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Ethnic disparities in immunisation: analyses of zero-dose prevalence in 64 countries

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ABSTRACT

Background The Sustainable Development Goals (SDGs) recommend stratification of health indicators by ethnic group, yet there are few studies that have assessed if there are ethnic disparities in childhood immunisation in low-income and middle-income countries (LMICs).

Methods We identified 64 LMICs with standardised national surveys carried out since 2010, which provided information on ethnicity or a proxy variable and on vaccine coverage; 339 ethnic groups were identified after excluding those with fewer than 50 children in the sample and countries with a single ethnic group. Lack of vaccination with diphtheria–pertussis–tetanus vaccine—a proxy for no access to routine vaccination or 'zero-dose' status—was the outcome of interest. Differences among ethnic groups were assessed using a χ^2 test for heterogeneity. Additional analyses controlled for household wealth, maternal education and urban–rural residence.

Findings The median gap between the highest and lowest zero-dose prevalence ethnic groups in all countries was equal to 10 percentage points (pp) (IQR 4–22), and the median ratio was 3.3 (IQR 1.8–6.7). In 35 of the 64 countries, there was significant heterogeneity in zero-dose prevalence among the ethnic groups. In most countries, adjustment for wealth, education and residence made little difference to the ethnic gaps, but in four countries (Angola, Benin, Nigeria and Philippines), the high–low ethnic gap decreased by over 15 pp after adjustment. Children belonging to a majority group had 29% lower prevalence of zero-dose compared with the rest of the sample.

Interpretation Statistically significant ethnic disparities in child immunisation were present in over half of the countries studied. Such inequalities have been seldom described in the published literature. Regular analyses of ethnic disparities are essential for monitoring trends, targeting resources and assessing the impact of health interventions to ensure zero-dose children are not left behind in the SDG era.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ In 2020, there were 17 million children aged 12–23 months who failed to receive any doses of a diphtheria–pertussis–tetanus-containing vaccine. In alignment with the Sustainable Development Goal and Immunisation Agenda 2030 motto of leaving no one behind, it is essential to identify these children through disaggregated analyses of existing datasets. Ethnicity within low-income and middle-income countries (LMICs) is a likely determinant of access to services and immunisation coverage. Yet, a PubMed search, searching articles from the last 10 years, produced a single multicountry study investigating gaps in immunisation coverage by ethnicity in 16 Latin American countries. We did not find any studies with data from multiple LMICs assessing differences in zero-dose prevalence by ethnicity.

WHAT THIS STUDY ADDS

⇒ We studied 64 LMICs and the median gap between the highest and lowest zero-dose prevalence ethnic group was 10 percentage points (pp). Gaps of 50 pp or higher were found in five countries. In most countries, these differences persisted after adjustment for wealth, maternal education and area of residence. We also found that children belonging to the majority ethnic group in a country tended to have lower zero-dose prevalence compared with the rest of the population.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND/OR POLICY

⇒ In most LMICs, targeting by ethnic group is a potential strategy for reaching all children with immunisations. Our findings from 64 countries indicate which groups may be targeted. Regular analyses of ethnic disparities are also essential for monitoring trends over time and contribute to leaving no children behind with health interventions.

INTRODUCTION

The 2030 Agenda for Sustainable Development, adopted by all United Nations member states in 2015, and the WHO Immunization Agenda 2030 (IA2030) have as their motto 'leave no one behind' and thus prioritise the elimination of within-country disparities due to income, gender, age, race, ethnicity and other relevant

characteristics.[1] Specifically, IA2030 envisions 'a world where everyone, everywhere, at every age, fully benefits from vaccines to improve health and well-being' and has as one of its targets the reduction of the number of zero-dose children globally by 50% by 2030. Therefore, ensuring high and equitable coverage with vaccines is extremely relevant at a global level and represents one of the 'best buys' in global health.[2]

Analyses of inequalities in vaccine coverage within low-income and middle-income countries (LMICs) are plentiful in the published literature, as well as in reports and websites from international organisations, but these analyses usually focus on inequalities associated with socioeconomic position, maternal education, gender and area of residence.[3] Other relevant dimensions of inequality, such as ethnicity, remain poorly investigated in LMICs. When available, such analyses tend to be restricted to single-country analyses.[4–6] We found a single multicountry study on this topic, which reported on 16 countries from Latin America and the Caribbean. Using data collected from 2004 to 2015, this study revealed the presence of ethnic gaps in vaccine coverage in most countries studied.[7] These findings are not unexpected, given that ethnicity is a complex construct associated with health outcomes due to differences in health beliefs and behaviours.[8] Ethnicity is also relevant to the dissemination of health information. Often, ethnic groups differ in terms of unequal access to socioeconomic opportunities and to health services.

