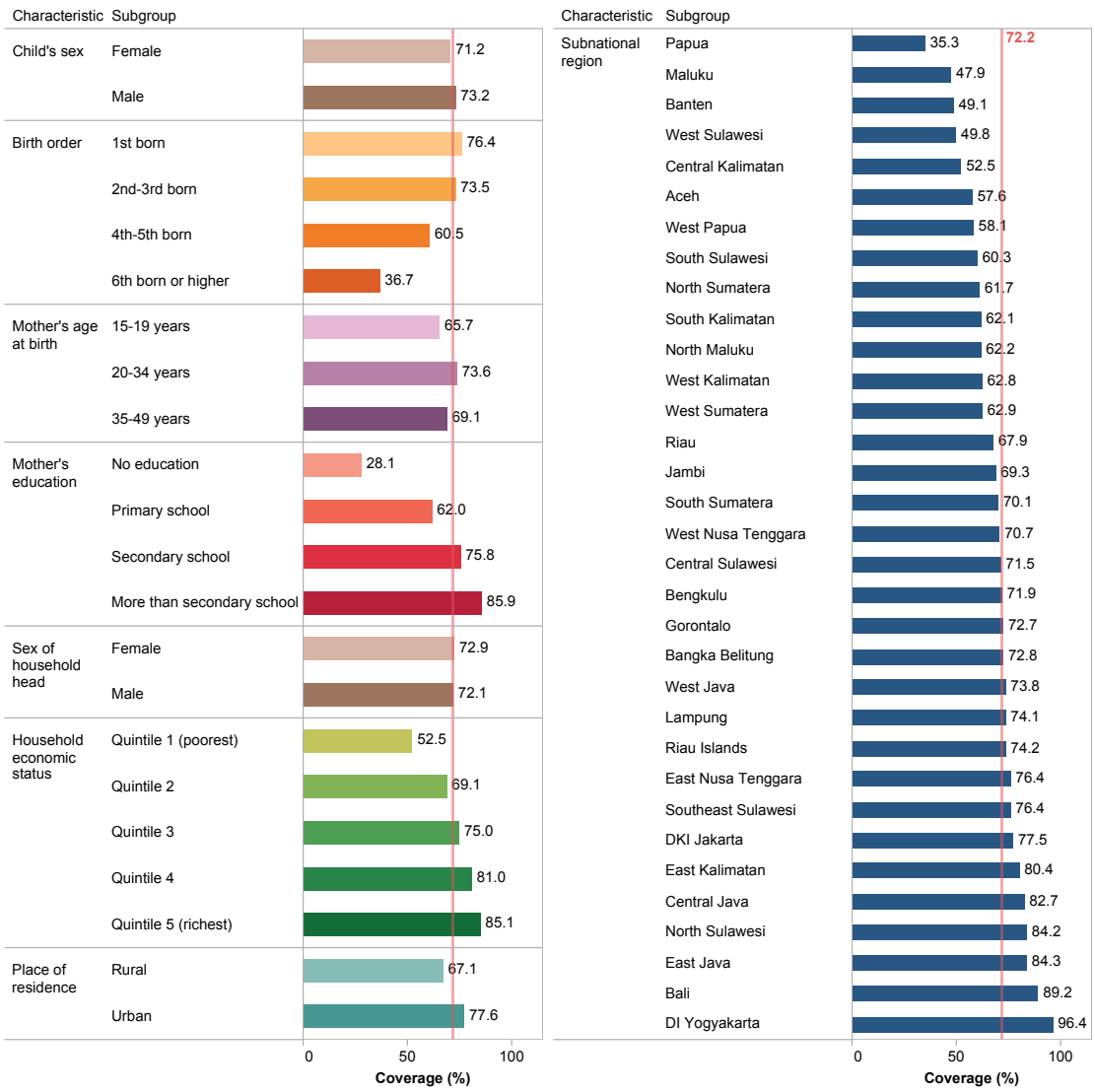
Disaggregation by background characteristics

DTP3 immunization coverage among one-year-olds in Indonesia was 72%. Figure 8.1 presents DTP3 immunization coverage in Indonesia by population subgroups.

Male and female children had similar levels of coverage. While 1st born and 2nd–3rd born children reported higher levels of coverage (76% and 74%, respectively), immunization coverage was lower among children born 4th–5th (61%) and much lower among those born 6th or higher (37%). DTP3 immunization coverage showed a reverse U-shape pattern by mother's age at birth: coverage was higher in the 20–34 years subgroup (74%) than the 15–19 years subgroup (66%) and the 35–49 years subgroup (69%).

A gradient in immunization coverage was observed across mother's education level and economic status, with increasing coverage in more-educated and richer subgroups. Both mother's education and economic status demonstrated a marginal exclusion pattern, whereby coverage was considerably lower in the most disadvantaged subgroup. There was no difference in coverage based on the sex of the household head.

FIGURE 8.1. DTP3 immunization coverage among one-year-olds in Indonesia, disaggregated by background characteristics (DHS 2012)



Note: The red vertical line shows the national average.

Place of residence inequality in childhood immunization showed a gap of 11 percentage points between urban and rural areas (78% in urban areas versus 67% in rural areas). Coverage across provinces varied significantly in Indonesia, with some provinces such as DI Yogyakarta reaching almost universal coverage (96%), while others, such as Banten, Maluku, Papua and West Sulawesi, had coverage levels below 50%.

Wealth- and education-related inequalities

The wealth-related ECI for DTP3 immunization coverage showed a positive value of 0.261, indicating that coverage was more concentrated among richer households. The magnitude of inequality across different levels of education showed a positive ECI value of 0.226, indicating that DTP3 coverage was higher among more-educated groups. Both ECIs were significantly significant. The wealth-

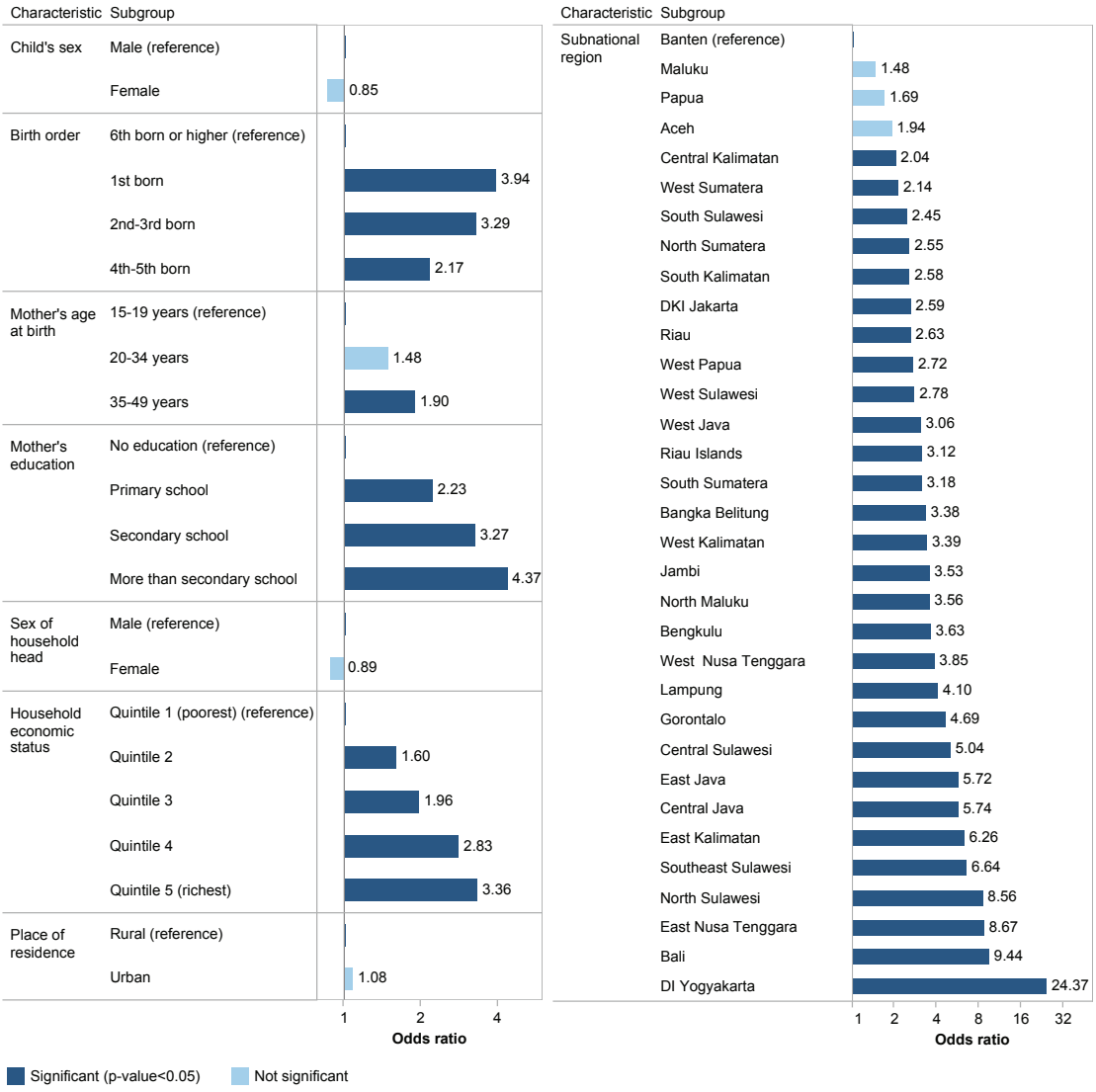
related concentration curve for DTP3 immunization coverage in Indonesia is available in Chapter 13.

Multiple regression analysis

Figure 8.2 shows associations between DTP3 immunization coverage and selected socioeconomic, demographic and geographic factors, controlling for other factors. There was a large variation in the odds of childhood immunization coverage across subnational regions, demonstrating a statistically significant association. For example, those living in the provinces of DI Yogyakarta, Bali, East Nusa Tenggara and North Sulawesi were more than 8 times as likely to be covered as those living in Banten.

Immunization coverage was strongly associated with birth order, mother's education, household economic status and subnational region. The

FIGURE 8.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in Indonesia, calculated as odds ratio (DHS 2012)



association between birth order and childhood immunization was negative: compared to children born 6th or higher, children with lower birth order were more likely to be covered. For instance, 1st born and 2nd–3rd born children were more than 3 times as likely to be covered. By mother's education level, compared to children in the no education subgroup, the odds of DTP3 immunization coverage were more than double in the primary education subgroup, more than triple in the secondary education subgroup, and more than quadruple in the subgroup with more than secondary education. A one-year-old child in the richest quintile had a 3.4 times higher chance of being covered than a child in the poorest quintile.

Mother's age at birth demonstrated an association with childhood immunization whereby children of mothers aged 35–49 years had a probability of being covered that was 1.9 times higher than children of mothers aged 15–19 years.

Child's sex, sex of household head and place of residence did not show associations with immunization coverage after adjusting for other factors.

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
3. Indonesia Ministry of National Development Planning, UNICEF. SDG baseline report on children in Indonesia. Jakarta: BAPPENAS and UNICEF; 2017.
4. State of health inequality: Indonesia. Geneva: World Health Organization; 2017.
5. Asia Pacific Observatory on Health Systems and Policies. The Republic of Indonesia health system review. New Delhi: World Health Organization, Regional Office for South-East Asia; 2017.
6. Fernandez RC, Awofeso N, Rammohan A. Determinants of apparent rural-urban differentials in measles vaccination uptake in Indonesia. Rural Remote Health. 2011;11(3):1702.
7. Herliana P, Douiri A. Determinants of immunisation coverage of children aged 12–59 months in Indonesia: a cross-sectional study. BMJ Open. 2017 December 22;7(12):e015790.

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in Indonesia.

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9. Kenya

Country context

Kenya has a population of 47 million, with 14.8% under 5 years of age *(1)*. The under-5 mortality rate was 98.1 deaths per 1000 live births in 1990, falling to 49.2 deaths per 1000 live births in 2016 *(2)*. Key child health policies and strategies, such as the removal of user fees for maternal and child health care, the Kenya Essential Package for Health, and the Community Health Strategy, have contributed to gains in child survival, though geographic and socioeconomic inequalities in child health intervention coverage persist *(3,4)*. Historically, Kenya consisted of eight provinces, which were restructured as 47 counties in the 2010 Constitution. (Note: the 2014 DHS retained the former provincial designations in its sampling design, and thus in this report, the counties are grouped according to these eight regions *(5)*.)

The Kenya Expanded Programme on Immunization was established in 1980 with the goal of achieving universal coverage of childhood immunizations *(6)*. The Expanded Programme on Immunization is managed by the Unit of Vaccine and Immunization within the Ministry of Health, and guided by successive 5-year Comprehensive Multi-Year Plans for immunization *(6)*. National and county level governments have distinct roles and responsibilities in delivering immunization services: national governments establish standards and guidelines, and provide technical assistance, while county governments oversee the planning and management of immunization service delivery at the facility level, and are responsible for ensuring adherence to national guidelines *(6)*.

Inequalities in immunization coverage in Kenya have been reported between provinces, and on the basis of maternal education, household wealth and birth order *(7,8)*. Childhood immunization activities are bolstered by high community-level awareness and acceptance of immunization, and the existence of Expanded Programme on Immunization focal points in every county. The current Comprehensive Multi-Year Plan acknowledges concerns about vaccine quality, as well as shortages and lack of training in the health workforce, and low government funding for immunization activities *(6)*.

Descriptive overview

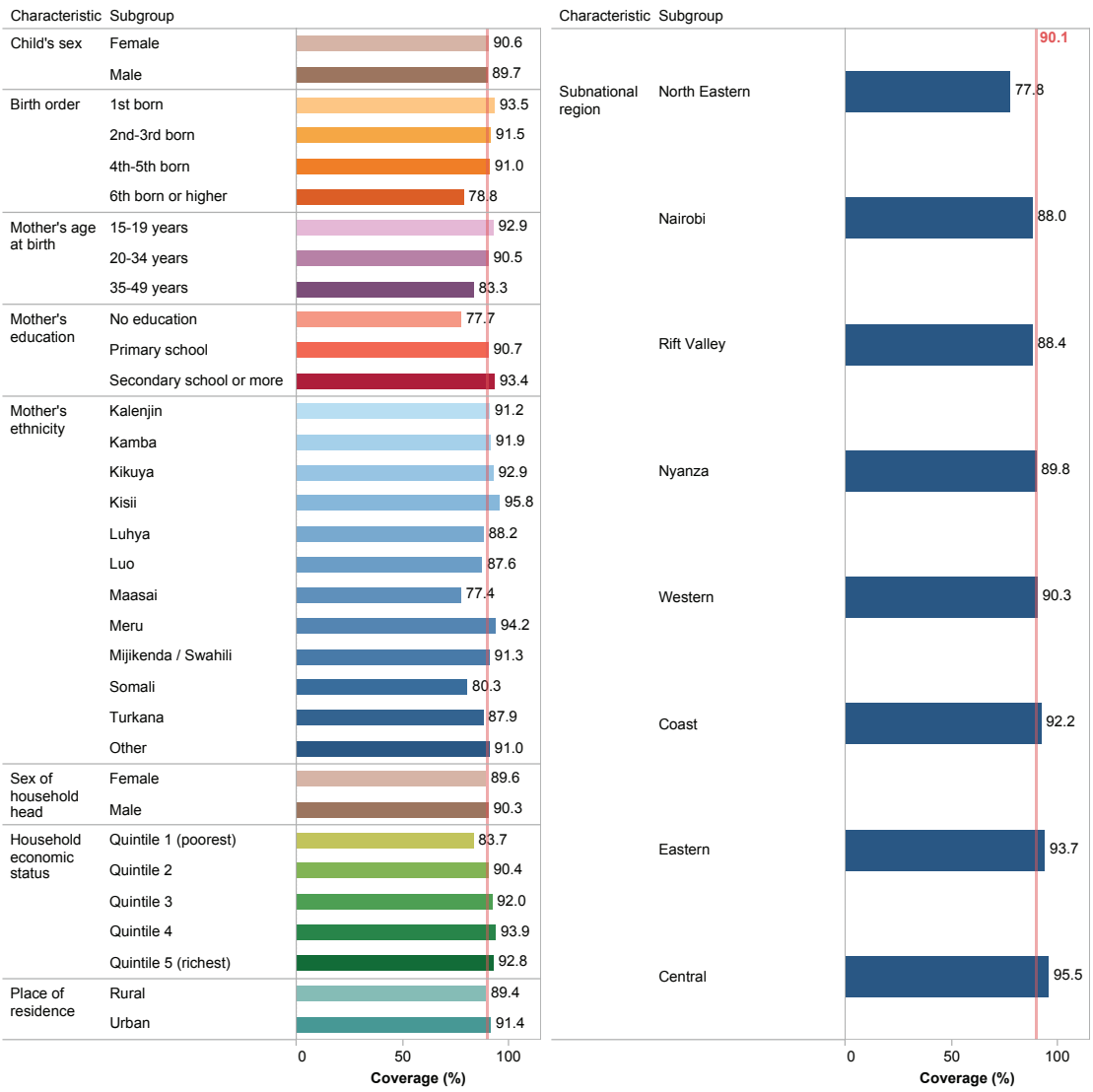
Disaggregation by background characteristics

Overall, DTP3 immunization coverage among one-year-olds in Kenya was 90%. Figure 9.1 presents disaggregated data for DTP3 immunization coverage among one-year-olds.