A comprehensive multicountry study of ethnic disparities in vaccinations is important for at least two reasons. First, it will help establish whether ethnic gaps in coverage are a widespread problem or whether these are only present in a few countries or world regions, as publication bias may result in overlooking countries where such gaps do not exist. Second, the study may help identify specific ethnic groups that have been hard to reach in selected countries, thus helping target future programmes.

To that end, we systematically identified publicly available household sample surveys from LMICs with information on diphtheria–pertussis–tetanus (DPT) vaccinations and on ethnicity or a proxy variable such as language spoken at home. We examined ethnic gaps in zero-dose prevalence as measured by lack of receipt of any doses of DPT-containing vaccine among children aged 12–23 months, and we assessed whether these gaps could be explained by differences among ethnic groups in terms of household wealth, maternal education or area of residence. We also assessed whether children belonging to the majority ethnic group in each country were more likely to be vaccinated than the remaining children in the country.

METHODS

Data sources and study samples

The survey database of the International Centre for Equity in Health includes all publicly available datasets from nationally representative Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS).[9 10] A total of 450 surveys from 124 countries were available for analyses. We identified 101 nationally representative DHS and MICS carried out from 2010 to 2019 in LMICs; 65 countries had information on immunisations and ethnicity or a proxy variable. Of these, Moldova was excluded due to the absence of any no-DPT children in the sample, and 64 countries (33 with DHS and 31 with MICS) were included in the analyses. Further information on the surveys is available elsewhere (DHS, https://dhsprogram.com/what-we-do/survey-Types/dHs.cfm, and MICS, http://mics.unicef.org/). Both survey programmes are highly comparable in terms of sampling and indicators.[11 12] Our sample included children aged 12–23 months from the 64 countries included. In Bosnia and Herzegovina (2011) and Peru (2019), we studied children aged 18–29 months because the measles vaccine is given after 12 months of age, in contrast to most countries where it is given at 9–12 months. Although measles vaccination is not included in our analyses, the use of these age ranges makes our indicator consistent with results from national survey reports and from recent publications on lack of vaccination.[13 14]

Immunisation indicator

The outcome variable—no-DPT prevalence—was defined as the proportion of children without any doses of a DPT-containing vaccine, including tetravalent and pentavalent vaccines. We used no DPT as a proxy for zero-dose children, that is, those who failed to have any routine vaccinations, to be consistent with the IA2030 monitoring definition of zero dose.[15] Information on immunisation status was extracted for children from two sources: vaccination cards or, when the child did not have a card or it was unavailable at the time of interview, the mother's or caregiver's report. We treated children with missing information on immunisation as not vaccinated.

Ethnicity indicators

Within each sampled household, women aged 15–49 years (DHS) or the head of the household (MICS) provided information on ethnicity or a proxy variable. These included self-reported ethnicity in 45 surveys, language spoken at home or by the household head in 17 surveys, skin colour and caste in one survey each (Cuba and India, respectively). In Latin America and the Caribbean, for consistency with earlier analyses, we grouped the ethnic variable into three categories as follows: reference (mostly individuals with European, or mixed European and indigenous ancestry), indigenous and Afrodescendants.[16] Our results show the ethnic group labels according to each survey dataset; some labels include more than one denomination, as was the case for Chad. We recoded

groups with fewer than 50 children into country-specific 'other' categories; if the 'other group' still included fewer than 50 children, these were excluded from all analyses. We defined majority ethnic group if half or more of the children in the sample belong to a given ethnic group in a country. For simplicity, we refer to ethnicity to indicate either ethnic group, language, skin colour or caste. A detailed listing of the ethnic groups in each country, including which one was classified as majority, is available in online supplemental tables 1 and 5.

Statistical analyses

We calculated crude and adjusted no-DPT prevalence and their 95% CIs by ethnic group as the marginal means from the prediction of a Poisson model with robust variance[17] in each country. The presence of variability among ethnic groups in a country was assessed using a χ^2 test for heterogeneity. The adjusted model tested whether wealth, education and residence explained the differences in no-DPT prevalence among ethnic groups. For both crude and adjusted prevalence, we calculated the coefficient of variation (CV) and highlighted ethnic groups with more precise estimates, CV <15%, (and CV <10% in the online supplemental materials) when presenting the results. We compared no-DPT prevalence between the highest-prevalence and lowest-prevalence ethnic groups in each country using differences and ratios. The statistical significance of the difference in no-DPT prevalence between the highest and lowest groups was assessed with an F-test. We described the distribution of prevalence differences and ratios using the median, IQR and range.

Also, we pooled all countries and fitted a Poisson model with robust variance[17] and fixed effect for countries to calculate crude and adjusted no-DPT prevalence ratios between the majority ethnic group (reference group) and all remaining children from the same country. Pooled results were weighted by the national population of children aged 12–23 months in 2016 (the median year of the surveys covered) obtained from the World Bank Population Estimates and Projections.[18]

The adjustment variables included maternal education, area of residence and wealth quintiles. Maternal education was coded in three groups based on self-report: none (no formal education); primary (any primary education, including completed primary education); and secondary or higher (any secondary education, including completed secondary education and partial or full higher education). Urban or rural residence was coded according to country-specific delimitations at the time of the survey. Household wealth indices included in the DHS and MICS datasets were used in the analyses. These were derived using principal component analyses of household assets and characteristics of the building, presence of electricity, water supply and sanitary facilities, among other variables associated with wealth. Because relevant assets may vary in urban and rural households, separate principal component analyses are carried out in each area, which are later combined into a single score using a scaling procedure to allow comparability between urban and rural households.[19]

The analyses were carried out with Stata (Stata Statistical Software V.17) and R (R Core Team V.4.1.0; R Foundation for Statistical Computing, Vienna, Austria) and accounted for the multistage survey design and sampling weights.

Role of the funding sources

Beyond the individual technical contributions of TMS and DRH, Gavi employees, the funders of the study had no role in the study design, data analysis, data interpretation or writing of the report. All authors had full access to the full data in the study and accept responsibility to submit for publication.

RESULTS

Sixty-four countries with 339 ethnic groups and a total of 168 846 children were studied. The number of ethnic groups ranged from 20 in Uganda to 2 in Costa Rica, Cuba, Dominican Republic, Guatemala, Iraq, Kyrgyzstan, Mexico, Myanmar, North Macedonia, Paraguay, Peru, South Africa, Suriname, Tajikistan, Thailand, Timor-Leste, Turkmenistan and Vietnam (table 1). In 38 countries, 50% or more of the children belonged to a single group, referred to as a majority group (online supplemental table 5).

Table 1 presents no-DPT prevalence in each country, in the largest ethnic group and in the lowest-prevalence and highest-prevalence (in terms of no-DPT) ethnic groups, as well as differences between the extreme groups in percentage points (pp), and the p value for the chi-test assessing heterogeneity in no-DPT prevalence among ethnic groups in each country. Online supplemental tables 2 and 3 show more detailed results, including the type of stratification variable (ethnicity, language, caste or skin colour), number of children, median no-DPT prevalence and high:low prevalence ratio for each country and no-DPT prevalence by ethnicity.

The median high–low no-DPT prevalence difference between ethnic groups was equal to 10 pp (IQR 4–22). Large prevalence gaps between extreme groups were observed in Afghanistan (84 pp), Chad (70 pp), Nigeria (57 pp), Philippines (60 pp) and Angola (50 pp). The median high:low prevalence ratio in all countries was 3.3 (IQR 1.8–6.7) (online supplemental table 2). In 35 of the 64 countries, there was significant heterogeneity in no-DPT prevalence among the ethnic groups (table 1 and online supplemental table 3). Among the remaining 29 countries, there were three (Central African Republic, Gambia and Papua New Guinea) where the 95% CIs of the two extreme groups did not overlap, although the overall test for heterogeneity showed p values above 0.05 (online supplemental table 3). Among these countries, the difference between the extreme groups ranged from 5 pp in Gambia (between ethnic groups Mandinka and others) to 24 pp in Central African Republic (between

Table 1 Countries included in the analyses, number of ethnic groups by country and no-DPT prevalence for ethnic groups