Male and female children had about the same level of DTP3 immunization coverage. Inequality by birth order was observed only for those born 6th or higher: while coverage among 1st, 2nd–3rd and 4th–5th born children ranged between 91% and 93%, it was 79% among child born 6th or higher.

DTP3 immunization coverage was lower among children of mothers aged 35–49 years (83%) than the younger subgroups, where coverage was 93% and 91% for mothers aged 15–19 years and 20–34 years, respectively. The no education subgroup reported coverage of 78%, which increased sharply in the primary education subgroup (91%); there were almost no additional gains in coverage among the higher education subgroup. DTP3 coverage varied with mother´s ethnic group: while the Maasai (77%) and the Somali (80%) demonstrated markedly lower immunization coverage than the national average, the Kisii (96%) were closest to universal coverage.

FIGURE 9.1. DTP3 immunization coverage among one-year-olds in Kenya, disaggregated by background characteristics (DHS 2014)



Note: The red vertical line shows the national average.

There was no difference in coverage based on the sex of the household head. Across wealth quintiles, the maximum gap in DTP3 immunization coverage remained less than 10 percentage points. The poorest quintile demonstrated distinctly lower coverage (84%) than the other four quintiles (90% to 94%).

Immunization coverage was nearly the same among children in urban areas (91%) and children in rural areas (89%). Across the eight subnational regions, the lowest coverage was reported by the North Eastern region (78%), which was at least 10 percentage points lower than any other region. The Central region presented the highest immunization coverage at 96%.

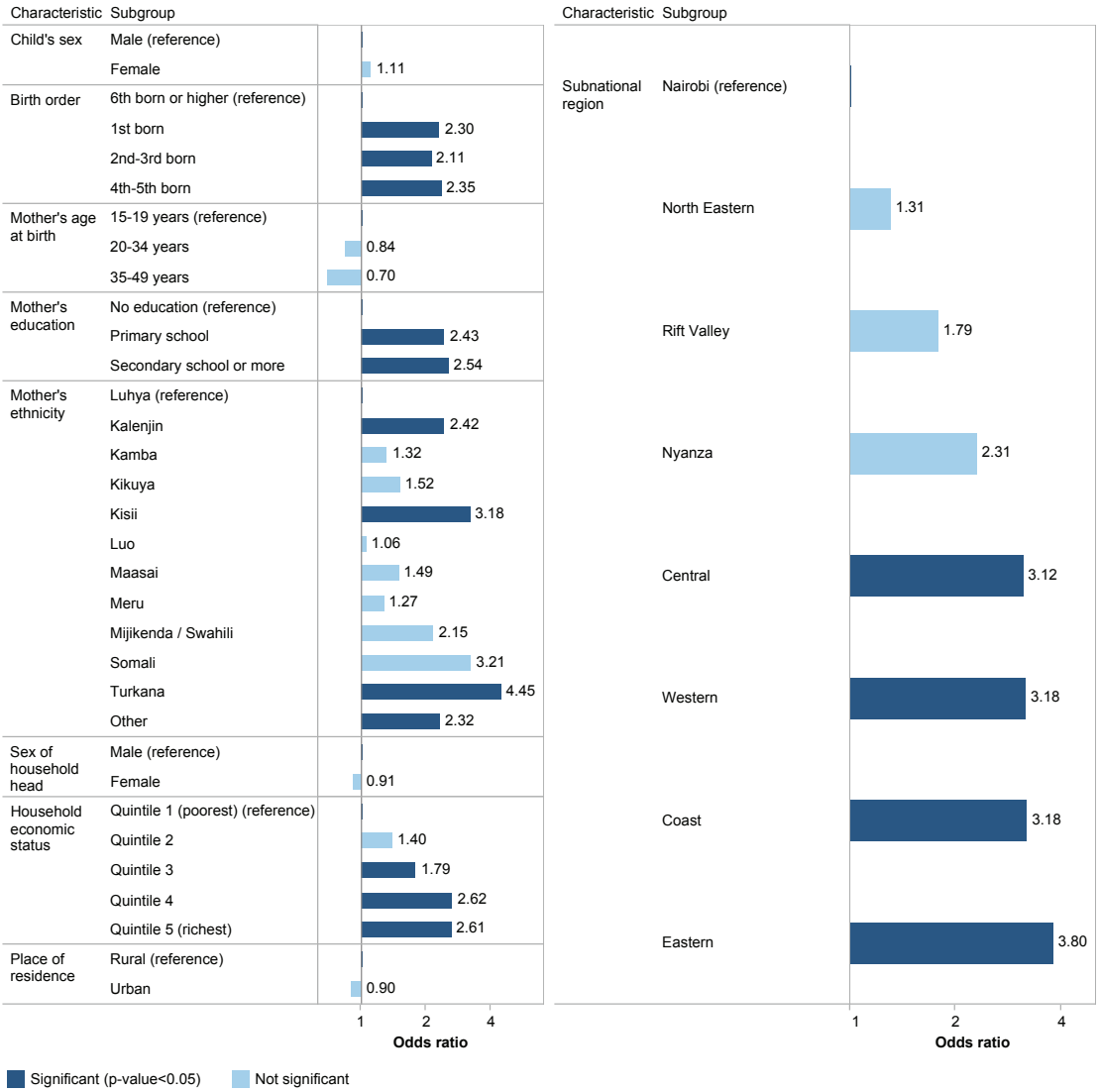
Wealth- and education-related inequalities

The wealth-related ECI for Kenya showed a positive value of 0.079, indicating minor inequality in DTP3 immunization coverage Education-related inequality, as measured by the ECI, showed a positive value of 0.091. This suggests that DTP3 coverage was slightly more concentrated among children of more-educated mothers. Although relatively small, inequalities in Kenya were statistically significant. The wealth-related concentration curve for DTP3 immunization coverage in Kenya is available in Chapter 13.

Multiple regression analysis

Figure 9.2 shows the adjusted associations between DTP3 immunization coverage and socioeconomic, demographic and geographic factors. After controlling for other factors, there was statistically significant inequality in DTP3 immunization

FIGURE 9.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in Kenya, calculated as odds ratio (DHS 2014)



coverage across regions in Kenya. For instance, the Eastern region had 3.8 times higher odds of immunization coverage than the reference region of Nairobi. According to mother's ethnicity, the Turkana, Kisii and Kalenjin reported significantly higher odds of coverage than the reference ethnic subgroup of Luhya by 4.5, 3.2 and 2.4 times, respectively.

After controlling for background characteristics, immunization coverage was positively associated with household economic status and mother's education. Relative to children in the poorest quintile, the odds of being covered by DTP3 was 2.6 times higher for children in each of the richest two quintiles (quintiles 4 and 5). Comparably, having at least secondary education increased the odds of coverage by 2.5 times, compared to no education.

Compared to children born 6th or higher, the odds of reporting DTP3 coverage were more than double for all other lower birth order subgroups, and associations were significant.

The remaining factors – child's sex, mother's age at birth, sex of the household head, and place of residence – did not demonstrate a significant association with DTP3 immunization.

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
3. Keats EC, Ngugi A, Macharia W, Akseer N, Khaemba EN, Bhatti Z et al. Progress and priorities for reproductive, maternal, newborn, and child health in Kenya: a Countdown to 2015 country case study. Lancet Glob Health. 2017;5(8):e782–e795.
4. Brault MA, Ngure K, Haley CA, Kabaka S, Sergon K, Desta T et al.; Bhutta ZA, editor. The introduction of new policies and strategies to reduce inequities and improve child health in Kenya: a country case study on progress in child survival, 2000–2013. PLoS ONE. 2017 August 1;12(8):e0181777.
5. Kenya National Bureau of Statistics, Ministry of Health Kenya, National AIDS Control Council Kenya, Kenya Medical Research Institute, National Council for Population and Development Kenya. Kenya Demographic and Health Survey 2014 [Internet]. Rockville MD: USAID; 2015 (https://dhsprogram.com/publications/publication-fr308-dhs-final-reports.cfm, accessed 22 May 2018).
6. Unit of Vaccines and Immunization Services. Comprehensive Multi-Year Plan for Immunization: July 2015–June 2019. Nairobi: Ministry of Health for Kenya; 2015.
7. Van Malderen C, Ogali I, Khasakhala A, Muchiri SN, Sparks C, Van Oyen H et al. Decomposing Kenyan socio-economic inequalities in skilled birth attendance and measles immunization. Int J Equity Health. 2013;12(1):3.
8. Onsomu EO, Abuya BA, Okech IN, Moore D, Collins-McNeil J. Maternal education and immunization status among children in Kenya. Matern Child Health J. 2015 August;19(8):1724–33.

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in Kenya.

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To access interactive tables, see Appendix 1.

10. Nigeria

Country context

Nigeria has a population of 181 million, with 17.2% under 5 years of age *(1)*. The country is divided into 36 states and one Federal Capital Territory, which are grouped into six geopolitical zones. As of 2016, the under-5 mortality rate in Nigeria was estimated at 104.3 deaths per 1000 live births, representing a reduction since 1990, when the country reported 212.9 under-5 deaths per 1000 live births *(2)*. Improvements in child mortality have occurred alongside a proliferation of child health policies and strategies, especially between 2005 and 2010 *(3)*.

Nigeria introduced the Expanded Programme on Immunization in 1979, which was successful in increasing immunization coverage over the subsequent decade *(4)*. Following declining immunization coverage in the early 1990s, the National Programme on Immunization was established in 1996, which merged with the National Primary Health Care Development Agency in 2007 *(4)*. The National Primary Healthcare Development Agency is responsible for providing free vaccines and coordinating immunization vaccine procurement initiatives. In recent years, Nigeria has made some progress in increasing immunization coverage due in part to demand-side factors such as increased awareness and community mobilization activities *(5)*.

National immunization coverage in Nigeria remains low, and varies across geographic areas, and according to socioeconomic and demographic factors such as ethnicity, parental occupation, wealth status and religious affiliation *(6–9)*. At a population level, childhood immunization programmes are adversely affected by: health personnel shortages; insufficient funds and resources for immunization activities; inadequate communication and promotion for immunization activities; lack of security in some parts of the country; and lack of high-quality data for monitoring and evaluation *(5)*.

Descriptive overview

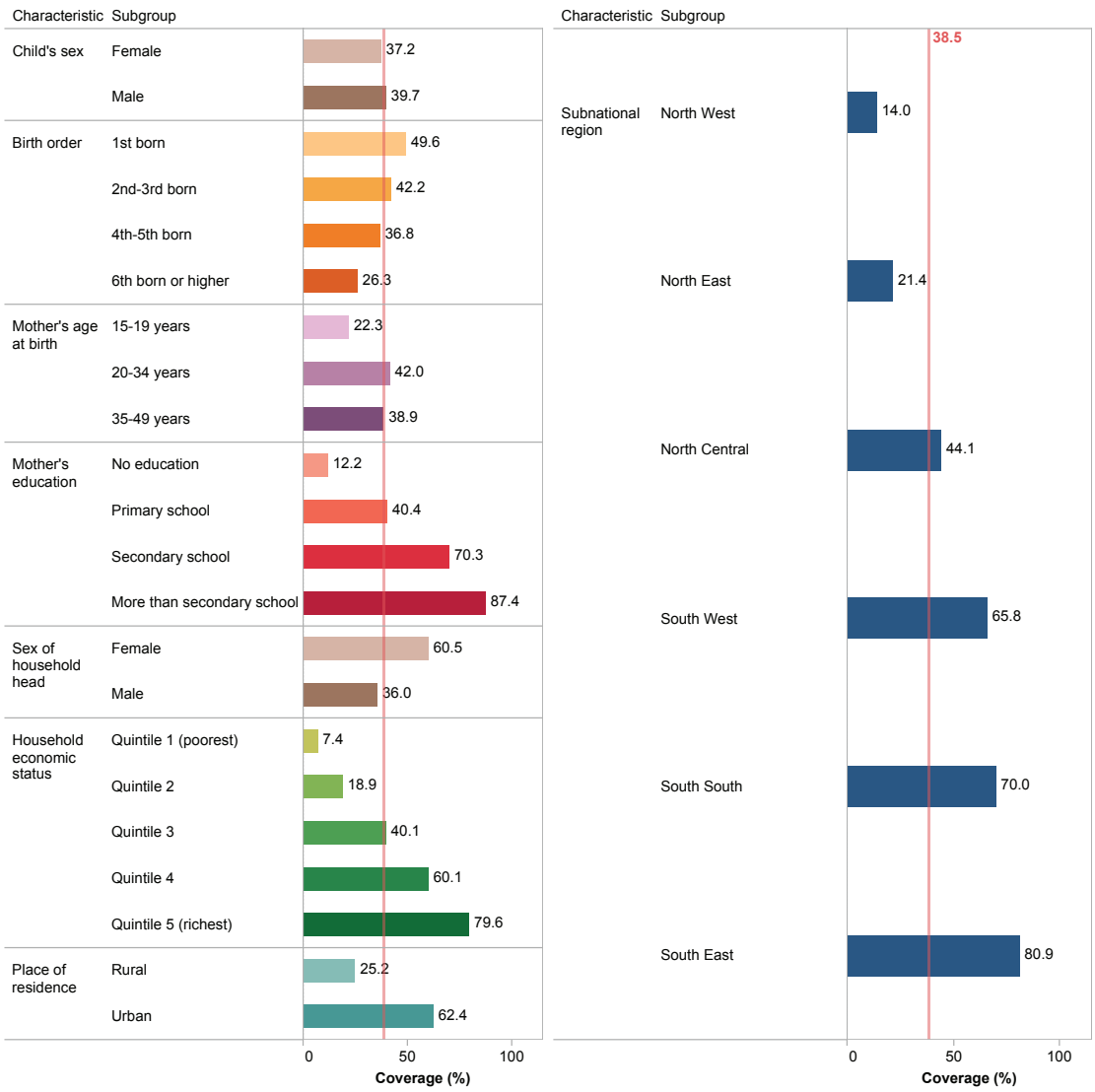
Disaggregation by background characteristics

The national coverage of DTP3 immunization coverage among one-year-olds in Nigeria was 39%. Figure 10.1 presents coverage of DTP3 immunization disaggregated by background characteristics.

Coverage differed by just 3 percentage points between males (40%) and females (37%). There was a negative relationship between DTP3 immunization coverage and birth order: with increasing birth order, the immunization coverage decreased. The level of coverage of one-year-olds that were 1st born children (50%) was about twice as high as the level of coverage among children born 6th or higher (26%). Considering DTP3 immunization coverage by mother's age at birth, coverage was highest among the 20–34 years subgroup (42%), and lowest in the 15–19 years subgroup (22%).

Results demonstrated large education-related and wealth-related inequalities in childhood immunization. The pattern of inequality was similar across education and wealth groups, showing step-wise increases in coverage, moving from the most disadvantaged to the most advantaged. Across the four education subgroups, immunization coverage increased by about 30 percentage points between each subgroup, moving from the no education subgroup to the secondary education subgroup, and by about 20 percentage points between secondary education and more than secondary education subgroups. Across wealth quintiles,

FIGURE 10.1. DTP3 immunization coverage among one-year-olds in Nigeria, disaggregated by background characteristics (DHS 2013)



Note: The red vertical line shows the national average.

coverage increased by about 20 percentage points between each quintile, from quintiles 2 to 5.

Immunization coverage was 2.5 times higher among children in urban areas (62%) than children in rural areas (25%). Across regions, there was significant variation in coverage, with northern regions performing markedly worse than southern regions. For example, while the best-performing South East region reported a coverage of 81%, the North West region showed coverage of only 14% – a gap of 67 percentage points.

Wealth- and education-related inequalities

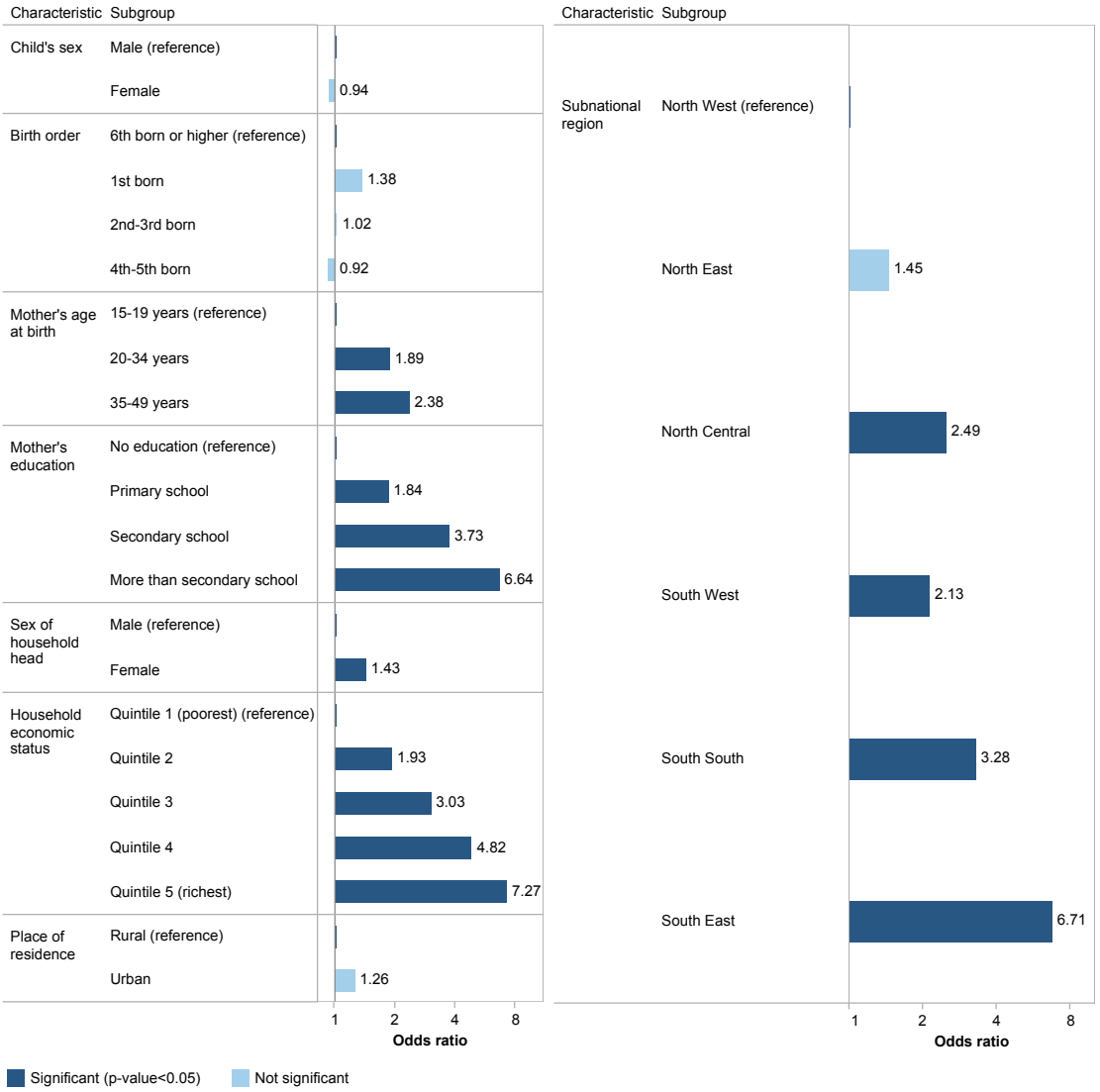
The wealth-related ECI for Nigeria showed a positive value of 0.612, indicating that coverage was

highly concentrated among the richest population. Education-related inequality was also very large in Nigeria, as demonstrated by a positive ECI value of 0.613. Similar to wealth-related inequality, this result shows that DTP3 coverage was highly concentrated among children with more-educated mothers. Both ECIs were statistically significant. The wealth-related concentration curve for DTP3 immunization coverage in Nigeria is available in Chapter 13.

Multiple regression analysis

Figure 10.2 shows the adjusted associations between DTP3 immunization coverage among one-year-olds and socioeconomic, demographic and geographic factors. Immunization coverage was strongly associated with economic status and mother's education, even after controlling for other characteristics. The odds of receiving the third dose

FIGURE 10.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in Nigeria, calculated as odds ratio (DHS 2013)



of the DTP vaccine among children in the richest quintile were more than 7 times higher than for children in the poorest quintile. The subgroup with the most education was more than 6 times more likely to be covered than the subgroup with the least education.

After controlling for other factors, large and statistically significant inequalities in DTP3 immunization coverage across regions were evident. Compared to the North West, all other regions reported odds of coverage that were between 1.5 and 6.7 times larger.

There was a significant positive relationship between immunization coverage and mother's age at birth: compared to the 15–19 years subgroup, the odds of coverage were 2.4 times higher in the 35–49 years subgroup and 1.9 times higher among the 20–34 years subgroup. Children in female-headed households had 1.4 times higher probability of immunization than children in male-headed households.

The sex of the child, birth order and place of residence showed no significant associations with DTP3 immunization coverage.

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
3. Kana MA, Doctor HV, Peleteiro B, Lunet N, Barros H. Maternal and child health interventions in Nigeria: a systematic review of published studies from 1990 to 2014. BMC Public Health [Internet]. 2015 December (http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-1688-3, accessed 6 April 2018).
4. National Primary Health Care Development Agency. Comprehensive EPI Multi-Year Plan 2011–2015. Abuja: Federal Ministry of Health Nigeria; 2011.
5. Global Vaccine Action Plan: priority country reports on progress towards GVAP-RVAP goals. Annex to the GVAP Secretariat Annual Report 2016. Geneva: World Health Organization; 2016.
6. Antai D. Inequitable childhood immunization uptake in Nigeria: a multilevel analysis of individual and contextual determinants. BMC Infect Dis [Internet]. 2009 December (http://bmcinfectdis.biomedcentral.com/articles/10.1186/1471-2334-9-181, accessed 6 April 2018).
7. Ataguba JE, Ojo KO, Ichoku HE. Explaining socio-economic inequalities in immunization coverage in Nigeria. Health Policy Plan. 2016 November;31(9):1212–24.
8. Oleribe O, Kumar V, Awosika-Olumo A, Taylor SD. Individual and socioeconomic factors associated with childhood immunization coverage in Nigeria. Pan Afr Med J [Internet]. 2017 (http://www.panafrican-med-journal.com/content/article/26/220/full/, accessed 6 April 2018).
9. State of inequality: childhood immunization. Geneva: World Health Organization; 2016.

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in Nigeria.

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To access interactive tables, see Appendix 1.

11. Pakistan

Country context

Pakistan has a population of 189 million, with 13.0% under 5 years of age *(1)*. The country is divided into eight subnational regions. Six of these regions were included in the report: four provinces; ICT Islamabad; and the administrative territory of Gilgit Baltistan. The 2012 DHS excluded two regions – Azad Jammu and Kashmir (Pakistan administered Kashmir) and Federally Administered Tribal Areas *(2)* – which were thus not included in this report. Over the past decades, the under-5 mortality rate in Pakistan has decreased from 138.8 deaths per 1000 live births in 1990 to 78.8 deaths per 1000 live births in 2016 *(3)*. Despite progress, certain aspects of child health such as nutrition have worsened, and the country faces security, social, political, economic and environmental challenges that have implications for health services *(4)*.

Pakistan initiated its Expanded Programme on Immunization in 1978, which after funding disruptions in the early 1990s, was revived in 1996–1997 *(5)*. The decentralization of the Pakistani health system in 2011 shifted certain roles and responsibilities for childhood immunization services from the federal to the provincial level: while federal authorities remain responsible for providing technical coordination and support as well as delivering on national commitments at the global and regional levels, provincial governments oversee the implementation and operation of immunization services *(6,7)*. National-level strategic planning for immunization is detailed in the 2014–2018 Comprehensive Multi-Year Plan, and subnational Comprehensive Multi-Year Plans guide planning, decision-making and budget allocations at local levels *(7)*.

Immunization coverage has been shown to vary by household economic status, maternal education level and place of residence *(8–10)*; such coverage gaps have persisted or worsened in recent years *(11)*. Barriers to immunization are related to disease awareness and risk perception, knowledge and perceptions about vaccines, transportation and wait time issues, vaccine and vaccinator availability, and immunization recordkeeping *(6)*. Strategies to increase childhood immunization coverage encompass efforts to build health worker capacity, improve data management and health information systems, create demand for routine immunizations, and upgrade cold-chain infrastructure *(6)*.

Descriptive overview

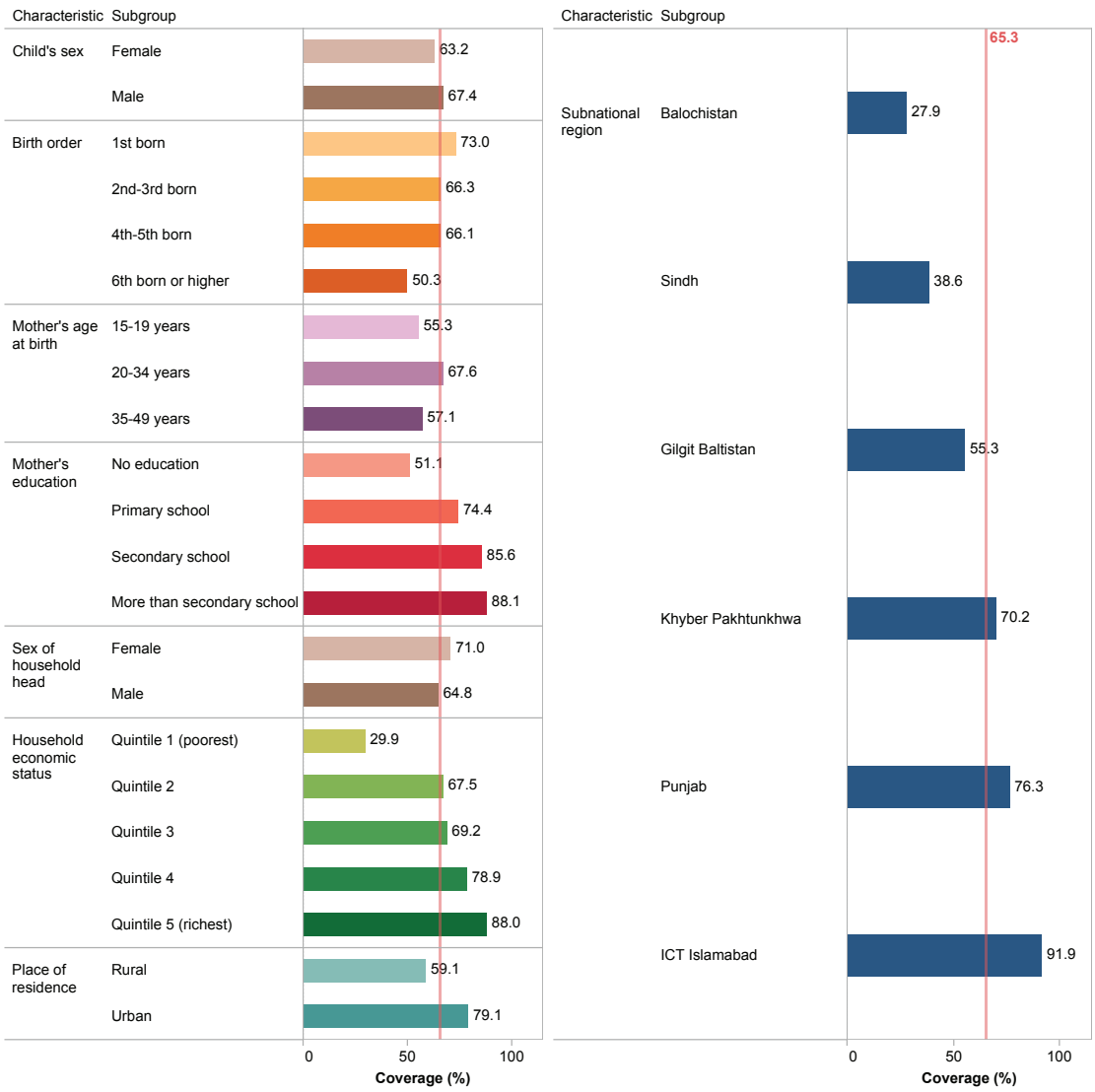
Disaggregation by background characteristics

Among one-year-olds in Pakistan, national DTP3 immunization coverage was 65%. Figure 11.1 presents coverage of DTP3 immunization by socioeconomic, demographic and geographic characteristics.

There was a 4 percentage point difference in coverage between males (67%) and females (63%), which was not statistically significant. DTP3 coverage decreased with increasing birth order: 1st born children reported coverage of 73%, whereas only half of children from the highest birth order subgroup (6th or higher) were covered (50%). The level of coverage across mother's age at birth showed a reverse U-shape pattern, where coverage peaked in the 20–34 years subgroup (68%) and was a little more than 10 percentage points lower in both the younger and older subgroups (55% and 57%, respectively).

The education-related and wealth-related gradient in DTP3 coverage presented patterns of marginal exclusion, characterized by the most disadvantaged subgroup (i.e. the least-educated or poorest) presenting markedly lower coverage than the other more advantaged subgroups.

FIGURE 11.1. DTP3 immunization coverage among one-year-olds in Pakistan, disaggregated by background characteristics (DHS 2012)



Notes: The red vertical line shows the national average. Data were not available for two subnational regions: Azad Jammu and Kashmir (Pakistan administered Kashmir) and Federally Administered Tribal Areas.

Children in urban areas had 20 percentage point higher coverage than children in rural areas (79% versus 59%). Regions also showed substantial variation in coverage. While coverage was only 28% in Balochistan and 39% in Sindh, it reached 92% in the ICT Islamabad region.