Country	Year	No-DPT prevalence (%)	P value for no DPT by ethnic group*	Ethnic groups (n)	Largest ethnic group			No-DPT prevalence by ethnic group				Difference (highest–lowest) in pp
					Percentage of all children in the group (%)	No-DPT prevalence (%)	95% CI	Lowest (%)	95% CI	Highest (%)	95% CI	
Afghanistan	2015	27	<0.001	9	40	34	28 to 40	15	6 to 23	99	97 to 100	84
Angola	2015	31	<0.001	9	63	21	18 to 24	16	9 to 23	66	47 to 86	50
Belize	2015	7	0.069	3	60	4	2 to 9	4	1 to 7	13	5 to 21	9
Benin	2017	16	<0.001	9	35	8	6 to 10	8	6 to 10	51	42 to 60	43
Bosnia and Herzegovina	2011	3	0.685	3	66	3	2 to 6	2	0 to 4	3	2 to 5	1
Burkina Faso	2010	6	<0.001	11	50	3	2 to 5	0	0 to 0	32	14 to 49	32
Cameroon	2018	17	0.111	7	68	18	15 to 22	8	3 to 14	28	19 to 37	20
Central African Republic	2018	45	<0.001	9	33	49	44 to 54	34	23 to 46	58	46 to 71	24
Chad	2014	42	<0.001	17	32	27	22 to 32	8	3 to 13	79	66 to 92	70
Colombia	2010	3	0.472	3	82	3	2 to 4	3	1 to 5	4	2 to 7	1
Congo Brazzaville	2014	14	<0.001	6	53	8	6 to 11	8	5 to 10	29	19 to 39	21
Congo, DR	2017	34	0.134	3	93	34	30 to 39	20	8 to 32	36	27 to 46	16
Costa Rica	2018	2	0.007	2	54	1	0 to 2	1	0 to 2	5	1 to 8	4
Côte d'Ivoire	2016	20	<0.001	6	26	23	18 to 28	10	7 to 13	25	20 to 31	16
Cuba	2019	3	0.025	2	67	1	1 to 3	1	1 to 2	5	0 to 10	4
Dominican Republic	2014	9	<0.001	2	91	8	6 to 9	8	6 to 9	22	16 to 27	14
Ethiopia	2016	27	<0.001	9	41	34	28 to 42	6	2 to 11	55	29 to 82	49
Gabon	2012	12	0.849	6	25	15	10 to 23	9	3 to 15	15	9 to 22	6
Gambia	2018	3	0.07	6	30	1	0;3	1	0 to 2	6	2 to 9	5
Ghana	2017	4	0.577	8	48	4	2;7	2	0 to 5	7	1 to 13	5
Guatemala	2014	2	0.003	2	53	1	1;2	1	1 to 2	4	3 to 5	3
Guinea	2018	38	<0.001	5	35	54	48;59	15	6 to 25	54	48 to 59	39
Guinea Bissau	2018	7	0.166	7	34	8	5 to 13	1	0 to 3	11	1 to 21	10
Guyana	2014	4	0.658	3	54	4	2 to 9	4	1 to 7	6	2 to 10	2
Honduras	2011	1	0.106	3	88	1	1 to 2	0	0 to 0	1	1 to 2	1
India	2015	10	<0.001	3	89	10	10;11	10	10 to 11	14	13 to 16	4
Iraq	2018	13	0.015	2	83	14	12;17	7	3 to 11	15	12 to 17	8
Jordan	2017	7	0.009	3	84	6	5 to 9	6	5 to 8	20	3 to 36	13
Kazakhstan	2015	4	0.001	3	73	3	2 to 5	3	2 to 4	13	5 to 21	10
Kenya	2014	2	<0.001	15	18	2	1 to 6	0	0 to 1	11	7 to 16	11
Kyrgyzstan	2018	9	0.179	2	84	8	5;12	8	5 to 11	14	5 to 22	6
Laos	2017	27	<0.001	4	57	19	16;22	19	16 to 22	43	37 to 49	24
Malawi	2015	3	0.136	9	34	2	1 to 4	1	0 to 3	7	2 to 12	6

Continued

Table 1 Continued

Country	Year	No-DPT prevalence (%)	P value for no DPT by ethnic group*	Ethnic groups (n)	Largest ethnic group			No-DPT prevalence by ethnic group				Difference (highest–lowest) in pp
					Percentage of all children in the group (%)	No-DPT prevalence (%)	95% CI	Lowest (%)	95% CI	Highest (%)	95% CI	
Mali	2018	18	<0.001	9	32	15	11 to 21	8	4 to 13	52	32 to 71	44
Mauritania	2015	14	0.06	3	80	15	12 to 18	15	12 to 17	25	9 to 41	10
Mexico	2015	8	0.365	2	91	8	5 to 11	8	5 to 10	11	4 to 17	3
Mongolia	2018	3	0.001	3	79	3	1 to 5	2	0 to 4	12	4 to 20	10
Montenegro	2013	6	0.338	3	53	3	1 to 9	4	0 to 7	11	0 to 22	7
Mozambique	2015	10	0.001	8	32	11	4 to 25	1	0 to 3	27	9 to 45	26
Myanmar	2015	13	<0.001	2	84	11	8 to 14	11	8 to 14	26	15 to 37	15
Namibia	2013	7	0.416	7	52	6	3 to 9	6	3 to 8	19	3 to 35	13
Nepal	2019	11	0.049	8	45	12	9 to 16	4	0 to 9	21	9 to 34	17
Niger	2012	14	<0.001	4	74	15	12 to 19	5	3 to 8	40	29 to 50	35
Nigeria	2018	35	<0.001	10	34	55	52 to 59	6	4 to 8	64	58 to 69	57
North Macedonia	2018	4	0.567	2	63	2	1 to 4	2	0 to 3	3	0 to 9	1
Pakistan	2017	14	<0.001	7	37	3	1 to 6	1	0 to 2	28	21 to 35	27
Panama	2013	8	0.02	3	65	6	4 to 11	5	1 to 9	14	8 to 19	9
Papua New Guinea	2016	36	0.148	3	57	36	31 to 41	15	1 to 29	38	32 to 45	24
Paraguay	2016	5	0.085	2	58	4	3 to 6	4	2 to 6	7	4 to 9	3
Peru	2019	5	0.156	2	94	5	4 to 6	5	4 to 6	7	4 to 10	2
Philippines	2017	13	<0.001	9	28	8	5 to 13	4	1 to 7	64	49 to 79	60
Senegal	2019	4	0.272	5	43	3	1 to 5	2	0 to 4	6	2 to 9	4
Sierra Leone	2019	5	<0.001	7	36	6	4 to 9	0	0 to 0	9	0 to 18	9
South Africa	2016	9	0.722	2	91	9	6 to 13	8	1 to 15	9	6 to 12	2
Suriname	2018	20	0.35	2	64	18	13 to 25	18	12 to 24	23	15 to 30	4
Tajikistan	2017	8	0.524	2	84	8	6 to 10	6	2 to 11	8	6 to 10	2
Thailand	2019	3	<0.001	2	91	2	1 to 4	2	1 to 3	15	2 to 29	13
Timor-Leste	2016	22	0.307	2	94	22	19 to 25	15	4 to 26	22	19 to 25	7
Togo	2017	9	0.408	4	37	10	7 to 16	6	2 to 10	12	4 to 21	7
Turkmenistan	2015	1	<0.001	2	91	1	0 to 2	0	0 to 0	1	0 to 1	1
Uganda	2016	5	0.072	20	15	6	3 to 10	1	0 to 2	15	1 to 30	15
Vietnam	2013	4	<0.001	2	85	2	1 to 4	2	1 to 4	12	6 to 18	10
Zambia	2018	2	0.099	8	37	2	1 to 4	1	0 to 2	10	0 to 23	10
Zimbabwe	2019	5	<0.001	3	84	6	4 to 9	0	0 to 0	6	4 to 8	6

Lowest refers to the ethnic group with the lowest no-DPT prevalence in the country. Highest refers to the ethnic group with the highest no-DPT prevalence in the country.
*χ^2 test for heterogeneity in no-DPT prevalence among all ethnic groups in each country.
no-DPT, children who did not received any doses of the diphtheria–pertussis–tetanus-containing vaccine; pp, percentage points.

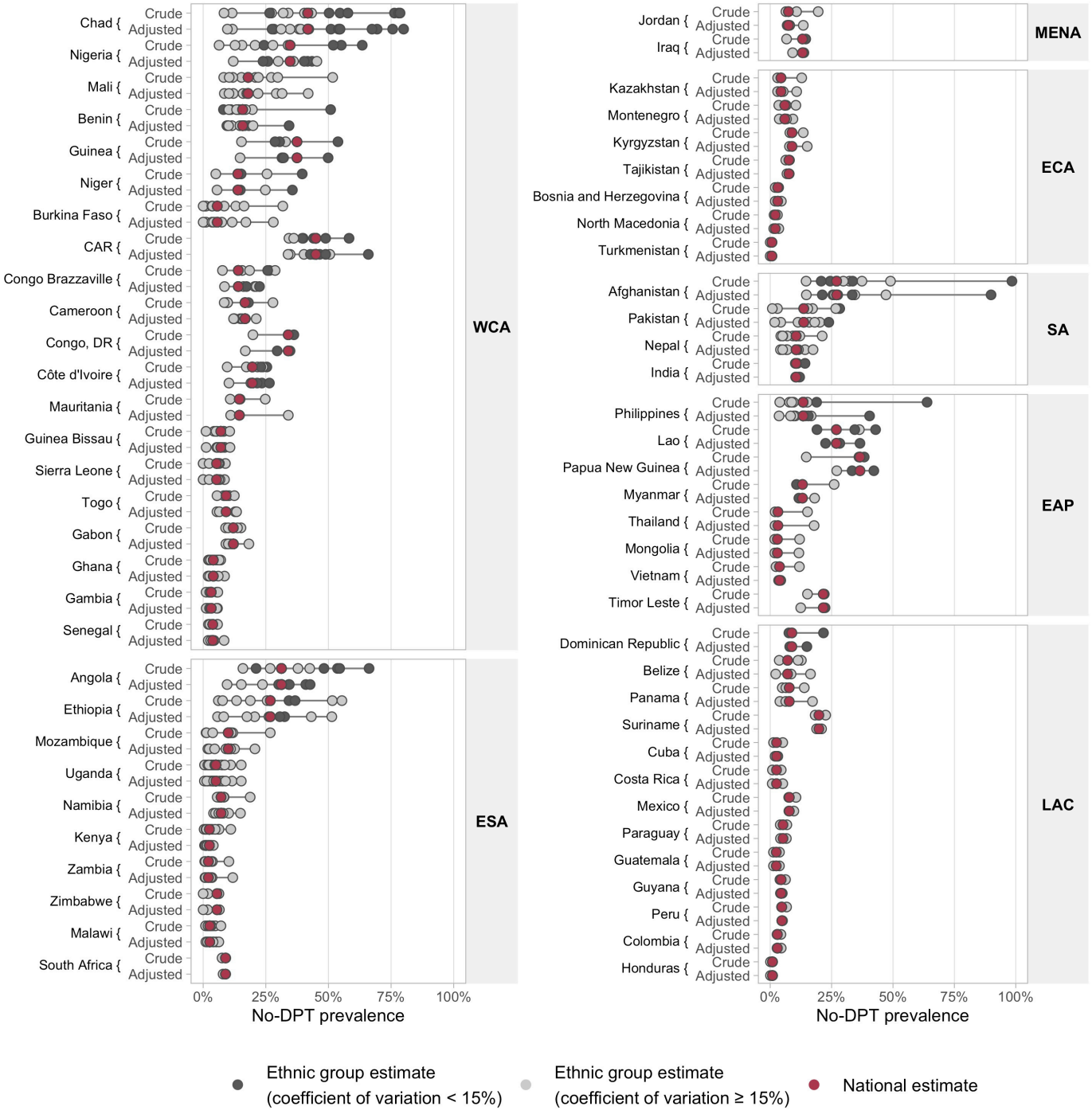

Figure 1 No-DPT prevalence by ethnic group in 64 countries. Black circles represent groups for which the coefficient of variation for prevalence was less than 15%. EAP, East Asia and The Pacific; ECA, Europe and Central Asia; ESA, Eastern and South Africa; LAC, Latin America and Caribbean; MENA, Middle East and North Africa; no-DPT, children who did not received any doses of the diphtheria–tetanus–pertussis-containing vaccine; SA, South Asia; WCA, West and Central Africa.

ethnic groups Mandja and Yakoma/Sango (table 1 and online supplemental table 3).

In 25 countries, at least one ethnic group presented no-DPT prevalence of 10 pp or more above the national average. Fifty-six ethnic groups in 15 countries showed 95% CIs for no-DPT prevalence that were fully above 20% (online supplemental table 3). At the other end of the prevalence range, 119 ethnic groups from 40 countries showed 95% CIs below 10%.

Figure 1 shows no-DPT prevalence by ethnic groups in the 64 countries grouped by region of the world. Two lines are shown per country, the top one with the crude and another with the adjusted prevalence levels. The national prevalence is shown as a red circle. More precise prevalence estimates (CV <15%) are shown as black circles and less precise estimates as grey circles. Our sensitivity analyses in online supplemental figure 2 show groups with CV of <10% as black circles, showing that fewer groups are

now highlighted, due to the more stringent cut-off. Full results and CIs are shown in online supplemental table 3, to which readers may refer to if interested in how adjustment influenced no-DPT prevalence in each country.