Wealth- and education-related inequalities

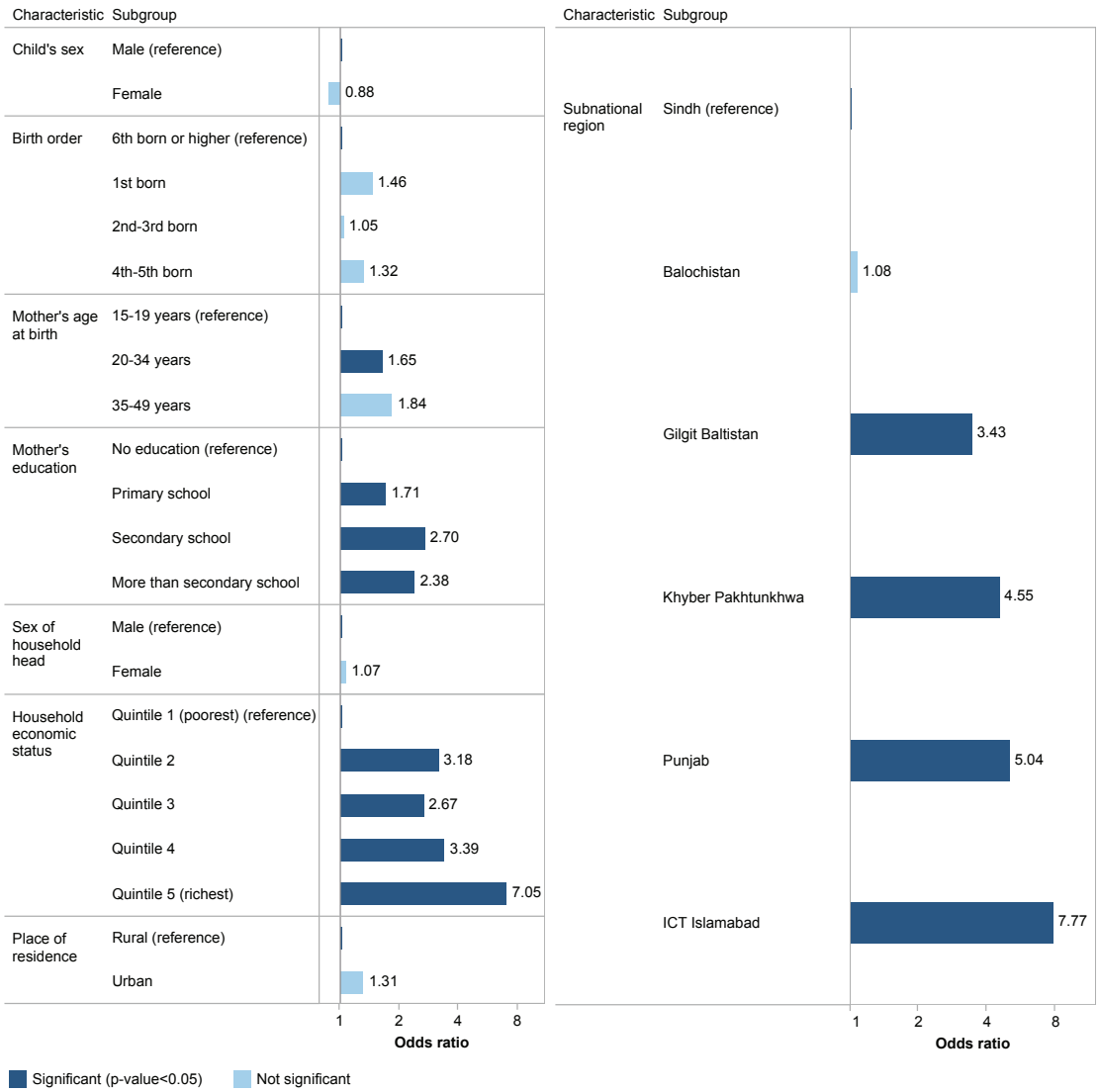
The wealth-related inequality of DTP3 coverage in Pakistan, measured by the ECI, had a positive value of 0.435, indicating that coverage was more concentrated among wealthier households. The ECI applied to summarize the magnitude of inequality across mother's education revealed a

positive value of 0.334. This suggests a higher level of coverage among children with more-educated mothers. Both wealth- and education-related ECIs were statistically significant. The wealth-related concentration curve for DTP3 immunization coverage in Pakistan is available in Chapter 13.

Multiple regression analysis

Figure 11.2 shows the adjusted associations between DTP3 immunization coverage among one-year-olds and selected socioeconomic, demographic and geographic characteristics. The odds of coverage differed greatly across regions,

FIGURE 11.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in Pakistan, calculated as odds ratio (DHS 2012)



Note: Data were not available for two subnational regions: Azad Jammu and Kashmir (Pakistan administered Kashmir) and Federally Administered Tribal Areas.

with all regions except Balochistan showing higher odds of DTP3 immunization than the reference of Sindh. Notably, ICT Islamabad had 7.8 times higher odds of coverage than Sindh.

After controlling for other characteristics, there was a strong association between immunization coverage and household economic status and mother's education. Relative to children in the poorest quintile, the odds of being covered were around 3 times higher for children in quintiles 2 to 4; this ratio increased to 7 times for children in the richest quintile. The subgroup with mother's education level of secondary education was 2.7 times more likely to be covered than the no education subgroup, and the subgroup with more than secondary education was 2.4 times more likely to be covered.

Compared to mothers 15–19 years of age, the odds of reporting coverage were 1.7 to 1.8 times higher in the older age subgroups, although only significant for the 20–34 years subgroup. Other factors including child's sex, birth order and sex of household head demonstrated non-significant associations with DTP3 immunization coverage, after controlling for background characteristics.

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. Pakistan Demographic and Health Survey 2012–2013 [Internet]. Islamabad: National Institute of Population Studies Pakistan and ICF International; 2013 (http://dhsprogram.com/pubs/pdf/FR290/FR290.pdf, accessed 22 May 2018).
3. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
4. Rizvi A, Bhatti Z, Das JK, Bhutta ZA. Pakistan and the Millennium Development Goals for Maternal and Child Health: progress and the way forward. Paediatr Int Child Health. 2015 October 2;35(4):287–97.
5. Owais A, Khowaja AR, Ali SA, Zaidi AKM. Pakistan's expanded programme on immunization: an overview in the context of polio eradication and strategies for improving coverage. Vaccine. 2013 July;31(33):3313–19.
6. Global Vaccine Action Plan: priority country reports on progress towards GVAP-RVAP goals. Annex to the GVAP Secretariat Annual Report 2016. Geneva: World Health Organization; 2016.
7. Ministry of National Health Services, Regulation and Coordination. Expanded Program on Immunization: Comprehensive Multi-Year Plan 2015–2018. Islamabad: Government of Pakistan; 2014.
8. Khan MT, Zaheer S, Shafique K. Maternal education, empowerment, economic status and child polio vaccination uptake in Pakistan: a population based cross sectional study. BMJ Open. 2017;7(3):e013853.
9. Zaidi SMA, Khowaja S, Kumar Dharma V, Khan AJ, Chandir S. Coverage, timeliness, and determinants of immunization completion in Pakistan: evidence from the Demographic and Health Survey (2006–2007). Hum Vaccines Immunother. 2014 June 4;10(6):1712–20.
10. Murtaza F, Mustafa T, Awan R. Determinants of nonimmunization of children under 5 years of age in Pakistan. J Fam Community Med. 2016;23(1):32.
11. State of inequality: childhood immunization. Geneva: World Health Organization; 2016.

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in Pakistan.

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To access interactive tables, see Appendix 1.

12. Uganda

Country context

Uganda has a population of 40 million, with 18.7% under 5 years of age *(1)*. The country saw a decrease in the under-5 mortality rate from 175.0 to 53.0 deaths per 1000 live births between 1990 and 2016 *(2)*. Child health outcomes are unevenly distributed across the country, as health service availability, quality and uptake are variable *(3)*. As of 2016, the country was divided into 112 administrative districts; for the purpose of the 2016 Uganda DHS and the analyses in this report, these districts were grouped into 15 subnational regions *(4)*.

Immunization activities in Uganda are supported by a functional National Immunization Technical Advisory Group *(5)*. The Expanded Programme on Immunization has had a history of mixed success, with progressive improvements realized between 2000 and 2006, followed by a period of declining performance *(6)*. The Expanded Programme on Immunization Revitalization Plan, spanning 2012 to 2014, brought funding and attention to immunization service delivery in poor-performing districts through: strengthening outreach and promotion activities; increasing supervisory visits; and implementing Reach Every District and Reach Every Child strategies *(5)*. In 2016, the Government of Uganda enacted the Immunization Act, declaring the compulsory immunization of children and other groups, and establishing an Immunization Fund to support activities *(7)*.

Immunization services in Uganda are primarily provided by nurses, midwives and nursing assistants, and volunteer village health teams assist with social mobilization activities *(5)*. Staff shortages, especially in hard-to-reach and underserved areas, is one critical barrier to universal immunization coverage; other barriers include irregular and insufficient outreach activities, vaccine shortages or stockouts at local levels, and inadequate monitoring and supervision *(5,6)*.

Descriptive overview

Disaggregation by background characteristics

As of 2016, the overall coverage of DTP3 immunization among one-year-olds was 79%. Figure 12.1 presents DTP3 immunization coverage in Uganda disaggregated by background characteristics.

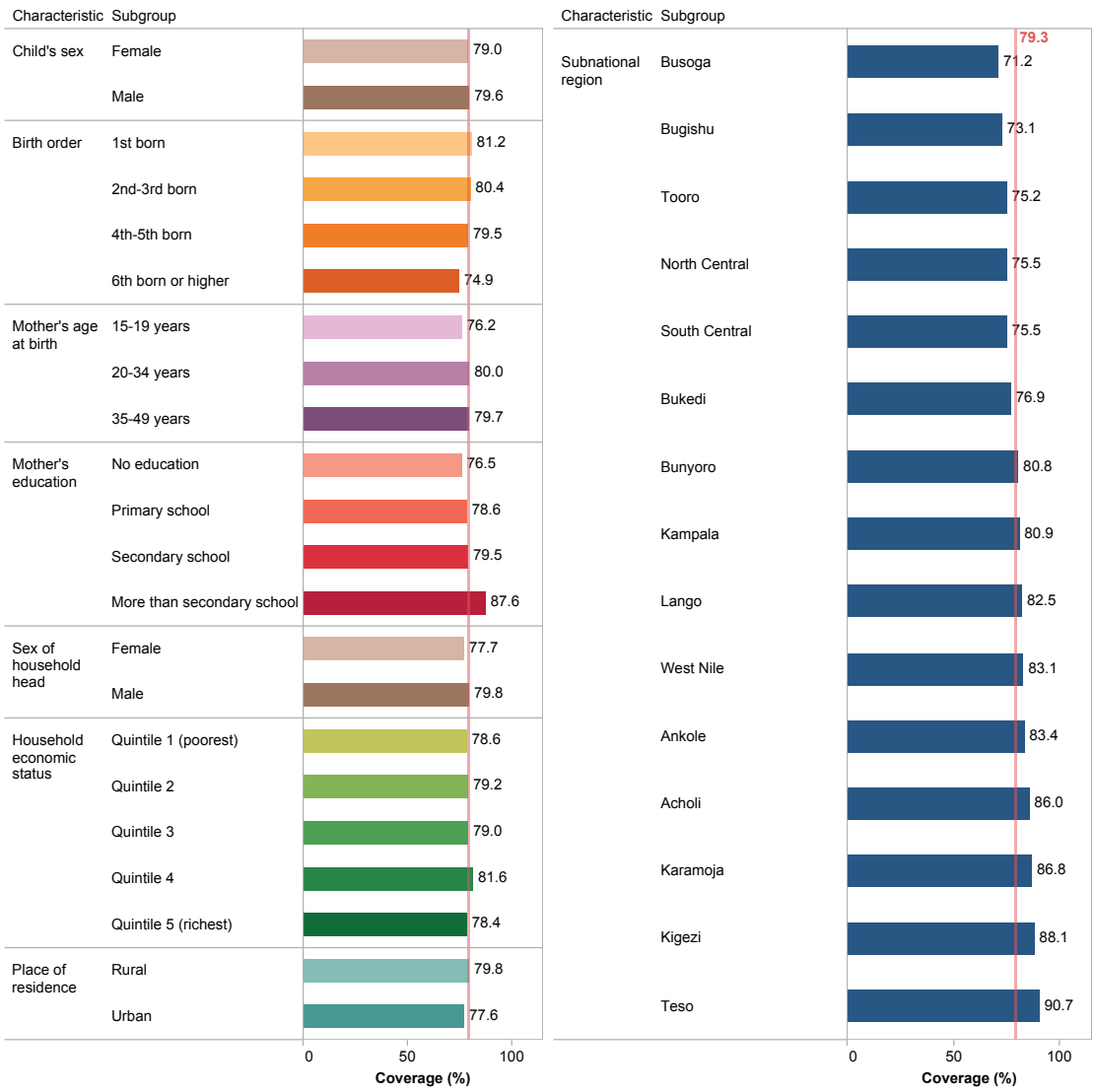
Overall, coverage across all subgroups remained within about 10 percentage points of the national average of 79%. Male and female children had about the same level of coverage. Little variation in coverage was reported across birth order subgroups ranging from 1st to 5th born children (around 80%), however, coverage was lower in higher order births (75%).

DTP3 immunization coverage by mother's age at birth was similar across all three subgroups, with slightly lower coverage in the 15–19 years subgroup (76%) than the 20–34 years and 35–49 years subgroups (80% in both). For education subgroups, DTP3 coverage was similar in the no education (77%), primary education (79%) and secondary education (80%) subgroups, however, increased by a larger margin for mothers with more than secondary education (88%).

Male- and female-headed households had about the same level of coverage. The wealth-related gradient showed very little inequality, with a maximum difference of just 4 percentage points between quintile 4 (82%) and quintile 5 (78%).

Rural and urban areas reported immunization coverage of 80% and 78%, respectively. Coverage

FIGURE 12.1. DTP3 immunization coverage among one-year-olds in Uganda, disaggregated by background characteristics (DHS 2016)



Note: The red vertical line shows the national average.

across regions, however, varied more markedly, with Busoga reporting the lowest coverage (71%) and Teso reporting the highest coverage (91%).

Wealth- and education-related inequalities

The wealth-related ECI for DTP3 immunization coverage in Uganda had a value of 0.010, which was not statistically significant. This suggests that there was no inequality in coverage among children with different levels of household wealth. By contrast, the education-related ECI in Uganda had a positive value of 0.055. This value indicates that coverage was more concentrated among children with more-educated mothers. While small, the education-related ECI in Uganda was statistically significant. The wealth-related concentration curve for DTP3

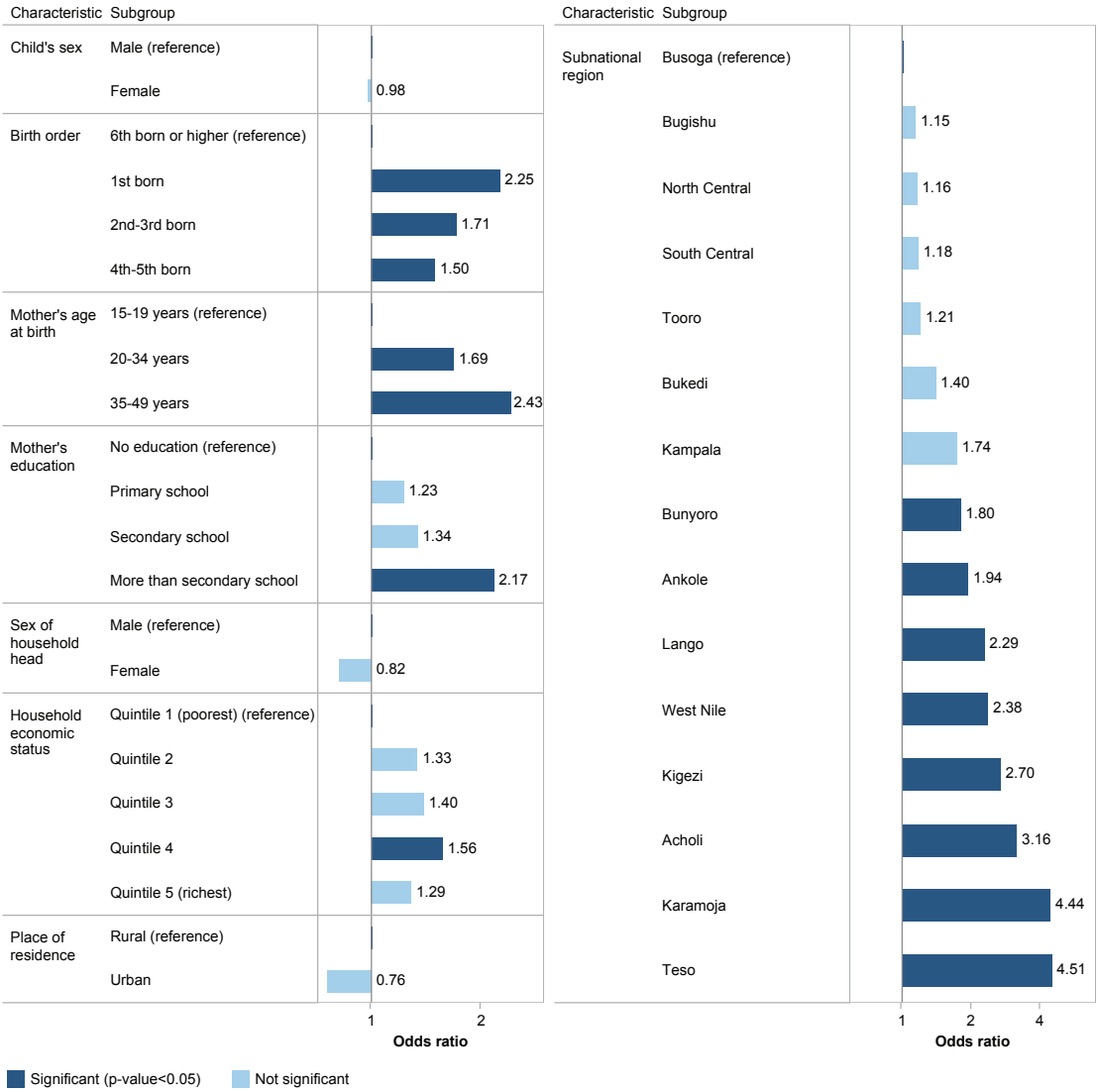
immunization coverage in Uganda is available in Chapter 13.