Adjustment for household wealth, maternal education and urban–rural residence made little difference in no-DPT prevalence gap in most countries. Among the 35 countries with statistically significant ethnic differences in the crude analyses, 26 remained significant in the adjusted analyses (online supplemental table 3). Six countries with non-significant differences in the crude analysis presented p values under 0.05 in the adjusted analysis: Belize, Central African Republic, Mauritania, Papua New Guinea, Togo and Uganda.

In 19 countries the high–low ethnic gap changed by more than 5 pp (17 countries showing a reduction and 2 an increase in the gaps) after adjustment for covariates (figure 1). The changes were greater than 15 pp in Angola (17 pp), Benin (18 pp), Nigeria (26 pp) and the Philippines (24 pp), in all of which the gaps were narrowed down after adjustment. Increases in the ethnic gaps above 5 pp due to adjustment were seen only in the Central African Republic (7 pp) and Mauritania (9 pp).

We zoomed in on the 10 countries with the highest absolute gap in terms of no-DPT prevalence (figure 2). Afghanistan and the Philippines stand out for each having a group (Nuristani and Maranao, respectively) with markedly higher no-DPT prevalence than any other ethnic group. Results for all countries are presented in online supplemental figure 1 and table 3. Some ethnic groups are present in more than one country. For example, the Baloch or Baluchi show high no-DPT prevalence in both Afghanistan (49.0%) and Pakistan (27.9%). The Fula (also Peulh, Fulani, Fullah and similar denominations) are present in 10 countries in the analyses, with no-DPT prevalence ranging widely from 0.0% in Sierra Leone to 63.5% in Nigeria. Online supplemental table 4 shows these and other examples of groups with no-DPT prevalence higher than 10% present in more than one country.

Among the 40 Gavi eligible countries in the sample, 72.5% had significant ethnic gaps in no-DPT prevalence between the extreme groups, with a median gap of 15.6 pp in Gavi countries and 5.2 pp in non-Gavi eligible countries. The highest median differences were found in the South Asia (22.1 pp) and West and Central Africa (17.9 pp) regions and in countries with more than eight ethnic groups (43.5 pp). Online supplemental table 6 shows the median no-DPT prevalence and the median high–low ethnic gaps according to Gavi eligibility status, UNICEF world regions, World Bank country income groups, number of ethnic groups and three ranges of no-DPT prevalence.

Lastly, we identified the 38 countries (59% of all countries) in which a single ethnic group comprised most of the children in the sample (a majority group) and compared their no-DPT prevalence with all the other groups combined using national child population

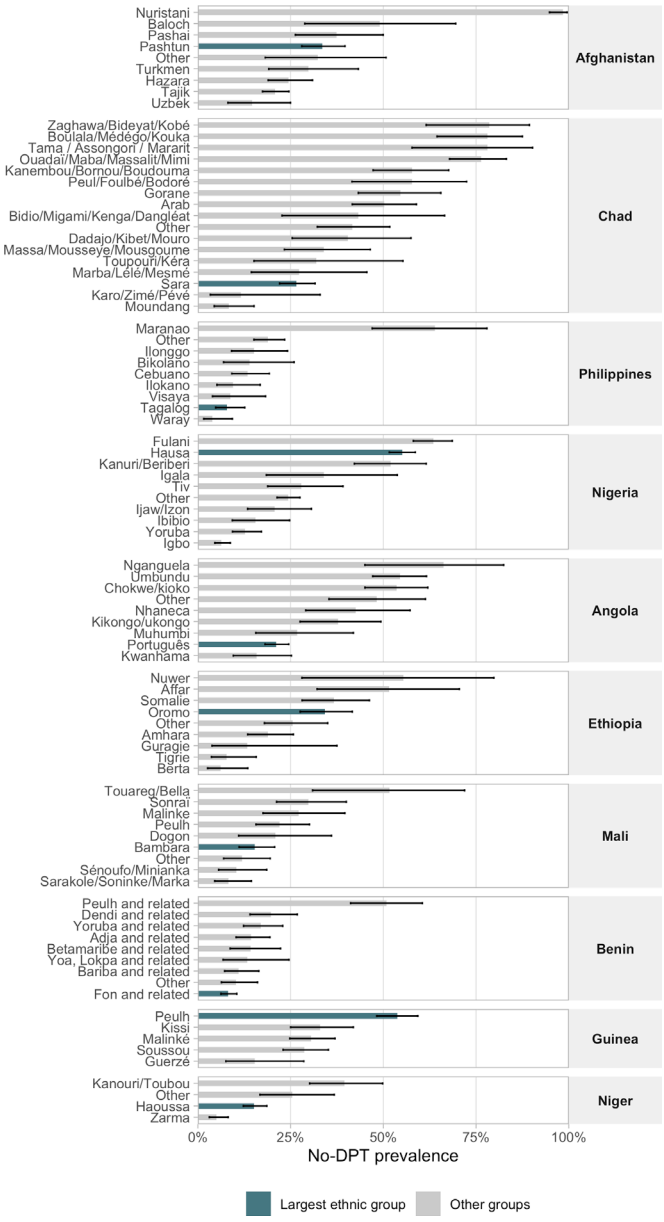

Figure 2 No-DPT prevalence according to ethnic group in the 10 countries with the highest absolute ethnic gaps. No-DPT, children who did not receive any doses of the diphtheria–tetanus–pertussis containing vaccine.

weights for pooling results. Children from the majority ethnicity tended to have lower no-DPT prevalence than those from the remaining groups in the same country. The crude prevalence ratio in the majority group relative to the rest of the population was equal to 0.71 (95% CI 0.66 to 0.77), while after adjustment for the three covariates, the ratio changed to 0.82 (95% CI 0.76 to 0.88). Further adjustment for sex of the child did not change the results (Prevalence Ratio (PR)=0.82, 95% CI 0.76 to 0.89).

DISCUSSION

We believe that this is the largest ever set of analyses on immunisation coverage according to ethnicity, covering

339 ethnic groups in 64 LMICs. Our results show that significant variability in no-DPT prevalence according to ethnicity was detected in more than half of the countries studied. We also showed that the largest ethnic group in each sample was not always the group with the lowest no-DPT prevalence among all ethnicities, but our pooled analyses showed that children belonging to the majority group tended to show higher coverage than all other children in the same country.

Studies from single LMICs have reported ethnic differences in immunisation coverage, as was the case in studies from China, Kenya, the Philippines and Pakistan.[4–6 20] We were only able to identify one multicountry study on immunisation coverage—in this case, with three DPT doses—by ethnic group; the analyses included 16 countries from Latin America and the Caribbean and relied on data collected from 2004 to 2015.[7] In three countries (Nicaragua, Panama and Paraguay), indigenous children had significantly lower coverage than the reference group composed of children of European or mixed ancestry. It should be noted, however, that immunisation coverage tends to be much higher in Latin America than in most LMICs.[21] None of the studies identified in our literature search reported on no-DPT children according to ethnicity. Given the current emphasis on reaching zero-dose children, there is a clear need for such studies to guide policy.