Multiple regression analysis

Figure 12.2 shows that, controlling for other factors, there was a large and statistically significant variation in the odds of childhood immunization across subnational regions in Uganda. For example, one-year-olds living in the regions of Karamoja and Teso were more than 4 times as likely to be covered as those living in Busoga, the region with the lowest DTP3 immunization coverage.

There was a significant positive relationship between immunization coverage and mother's age at birth: compared to the 15–19 years subgroup, the odds of coverage were 2.4 times higher in the 35–49 years subgroup and 1.7 times higher among the 20–34 years subgroup. Birth order demonstrated a

FIGURE 12.2. Adjusted associations between DTP3 immunization coverage among one-year-olds and background characteristics in Uganda, calculated as odds ratio (DHS 2016))



significant association with immunization coverage. Most notably, 1st born children were 2.3 times more likely to report DTP3 immunization coverage than children born 6th or higher. Mother's education was also associated with DTP3 immunization when comparing the most- and least-educated, with the most-educated subgroup having a 2.2 times higher chance of immunization than the least-educated subgroup.

Overall, immunization was not significantly associated with household economic status. Child sex, sex of household head and place of residence demonstrated no association with childhood immunization, when accounting for other background characteristics

References

1. United Nations Population Division. World population prospects: 2017 revision [Internet]. New York: United Nations; 2017 (https://esa.un.org/unpd/wpp, accessed 21 February 2017).
2. Levels and trends in child mortality report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, World Health Organization, World Bank and United Nations [Internet]. New York: United Nations Children's Fund; 2017 (http://www.childmortality.org/files_v21/download/IGME%20report%202017%20child%20mortality%20final.pdf, accessed 21 February 2018).
3. Republic of Uganda, UNICEF. Country Programme Action Plan 2016–2020. Kampala: UNICEF Uganda Country Office; 2015.
4. Uganda Bureau of Statistics, ICF International. Uganda Demographic and Health Survey 2011. Kampala: ICF International Inc.; 2012.
5. Global Vaccine Action Plan: priority country reports on progress towards GVAP-RVAP goals. Annex to the GVAP Secretariat Annual Report 2016. Geneva: World Health Organization; 2016.
6. Republic of Uganda. Uganda National Expanded Programme on Immunization Multi Year Plan 2012–2016: Updated cMPY August 2013. Geneva: World Health Organization and UNICEF; 2013.
7. Immunisation Act, 2016 [Internet]. Kampala: Republic of Uganda; 2016 (https://www.sabin.org/sites/sabin.org/files/uganda_immunization_act_2015.pdf, accessed 27 May 2018).

Interactive visuals and tables

Interactive visuals and tables allow for further exploration of inequality in childhood immunization in Uganda.

To access interactive visuals:

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

http://apps.who.int/gho/data/view.wrapper.HE-VIZ21?lang=en&menu=hide

To access interactive tables, see Appendix 1.

13. Multicountry assessment

Integrating the country-specific findings presented in Chapters 3 to 12, this chapter provides a multicountry overview of DTP3 immunization coverage and inequality across the Gavi, the Vaccine Alliance 10 tier-1 countries. A multicountry perspective permits benchmarking – the comparison of data from similar countries to get a sense of how any one country performs in relation to others. This chapter begins by comparing DTP3 immunization coverage nationally and by within-country subgroups. Then, the chapter assesses differences in within-country inequality using concentration curves and inequality summary measures (wealth- and education-related concentration indices). Finally, the chapter documents differences in the adjusted associations between DTP3 coverage and selected socioeconomic, demographic and geographic factors. The interactive visuals and tables that accompany the report provide additional opportunities for multicountry data exploration.

Interactive visuals and tables

Interactive visuals and tables facilitate further exploration of inequality in childhood immunization across the 10 priority countries.

To access interactive visuals:

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

http://apps.who.int/gho/data/view.wrapper.HE-VIZ22?lang=en&menu=hide

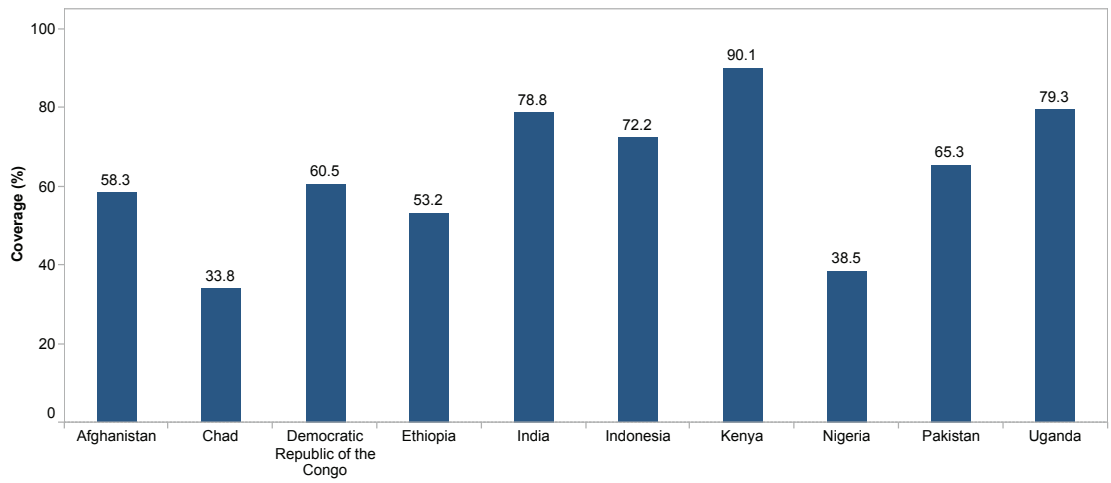
To access interactive tables, see Appendix 1.

Descriptive overview

National childhood immunization coverage

Countries reported variable levels of national DTP3 immunization coverage (Figure 13.1). The national immunization coverage was markedly different across countries: the countries with the lowest coverage were Chad (34%) and Nigeria (39%); Kenya reported the highest national coverage at 90%.

FIGURE 13.1. National DTP3 immunization coverage among one-year-olds in 10 priority countries (DHS 2012–2016 and NFHS 2015)

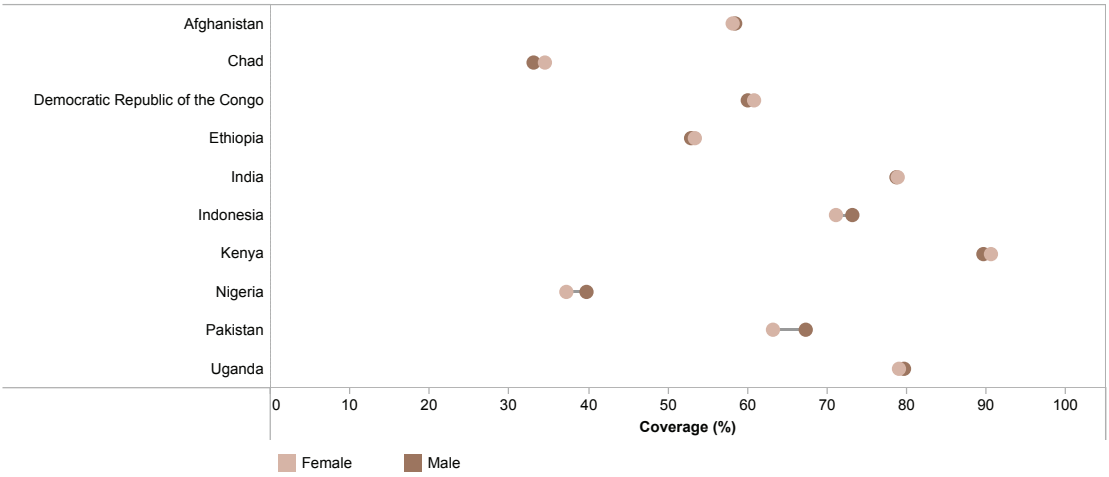


Disaggregation by background characteristics

Child's sex

The 10 priority countries demonstrated almost no variation in DTP3 immunization coverage according to the sex of the child (Figure 13.2). In nine of the 10 countries, the gap was around 2 percentage points or less; Pakistan reported inequality of 4 percentage points, favouring boys. In all cases, the differences between boys and girls were not statistically significant.

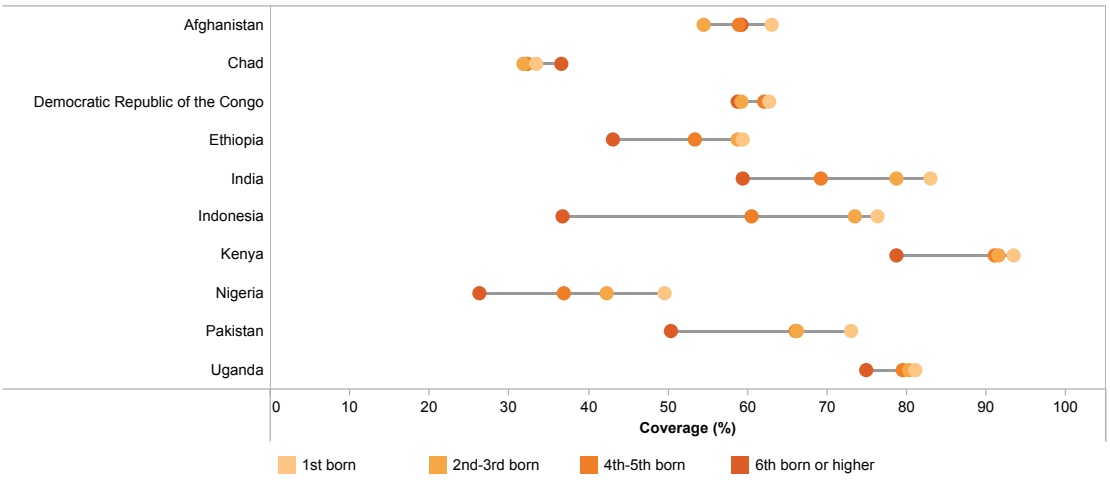
FIGURE 13.2. DTP3 immunization coverage among one-year-olds by child's sex in 10 priority countries (DHS 2012–2016 and NFHS 2015)



Birth order

Overall, DTP3 immunization coverage tended to be highest among 1st born children and lower among higher birth order children (Figure 13.3). Across countries, coverage was markedly lower among 6th born children (or higher) than across other subgroups, with some exceptions. India, Indonesia, Nigeria and Pakistan presented particularly large differentials in immunization coverage by birth order, with gaps between the lowest and highest birth order group spanning more than 20 percentage points; two countries (Chad and Democratic Republic of the Congo), in contrast, showed little variation in immunization coverage according to birth order (less than 5 percentage points difference between the best- and worst-performing subgroups).

FIGURE 13.3. DTP3 immunization coverage among one-year-olds by birth order in 10 priority countries (DHS 2012–2016 and NFHS 2015)

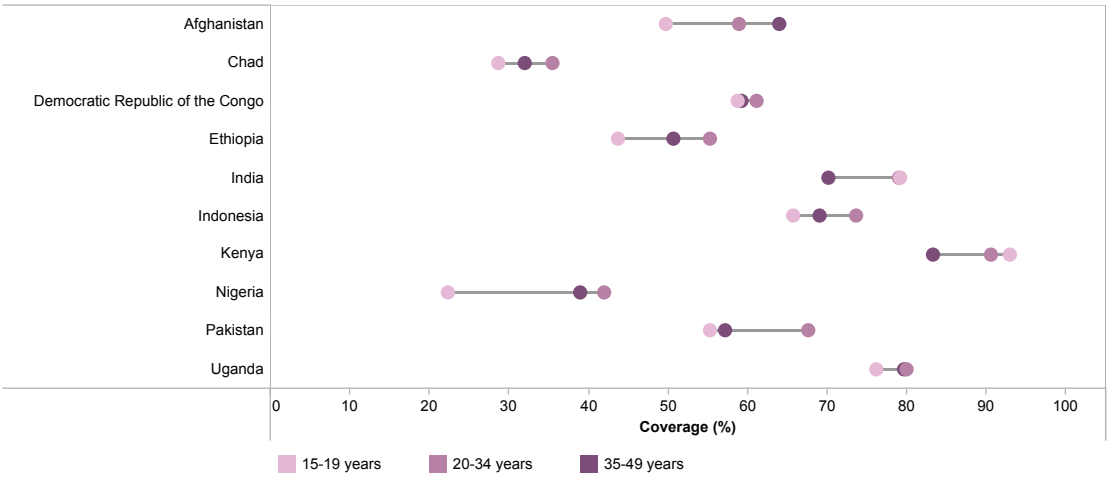


Mother's age at birth

DTP3 immunization coverage was highest among children whose mothers were 20–34 years in seven of the study countries (with the exception of Afghanistan, India and Kenya) (Figure 13.4). In the Democratic Republic of the Congo, however, the differences in mean coverage between age subgroups were not statistically significant.

There was more across country variation in DTP3 coverage among the subgroup of mothers aged 15–19 years than in either of the other two subgroups. While the difference between the country with the highest and lowest coverage for the 15–19 years subgroup was 71 percentage points, this difference was 55 percentage points for the 20–34 years subgroup and 51 percentage points for the 35–49 years subgroup.

FIGURE 13.4. DTP3 immunization coverage among one-year-olds by mother's age at birth in 10 priority countries (DHS 2012–2016 and NFHS 2015)



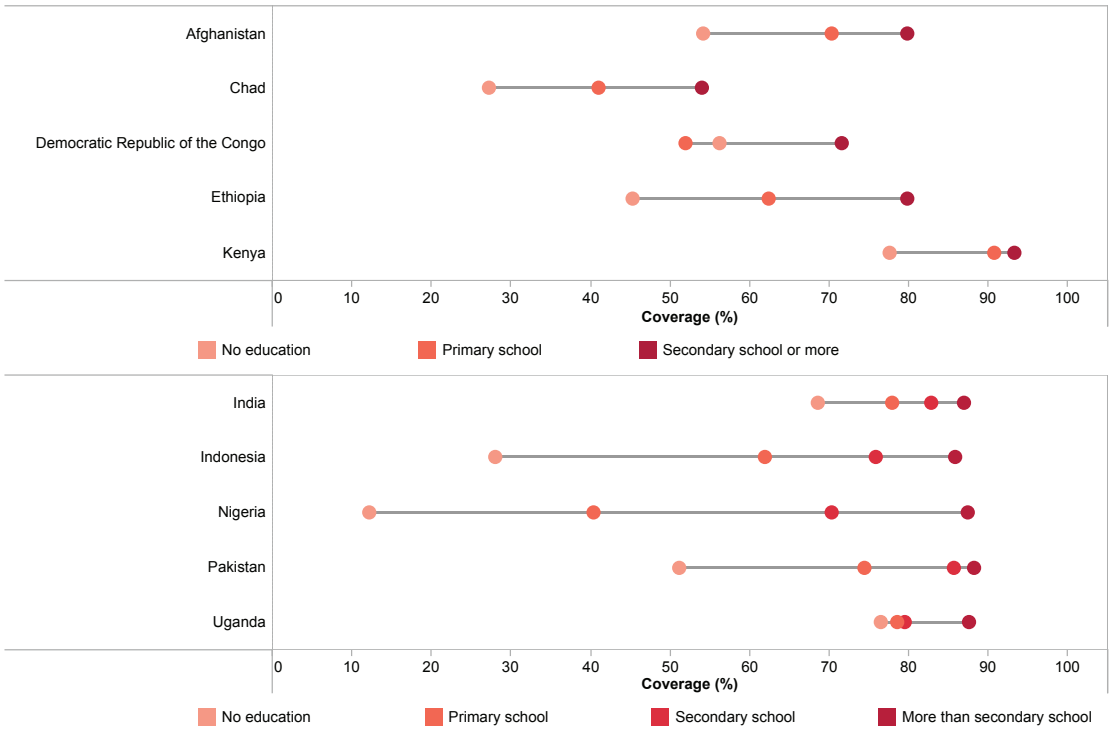
Mother's education

Across all 10 priority countries, DTP3 immunization coverage was consistently higher among children of mothers with more education (Figure 13.5). For example, median coverage for mothers with primary school was 14 percentage points higher than for mothers with no education.

The pattern of inequality across mother's education subgroups differed across countries, noting that some countries had four education subgroups (India, Indonesia, Nigeria, Pakistan and Uganda) and other countries had three (Afghanistan, Chad, Democratic Republic of the Congo, Ethiopia and Kenya). For instance, Chad and Ethiopia and to some extent, Nigeria, demonstrated a linear gradient with approximately similar increases in coverage across education subgroups. In Afghanistan, India, Indonesia, Kenya and Pakistan, differences in coverage were larger between the no education and primary education subgroups than between the primary education and higher education subgroups. The Democratic Republic of the Congo and Uganda, by contrast, showed notably larger increases in coverage in higher education subgroups relative to lower education subgroups.

Within each education subgroup, DTP3 coverage varied greatly across countries. The range in coverage across countries in the subgroup of mothers with no education was 66 percentage points, spanning from 12% in Nigeria to 78% in Kenya. In the subgroup with higher education, the gap between the best- and worst-performing country was 39 percentage points (from 54% in Chad to 93% in Kenya), indicating a lower but still relevant variation in coverage.

FIGURE 13.5. DTP3 immunization coverage among one-year-olds by mother's education in 10 priority countries (DHS 2012–2016 and NFHS 2015)



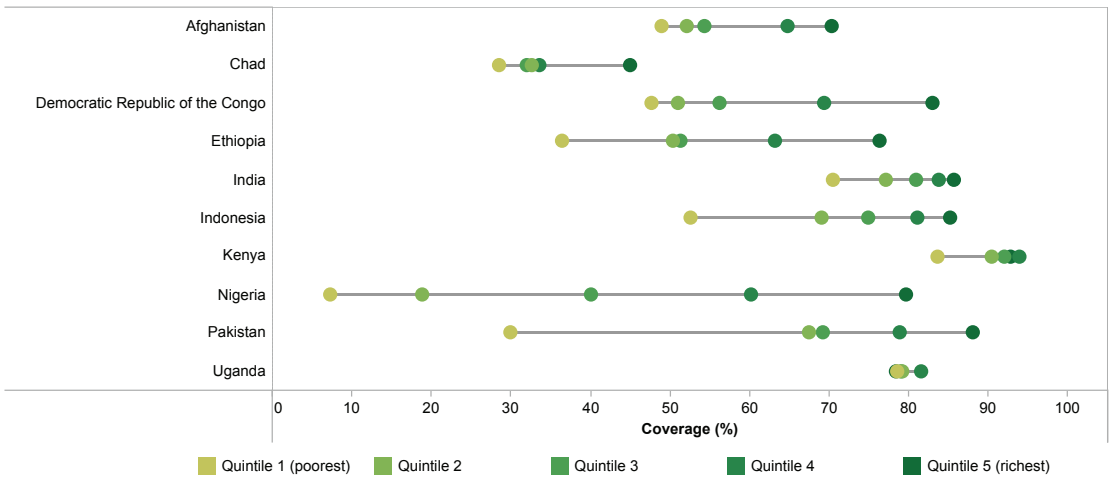
Household economic status

Figure 13.6 shows DTP3 immunization coverage by wealth quintile for each of the 10 priority countries. In the majority of countries (7 out of 10), immunization coverage increased in each progressively wealthier quintile; in 9 out of 10 countries, DTP3 immunization coverage was significantly higher in the richest quintile compared to the poorest. Uganda was the only country that reported no significant difference between the richest and poorest quintiles. The sharpest gradients were evident in Nigeria, Pakistan and Ethiopia where, relative to the poorest quintile, coverage in the richest quintile was about 10, 3 and 2 times higher, respectively. Nigeria presented the largest absolute inequality, with a rich–poor difference spanning over 70 percentage points.

Different patterns of inequality were detected across countries. For example, Nigeria showed a queuing pattern where coverage increased in a linear relationship with approximately equal gains in coverage across wealth quintiles. Indonesia and Pakistan demonstrated patterns of marginal exclusion where the poorest quintile had substantially lower coverage than the other four quintiles.

Looking at cross-country performance by quintiles revealed greatest variation in the poorest quintile, and least variation among the richest quintile. The range between the quintile 1 subgroup with the highest coverage (84% in Kenya) and the quintile 1 subgroup with the lowest coverage (7% in Nigeria) was 76 percentage points. Among performance in quintile 5, this range was much narrower. With the exception of the outlier of Chad, which showed a notably low level of coverage even among the richest, the subgroup performance ranged from 70% in Afghanistan to 93% in Kenya: 23 percentage points.

FIGURE 13.6. DTP3 immunization coverage among one-year-olds, by household economic status in 10 priority countries (DHS 2012–2016 and NFHS 2015)

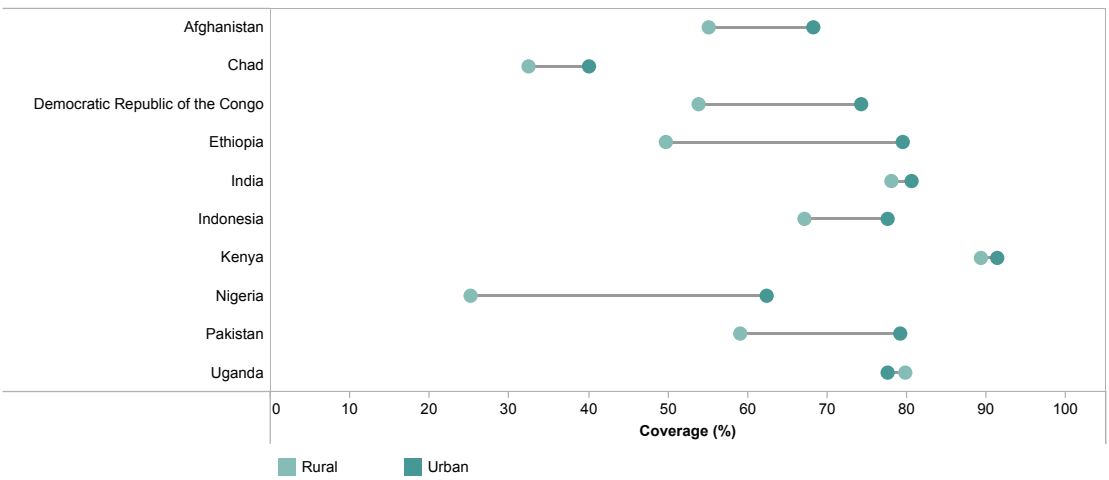


Place of residence

Urban areas tended to report higher levels of childhood immunization coverage than rural areas; the magnitude of the urban–rural gap, however, varied greatly across countries (Figure 13.7). While Nigeria and Ethiopia had an absolute difference between urban and rural areas of 37 and 30 percentage points, respectively, this difference was minimal in India, Kenya and Uganda, amounting to 2–3 percentage points.

Across countries, the variation in the level of coverage in rural areas was larger than in urban areas: in the rural subgroup, coverage ranged from 25% in Nigeria to 89% in Kenya (64 percentage points), whereas in the urban subgroup, coverage ranged from 40% in Chad to 91% in Kenya (51 percentage points).

FIGURE 13.7. DTP3 immunization coverage among one-year-olds by place of residence in 10 priority countries (DHS 2012–2016 and NFHS 2015)

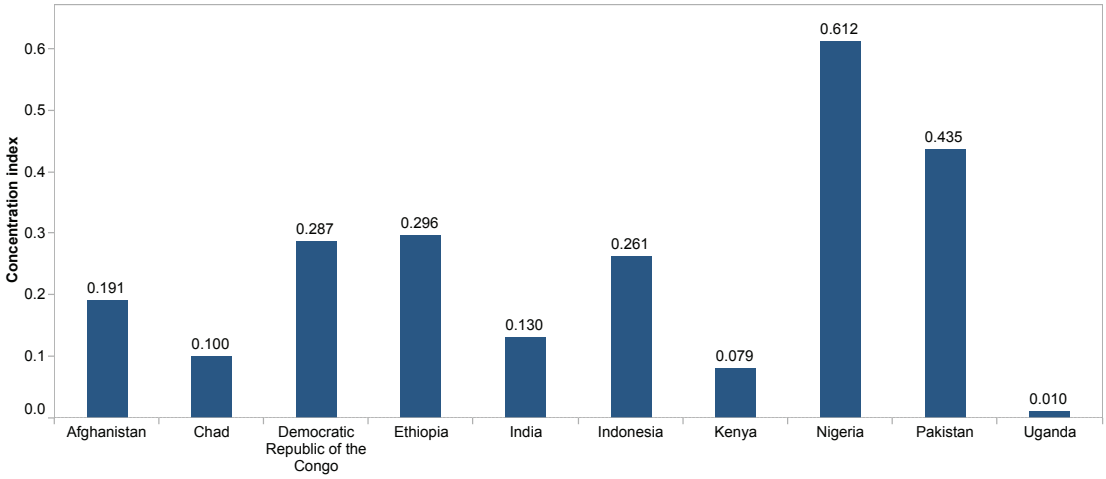


Wealth- and education-related inequalities

Concentration indices

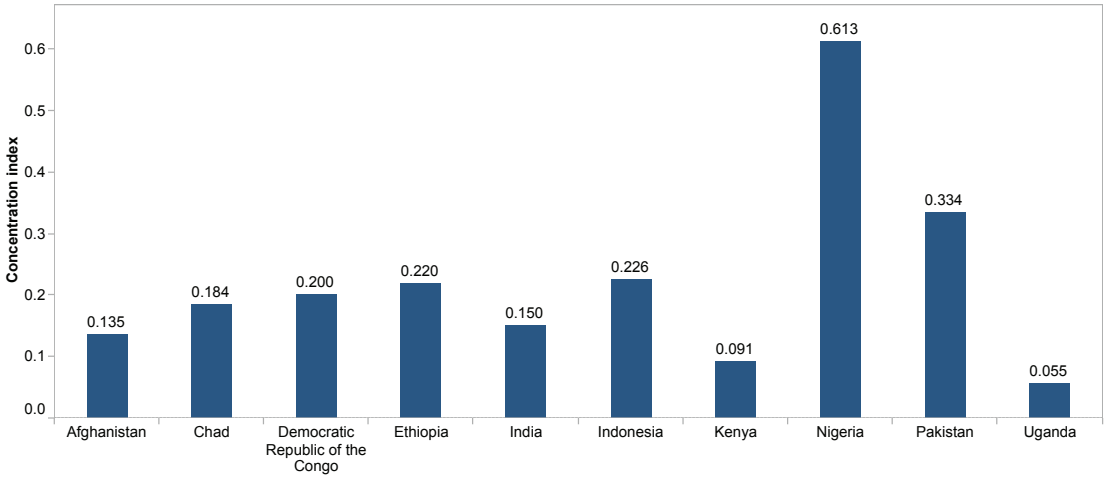
Erreygers concentration indices (ECI) depicting the magnitude of wealth- and education-related inequality in each of the 10 priority countries are shown in Figures 13.8 and 13.9. The wealth-related ECI for DTP3 immunization coverage was positive and statistically significant for all countries, except Uganda, indicating that immunization coverage among one-year-olds tended to be concentrated among wealthier households (Figure 13.8). Consistent with the concentration curves shown above, the largest inequality was observed in Nigeria where the wealth-related ECI was 0.612, followed by Pakistan with an ECI value of 0.435. The Democratic Republic of the Congo, Ethiopia and Indonesia had similar ECI values, falling just short of 0.3, confirming that DTP3 coverage in these countries was concentrated among the richer. Chad, India and Kenya had lower levels of wealth-related inequality, and Uganda demonstrated no inequality.

FIGURE 13.8. Wealth-related Erreygers concentration index for DTP3 immunization coverage among one-year-olds in 10 priority countries (DHS 2012–2016 and NFHS 2015)



The ECI values for education-related inequality were all positive, indicating higher coverage among children of mothers with more education (Figure 13.9). Nigeria was the country with the largest education-related inequality in DTP3 immunization coverage (ECI=0.613), and Pakistan reported the second largest education-related inequality (ECI=0.334). Uganda reported a small but statistically significant positive ECI for education-related inequality (0.055), suggesting that, although DTP3 coverage did not differ by household economics status, it did vary by mother's level of education.

FIGURE 13.9. Education-related Erreygers concentration index for DTP3 immunization coverage among one-year-olds in 10 priority countries (DHS 2012–2016 and NFHS 2015)

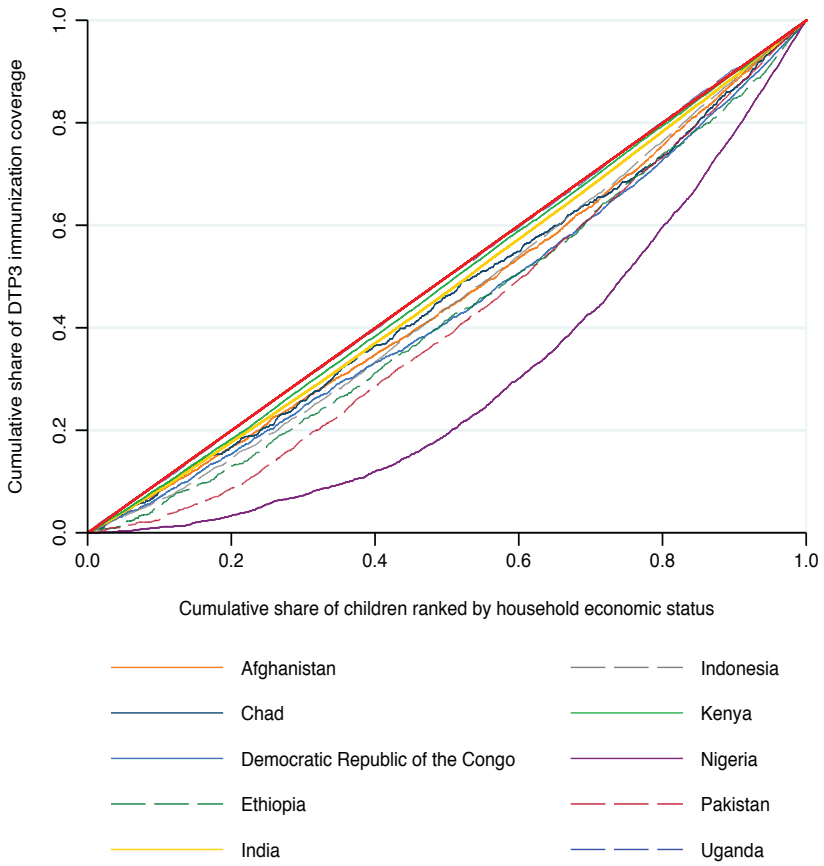


Concentration curves

Concentration curves illustrating wealth-related inequality in DTP3 immunization coverage across the 10 priority countries are displayed in Figure 13.10. The concentration curves show the cumulative share of DTP3 coverage plotted against the cumulative share of children ranked from poorest to richest household.