The literature, mostly from high-income countries, suggests that while adjusting for sociodemographic variables when comparing health outcomes among ethnic groups often attenuates disparities, these still persist.[22] In our own analyses, ethnic gaps did not change markedly in most countries after adjustment for maternal education, household wealth and urban–rural residence. The exceptions included Angola, Benin, Nigeria and the Philippines, where the results suggest that socioeconomic factors account for a substantial proportion of the gaps. In many countries where the gaps persisted after adjustment, ethnic-based discrimination affecting the deployment and population access to essential services may account for much of the observed disparities. These differences could also reflect subnational variations in access, as some ethnic groups are highly concentrated in specific areas. For example, in Kenya, the largest no-DPT prevalence was found among Somali children who live in the Northeast of the country, and in the Philippines, the Maranao children, who inhabit a well-delimited area of Mindanao island, show much higher no-DPT prevalence that in any other ethnic group in the country.

Our analyses have limitations, which include the use of self-reported ethnicity or proxy variables; this also applies to most studies of ethnic disparities in health.[23] The way by which different ethnic groups were classified depended on the agencies that developed questionnaires for each country, which may not have used consistent approaches, as is suggested by the wide variability in the number of groups among countries. Also, many survey datasets include some groups labelled as 'other ethnicities'; due to sample size limitations, we also included in this category additional ethnic groups with fewer than 50 children in the sample. A particular case is that of India, where the ethnicity variable included only three groups: (any) caste, no caste or tribe, and tribe, with 89.0%, 3.8% and 7.2% of all children, respectively. This classification showed that no-DPT prevalence range, from 10.2% among the former to 14.2% among the latter, but further breakdown showing the main castes would have been useful.

Our option for not reporting estimates for groups with small numbers of children has led to the omission of some potentially informative ethnic groups in some countries, for example, white ethnic groups in South Africa. In addition, there may be inconsistencies between successive surveys in some countries; for example, the Nigeria 2016 MICS recognised only four groups, whereas the 2018 DHS used in the present analyses identified 10 groups plus an other category (online supplemental table 1). One should also note that some ethnic groups, such as nomads or those living in conflict-afflicted areas, may be under-represented in the sample. An additional limitation refers to the fact that surveys included in the analyses took place over a 9-year period, although we gave preference to more recent surveys when more than one existed for the same country. For countries without recent surveys, our findings may fail to describe the current situation.

In as much as we would like to calculate summary measures of inequality in order to rank countries according to the overall magnitude of ethnic gaps, such measures tend to show higher values in countries with many ethnic groups than for countries with few groups. In our analyses, significant differences between the highest and lowest ethnic groups in terms of zero-dose prevalence ($p<0.05$) were observed in 45% of countries with two to three groups, 61% of those with four to eight groups, and in all but one country with nine or more groups (online supplemental table 6). This limitation affects all summary measures of inequality for unordered categories.[24 25]

Our analyses are limited to countries with recent surveys providing data both on ethnicity and DPT coverage. We examined surveys from over 100 countries to identify 64 that could be included in the present analyses. Whether or not our results may be generalised to other LMICs is debatable, but the fact that most countries showed significant ethnic gaps in no-DPT prevalence suggests that such inequalities may be present in countries that were not studied.

The purpose of our analyses was to present a broad picture of inequalities according to ethnic groups in access to immunisation based on recent national surveys. A detailed examination of the national contexts in which these inequalities exist is beyond the scope of the present analyses, but we hope that our results will motivate national researchers and other country actors to delve deeper into these disparities and their determinants.

Further research may include an examination of the drivers of immunisation inequalities in different countries and comparisons between countries with contrasting patterns of ethnic group inequalities. Attention should also be given to investigate why some groups that cross national boundaries, such as the Fula or Baloch, often show wide differences in coverage among countries where they are present.

Ideally, equity-oriented health programming and research on health inequalities should rely on multiple stratification variables. Although wealth and educational inequalities are useful for advocacy purposes and for monitoring time trends, they are often insufficient for targeting interventions at specific groups, as the poor and uneducated may be spread throughout a country. Geographical inequalities are better suited for targeting, but within a given province or district, there may be important disparities, as is the case for large metropolitan areas. Stratification of health indicators according to ethnicity will likely contribute to existing analyses in terms of monitoring, targeting of interventions to easily defined population subgroups, and evaluating the equity impact of health services and programmes. Given that ethnicity appears to be a significant predictor of immunisation status in many LMICs, we advocate for greater attention to recording ethnicity in surveys and—in particular—in routine health information systems.

In summary, we find it astonishing that ethnicity has not been studied as an important driver of health inequalities in LMICs, particularly in terms of immunisation coverage. Ethnicity is a complex concept encompassing culture, language and ancestry, which acts as a determinant of health beliefs and behaviours.[8] It also affects social cohesion and therefore the dissemination of health information. In many, if not most, countries, ethnicity drives unequal access to socioeconomic opportunities and use of public goods including health services. As such, we show that ethnicity is an important determinant of immunisation inequalities in many LMICs that should be considered in order to reach zero-dose children and the communities where they live, thus ensuring that no child is left behind.

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