For 9 out of 10 countries (excepting Uganda), the concentration curve was below the line of equality, demonstrating that DTP3 coverage was more concentrated among children from richer households. Countries demonstrated variation in how far the concentration curve fell from the line of equality, indicating differing levels of wealth-related inequality. Nigeria had the most pronounced inequality, depicted by the concentration curve that falls below other curves at all points, whereas the concentration curve for Kenya fell close to the line of equality. The concentration curve for Uganda is almost on the line of equality, indicating that DTP3 immunization coverage was equally distributed across children of different household economic status.

FIGURE 13.10. Concentration curves for DTP3 immunization coverage by household economic status in 10 priority countries (DHS 2012–2016 and NFHS 2015)



Note: The red diagonal line represents the line of equality.

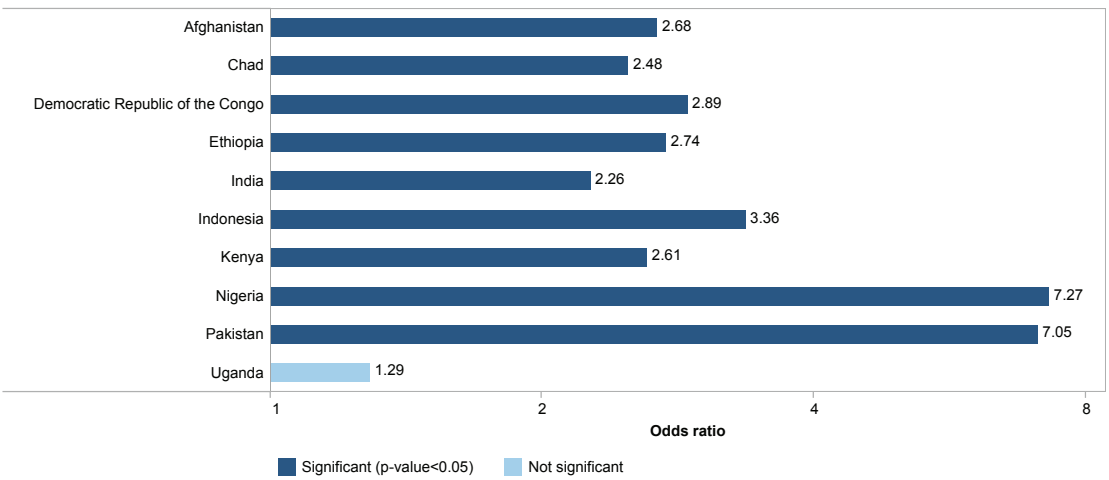
Characteristics associated with DTP3 immunization coverage across countries

Figures 13.11 and 13.12 present estimated odds ratios for the adjusted association between DTP3 immunization coverage and select socioeconomic, demographic and geographic factors across priority countries.

In all countries except Uganda, children in the richest quintile had a significantly higher chance of being vaccinated compared with those from the poorest quintile, after controlling for other factors; in Nigeria and Pakistan, this chance was 7 times higher (Figure 13.11).

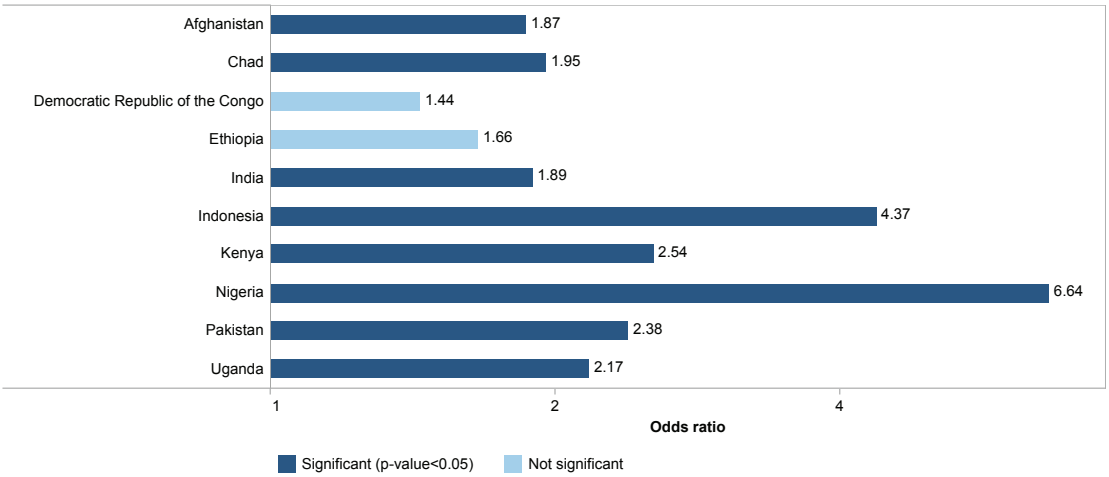
The odds of DTP3 immunization were higher among the higher education subgroups relative to the subgroup with no education (Figure 13.12). The adjusted association between mother's education and coverage, however, varied largely across countries. The association was not statistically significant in the Democratic Republic of the Congo and Ethiopia. In Nigeria and Indonesia, however, the odds of being vaccinated were 6.6 and 4.4 times higher, respectively, among the most-educated subgroup compared to the least-educated subgroup.

FIGURE 13.11. Adjusted associations between household economic status and DTP3 immunization coverage among one-year-olds in 10 priority countries, calculated as odds ratio for the richest quintile compared with the poorest quintile (DHS 2012–2016 and NFHS 2015)



Note: The adjusted odds ratios compare quintile 5 against the reference subgroup of quintile 1, adjusting for other characteristics: child's sex; birth order; mother's age at birth; mother's education; mother's ethnicity or caste/tribe (where applicable); sex of household head (except Afghanistan); place of residence; and subnational region.

FIGURE 13.12. Adjusted associations between mother's education and DTP3 immunization coverage among one-year-olds in 10 priority countries, calculated as odds ratio for the most educated compared with the least educated (DHS 2012–2016 and NFHS 2015)

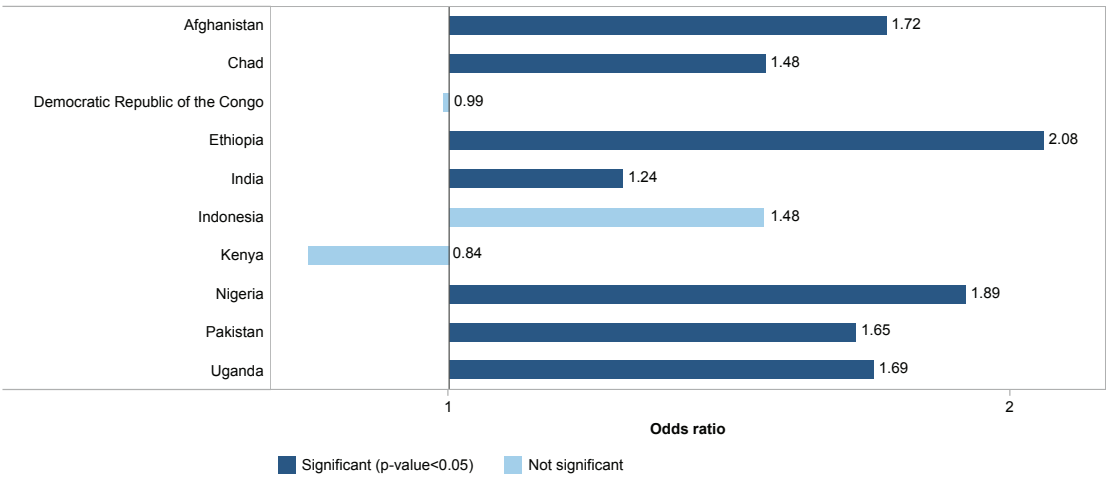


Notes: In Afghanistan, Chad, the Democratic Republic of the Congo, Ethiopia and Kenya, the most-educated subgroup was the combined category of "secondary school or more", applied due to small sample sizes of women with higher levels of education; in all other countries, the most-educated subgroup was "more than secondary school".

The adjusted odds ratios compare the most-educated subgroup against the reference subgroup of no education, adjusting for other characteristics: child's sex; birth order; mother's age at birth; mother's ethnicity or caste/tribe (where applicable); sex of household head (except Afghanistan); household economic status; place of residence; and subnational region.

After controlling for other factors, there were mixed associations between DTP3 coverage and mother's age at birth (Figure 13.13). In the Democratic Republic of the Congo and Kenya, the odds of coverage among the subgroup with mothers aged 20–34 years were close to and not statistically different from the subgroup with mothers aged 15–19 years; however, in Ethiopia and Nigeria, the odds of coverage in the 20–34 years subgroup were around twice as high, compared to the 15–19 years subgroup.

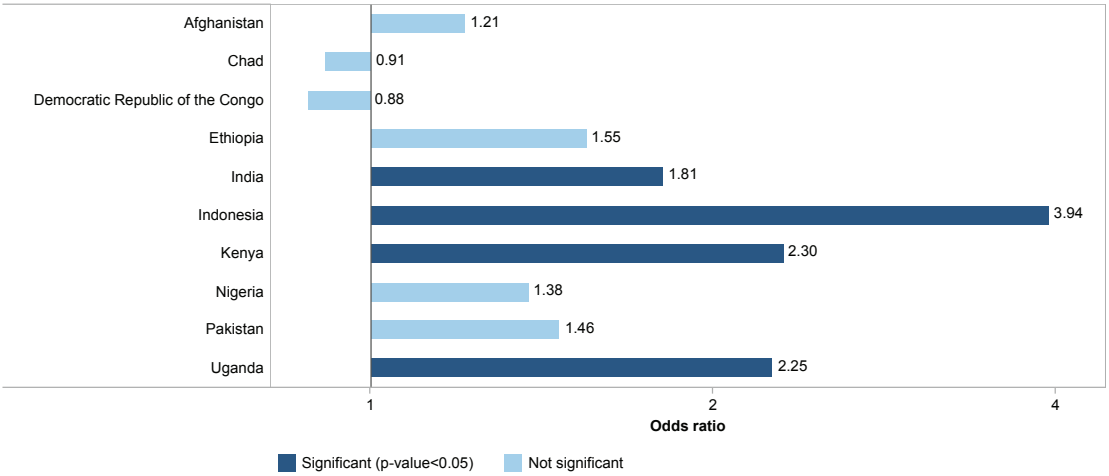
FIGURE 13.13. Adjusted associations between mother's age at birth and DTP3 immunization coverage among one-year-olds in 10 priority countries, calculated as odds ratio for the 20–34 years subgroup compared with the 15–19 years subgroup (DHS 2012–2016 and NFHS 2015)



Note: The adjusted odds ratios compare the 20–34 years subgroup against the reference subgroup of 15–19 years, adjusting for other characteristics: child's sex; birth order; mother's education; mother's ethnicity or caste/tribe (where applicable); sex of household head (except Afghanistan); household economic status; place of residence; and subnational region.

Six countries out of 10 did not report statistically significant associations between DTP3 immunization coverage and birth order (Figure 13.14). In Indonesia, however, the odds were 4.0 times higher among 1st born children compared to 6th born or higher; in Kenya and Uganda the odds were 2.3 times as high and in India, 1.8 times as high.

FIGURE 13.14. Adjusted associations between birth order and DTP3 immunization coverage among one-year-olds in 10 priority countries, calculated as odds ratio for the 1st born compared with the 6th born or higher (DHS 2012–2016 and NFHS 2015)

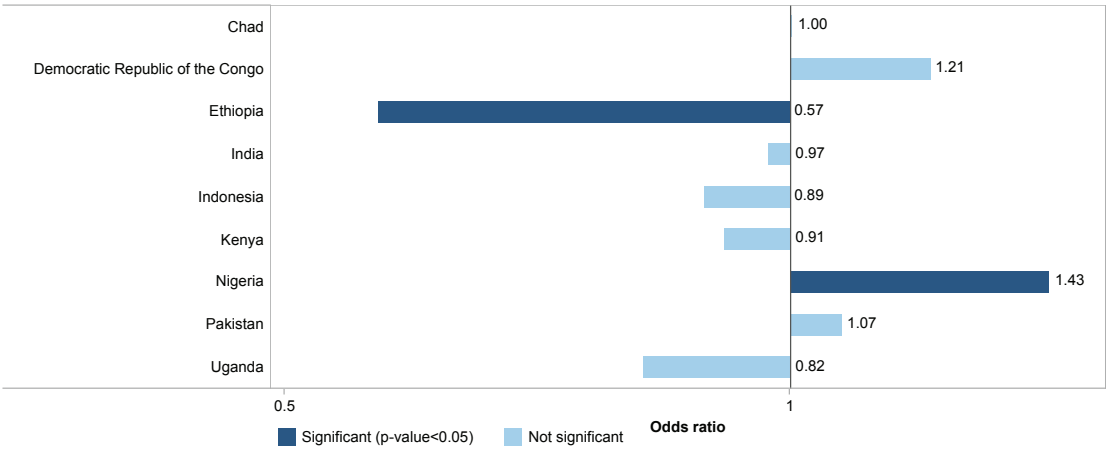


Note: The adjusted odds ratios compare the 1st born subgroup against the reference 6th born or higher subgroup, adjusting for other characteristics: child's sex; mother's age at birth; mother's education; mother's ethnicity or caste/tribe (where applicable); sex of household head (except Afghanistan); household economic status; place of residence; and subnational region.

Most countries (7 out of 9) did not report a significant association between DTP3 coverage and the sex of household head (Figure 13.15). Ethiopia and Nigeria demonstrated significant, though opposite associations: in Ethiopia, children in female-headed households had a lower chance of coverage (0.6 times) than children in male-headed households; in Nigeria, children in female-headed households had 1.4 times higher chance of immunization than children in male-headed households.

Notes: The adjusted odds ratios compare females against the reference subgroup males, adjusting for other characteristics: child's sex; birth order; mother's age at birth;

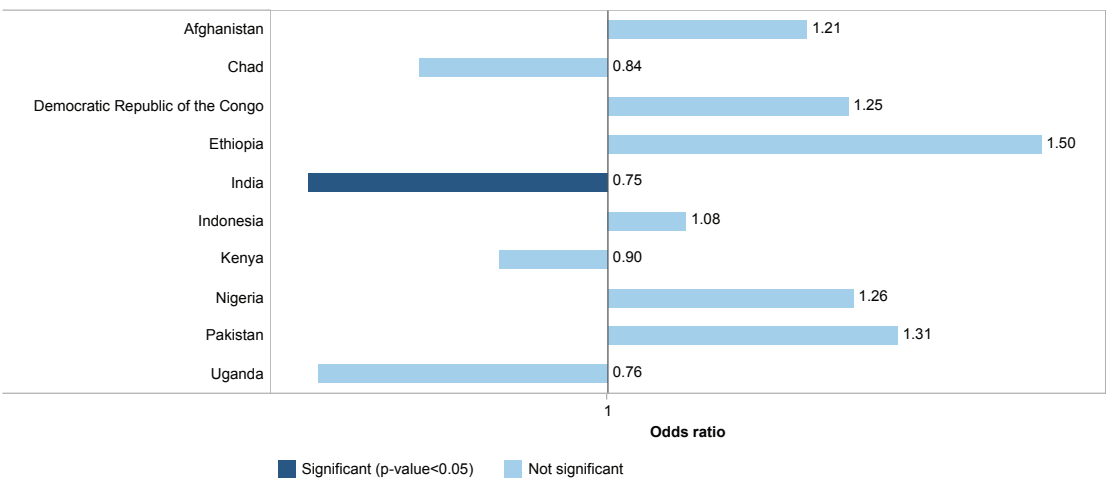
FIGURE 13.15. Adjusted associations between sex of household head and DTP3 immunization coverage among one-year-olds in 10 priority countries, calculated as odds ratio for females compared with males (DHS 2012–2016 and NFHS 2015)



Notes: The adjusted odds ratios compare females against the reference subgroup males, adjusting for other characteristics: child's sex; birth order; mother's age at birth; mother's education; mother's ethnicity or caste/tribe (where applicable); household economic status; place of residence; and subnational region. Afghanistan was not included in this analysis because nearly all households (99%) were headed by males.

In 9 out of the 10 priority countries, there was no statistically significant association between DTP3 immunization coverage and place of residence, after controlling for other factors (Figure 13.16). Children living in urban areas of India, however, had a significantly lower chance (0.75 times) of reporting high coverage comparing to those living in rural areas.

FIGURE 13.16. Adjusted associations between place of residence and DTP3 immunization coverage among one-year-olds in 10 priority countries, calculated as odds ratio for urban compared with rural (DHS 2012–2016 and NFHS 2015)



Note: The adjusted odds ratios compare the urban subgroup against the reference rural subgroup, adjusting for other characteristics: child's sex; birth order; mother's age at birth; mother's education; mother's ethnicity or caste/tribe (where applicable); sex of household head (except Afghanistan); household economic status; and subnational region.

14. Conclusion

Taking stock

For many countries, universal childhood immunization has not yet been achieved. Taking a closer look at the Gavi, the Vaccine Alliance 10 tier-1 countries – Afghanistan, Chad, Democratic Republic of the Congo, Ethiopia, India, Indonesia, Kenya, Nigeria, Pakistan and Uganda – this report described within-country inequalities in childhood immunization and probed further into factors associated with DTP3 coverage. Using comparable DHS and NFHS data and analysis methods, multicountry analyses were conducted to assess performance across the 10 countries.

The report conveys several important findings. Although the 10 priority countries were all home to large numbers of unvaccinated or under-vaccinated children, the magnitude and patterns of inequality varied markedly. The descriptive analyses of disaggregated data across different dimensions of inequality revealed certain similarities and differences across the 10 countries.

- None of the countries showed statistically significant inequality in childhood immunization based on child sex.
- Inequalities by mother's education, household economic status and subnational region were prevalent in nearly all countries, with variable patterns.
- In all five countries where disaggregated data by mother's ethnicity or caste/tribe were presented, inequalities were evident.
- All countries but one (Democratic Republic of the Congo) reported inequality by mother's age at birth.
- The majority of countries (8 out of 10) reported statistically significant higher coverage in urban than rural areas; in six of these countries, differences were larger than 10 percentage points.
- Most countries (7 out of 10) reported inequality by birth order with lowest immunization coverage among children born 6th or higher.

The ECI, a summary measure of absolute inequality, drew on data from all subgroups to express within-country inequality by wealth and education. Nine out of 10 countries (all but Uganda) showed wealth-related inequality that favoured richer households, and all 10 countries showed education-related inequality that favoured children with more-educated mothers. For both wealth and education, Nigeria had the most pronounced inequality, followed by Pakistan. Kenya and Uganda were the countries with the lowest levels of wealth- and education-related inequality.

Multiple regression analyses permitted a closer look at the associations between each of the selected factors and childhood immunization coverage, adjusting for other characteristics. In each of the 10 countries, the odds of childhood immunization coverage varied significantly across subnational regions. All countries demonstrated positive associations between mother's education level and childhood immunization coverage – in all countries but Uganda, this association was statistically significant (and in Uganda the association was nearly significant). Most countries, except for Uganda, reported positive associations between household economic status and childhood immunization coverage.

In several cases, the patterns of childhood immunization coverage suggested by the descriptive analyses were not significant after adjusting for other factors in the multiple regression analyses. For example, after adjusting for other factors, just one country (India) retained a significant association between coverage and place of residence.

Compounded vulnerability and advantage

Children who experience multiple forms of disadvantage are less likely to be vaccinated than children who experience a single type of disadvantage. For example, a child who lives in an underserved region may be at an increased risk of remaining unvaccinated if the child also belongs to a poor household. Conversely, children who belong to multiple subgroups that hold advantages are more likely to be covered. In many countries, children who are 1st born and whose mothers are highly educated have compounded advantage.

Certain living conditions and characteristics compound to exacerbate vulnerability or advantage. For instance:

In **Afghanistan** in 2015, a child of a teenaged mother with no education had one third the chance of being vaccinated as a child of a mother 20–49 years of age with secondary education or higher; if the child of the uneducated, teenaged mother belonged to the poorest 20%, this chance dropped to one ninth (compared to a child of a highly educated mother aged 20–49 years in the richest 20%).

In **Chad** in 2014–2015, a child of a mother aged 20–34 years with secondary education or higher and belonging to the richest 20% had up to 7.2 times higher chance of receiving DTP3 immunization compared with a child of a teenaged mother with no education, from the poorest 20% household.

In **Ethiopia** in 2016, the chance of receiving the third dose of DTP vaccine was 6.7 times higher for a child whose mother was 20–49 years of age and primary school educated, and who lived in a male-headed household, compared with a child of a teenaged mother with no education in a female-headed household.

In **India** in 2015–2016, children with highly educated mothers aged 20–49 years who belonged to the richest 20% of the population had a 5.3 times higher chance of being vaccinated, compared with children born to teenaged mothers with no education, in the poorest 20% of the population.

In **Indonesia** in 2012, a child who was part of a household in the richest 20%, and whose mother was aged 35–49 years, had a 6.4 times greater chance of being vaccinated compared to a child living in a household of the poorest 20%, and whose mother was a teenager.

In **Kenya** in 2014, children had a higher chance of being vaccinated if they belong to the richest 40% of households and their mother had at least primary school education: compared to those in the poorest 20% and whose mother had no education, their chances were 6.3 times higher.

In **Nigeria** in 2013, children of mothers aged 20–34 years who were highly educated, living in a rich household in the South South region were among the most advantaged in terms of childhood immunization: their chance of being vaccinated was 300 times higher than children with teenaged mothers with no education, living in poor households in the North West region.

In **Pakistan** in 2012–2013, a child of a mother aged 20–34 years with higher than secondary education and from the richest 20% of the population had a 28 times higher chance of being vaccinated, compared with a child of a teenaged mother with no education and from the poorest 20% of the population.

Note: the above examples do not necessarily represent the most advantaged or disadvantaged subgroups; there may be other combinations of compounded vulnerability and advantage.

Understanding the analysis

Evaluating performance based on national averages alone masks the situation in population subgroups. The analyses of this report drew from data disaggregated by a range of socioeconomic, demographic and geographic factors; these data lend insight into the gaps in childhood immunization coverage within countries. The findings help to reveal missed opportunities for childhood immunization by identifying poor-performing subgroups and suggesting factors associated with lower coverage.

This report is novel because it combined several types of analyses to yield a comprehensive multicountry overview of inequalities in childhood immunization and the factors that underlie immunization coverage. Descriptive analyses of disaggregated data set the stage of how coverage varied between subgroups. Expanding on this, concentration index, a summary measure of inequality, and concentration curves, the graphical demonstration, generated a concise representation of the situation across economic status and education subgroups, which could be compared across multiple countries (benchmarking). Then, multiple regression analyses provided a closer examination of factors that contributed to coverage. Taken together, these analyses provided more insight into explanations of national coverage and equity in immunization coverage and can be used to generate hypotheses for further investigation.

All analyses have limitations. An awareness of the relevant limitations of the underlying data and methods helps to avoid misinterpretation of the findings. In this report, the analyses drew from cross-sectional data, and thus claims about causality should be avoided. While the data used in this report were all collected as part of the DHS or NFHS, the year of the most recent available survey varied for the 10 countries, ranging from 2012 to 2016. National coverage of childhood immunization can fluctuate over time, and the findings should be understood as a reflection of the survey year.

The report covered only one indicator of childhood immunization (DTP3 immunization coverage), and the findings may not be directly applicable to other childhood immunization indicators. Limitations inherent to the underlying dataset were evident in this report (for example, the omission of certain subnational regions in Pakistan). For some countries, low sample sizes for certain ethnic and education subgroups necessitated the combination of multiple subgroups into one, changing the nature of the resulting analysis.

A more nuanced and detailed understanding of the results and their underlying data can be derived from the interactive visuals and tables that accompany the report. For all disaggregated estimates, the interactive visuals include information about population share – the percentage of the population that is represented by a given population subgroup. Population share offers important insight into interpreting findings that arise from disaggregated data and associations. For example, across countries, the percentage of children of mothers with no education varied: in Afghanistan, 81% belonged to the no education subgroup, whereas in Indonesia, less than 2% belonged to the no education subgroup. The interactive visuals and tables indicate where estimates were based on low sample sizes and include 95% confidence intervals for all estimates.

Moving forward

The 10 countries featured in this report each face a distinct situation with regard to childhood immunization coverage. When paired with in-depth knowledge of the country context nationally and locally – including the political situation, existing policies, living conditions, culture, etc. – the results of this report can be used to inform equity-oriented policies, programmes and practices to promote universal childhood immunization coverage.

Characteristic patterns of inequality can be linked to broad policy recommendations *(1)*. Generally, low national levels of coverage are best addressed by universally oriented policy approaches that

Innov8 approach for reviewing national health programmes to leave no one behind

The *Innov8 approach for reviewing national health programmes to leave no one behind* is a WHO resource that facilitates the application of national health inequality monitoring to national health programming. As part of the 8-step approach, Innov8 guides multidisciplinary review teams through identifying populations left behind, assessing barriers and facilitating factors, identifying mechanisms that lead to health inequalities, and strengthening monitoring and evaluation. For more information about *Innov8 approach for reviewing national health programmes to leave no one behind*, see: http://www.who.int/life-course/publications/innov8-technical-handbook/en/.

also promote accelerated improvements in disadvantaged subgroups. For instance, Chad, with low national coverage of 34%, would benefit from strengthening efforts aimed at overall improvement, with a focus on the five subnational regions that report coverage of 10% or less. Nigeria, a country with similarly low national coverage (39%), demonstrated elevated within-country inequality according to many dimensions. In addition to a focus on overall improvement, policy approaches in Nigeria require special consideration of: northern regions (especially the North West and the North East); poor households; families of less-educated women (nearly half of mothers have no education); rural residents; and male-headed households. In Afghanistan and Ethiopia, DTP3 coverage was fairly low overall, with pronounced inequality by certain characteristics, which indicate potential entry points for targeted policies and programmes. For instance, in Afghanistan, immunization coverage was almost zero among children of some ethnic groups (especially the Nuristanis), and regions (including Nooristan and Urozgan). Likewise, Ethiopia reported elevated inequality by mother's ethnicity, with Affar, Oromo and Somallie subgroups falling behind.

In contrast, countries with high inequality alongside higher national levels of coverage require a targeted policy approach that prioritizes the most vulnerable. For instance, Kenya, with 90% childhood immunization coverage, displayed marginal exclusion patterns of inequality across certain dimensions, indicating that renewed efforts are warranted to reach the poorest, least-educated and largest families. Relative to the other priority countries, Indonesia also had high national childhood immunization coverage at 72%. Policies targeted towards subgroups with lower coverage, such as larger families, poorer household, less-educated mothers, and those living in poor-performing regions (Banten, Maluku, Papua and West Kalimantan), would be positioned to reduce inequalities and further improve the national coverage.

Of the 10 priority countries featured in this report, Uganda reported the lowest levels of inequality. Here, sustained efforts, supported by ongoing monitoring, are warranted to ensure that inequalities in childhood immunization coverage are minimized, and that all children have the chance to benefit from immunization.

This report drew from the latest publicly available DHS and NFHS data to explore national performance and within-country inequalities. The findings of this report serve as a basis to identify areas for additional inquiry. The questions that arise from these findings are vast and may be pursued through diverse types of research. For example, expanded quantitative analyses can be performed to delve into questions related to the inequalities described in the report, such as how the national performance and within-country inequalities have changed over time and which factors are associated with these changes. In countries where the DHS or other national surveys have a very large sample size and/or are representative at the state or province level (including India, Indonesia and Pakistan), further studies can be done to interrogate factors associated with coverage at subnational levels. Investigations of a qualitative nature may explore the root causes and drivers of inequality. Qualitative studies are important in their own right, and to add context to quantitative findings, for example,

exploring how and why inequalities arise. WHO is now refining approaches (including qualitative methods) to assess demand- and supply-side barriers to effective coverage with health services *(2)*.

One emerging area for further exploration is childhood immunization among the urban poor. With rising rates of rural-to-urban migration in many countries, concerns about restricted access to health services, including childhood immunization, among those in informal settlements are mounting *(3–5)*. At present, however, there is a paucity of data available about these subpopulations, and the extent of inequality and its root causes are not fully understood. For instance, the DHS, a major source of household survey data in many low- and middle-income countries, does not systematically capture this population through its sampling design. Expanded and targeted data collection efforts, for both quantitative and qualitative research, are required to better understand this issue.

Ongoing monitoring and evaluation of childhood immunization, including inequalities, drivers and determinants, are important to systematically track the impact of policies and programmes, and to identify bottlenecks in programme delivery and implementation. To this end, health information systems should be strengthened to adequately collect, manage and analyse data, and report on information about health and health determinants. In many low- and middle-income countries, additional investments are needed to establish components of health information systems. This includes: data collection through population health surveys, facility-based administrative data, as well as civil registration and vital statistics and censuses; and capacity-building for data analysis and reporting.

Overall, sustainable and equity-oriented childhood immunization programmes rely on strong health systems that are attentive and responsive to the realities of the populations that they serve *(6)*. Equity-oriented health systems share certain characteristics: intersectoral action to promote health; inclusion of population groups and civil society; progression towards universal health coverage; and adoption of a comprehensive primary health care approach *(7)*. This report demonstrates that childhood immunization coverage is linked to factors beyond the health system. Coordinated efforts across health and other sectors should aim to reduce barriers to childhood immunization and reinforce strategies that work well.

Detailed explorations of health inequalities, encompassing multiple health topics and the factors that affect performance, contribute to wider ambitions to pursue sustainable development. Pledging that no one will be left behind, the United Nations 2030 Agenda for Sustainable Development requires a comprehensive understanding of where missed opportunities lie, and the barriers that impede progress.

References

1. Handbook on health inequality monitoring: with a special focus on low- and middle-income countries. Geneva: World Health Organization; 2013.
2. Towards universal coverage for preventive chemotherapy for Neglected Tropical Diseases: guidance for assessing "who is being left behind and why". Geneva: World Health Organization; 2017.
3. Awoh AB, Plugge E. Immunisation coverage in rural–urban migrant children in low- and middle-income countries (LMICs): a systematic review and meta-analysis. J Epidemiol Community Health. 2016 March;70(3):305–11.
4. Fotso J-C, Ezeh AC, Madise NJ, Ciera J. Progress towards the child mortality millennium development goal in urban sub-Saharan Africa: the dynamics of population growth, immunization, and access to clean water. BMC Public Health [Internet]. 2007 December (http://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-7-218, accessed 23 May 2018).
5. Soura AB, Mberu B, Elungata P, Lankoande B, Millogo R, Beguy D et al. Understanding inequities in child vaccination rates among the urban poor: evidence from Nairobi and Ouagadougou Health and Demographic Surveillance Systems. J Urban Health. 2015 February;92(1):39–54.
6. Brearley L, Eggers R, Steinglass R, Vandelaer J. Applying an equity lens in the Decade of Vaccines. Vaccine. 2013 April;31:B103–7.
7. Gilson L, Doherty J, Lowenson R, Francis V. Challenging inequity through health systems. Final report. Knowledge Network on Health Systems. WHO Commission on the Social Determinants of Health. Geneva: World Health Organization; 2007.

Appendix 1

Interactive tables contain the complete set of data from the 10 priority countries, for further reference. The information in these tables corresponds with the descriptive overview and multivariate regression analysis components of the report. The descriptive overview tables include national average, disaggregated data estimates, 95% confidence intervals and population share; cases of limited data availability are noted. The multivariate regression analysis tables include odds ratios and 95% confidence intervals, as well as information about the characteristics of the model.

Interactive tables

Interactive tables include information about disaggregated data and multiple regression models.

To access the interactive tables:

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

http://apps.who.int/gho/data/view.wrapper.HE-VIZ23?lang=en&menu=hide

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ISBN 978 92 4 156561 5

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