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Country-level predictors of vaccination coverage and inequalities in Gavi-supported countries

Catherine Arsenault [a,*], Mira Johri [b,c], Arijit Nandi [a,d], José M. Mendoza Rodríguez [e], Peter M. Hansen [f], Sam Harper [a,d]

[a] Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Montreal, Canada
[b] Centre de recherche du Centre Hospitalier de l'Université de Montréal (CRCHUM), Montreal, Canada
[c] Département de gestion, d'évaluation et de politique de santé, École de santé publique de l'Université de Montréal (ESPUM), Montreal, Canada
[d] Institute for Health and Social Policy, McGill University, Montreal, Canada
[e] Statistics Canada, Ottawa, Canada
[f] Gavi, the Vaccine Alliance, Geneva, Switzerland

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ABSTRACT

Background: Important inequalities in childhood vaccination coverage persist between countries and population groups. Understanding why some countries achieve higher and more equitable levels of coverage is crucial to redress these inequalities. In this study, we explored the country-level determinants of (1) coverage of the third dose of diphtheria-tetanus-pertussis- (DTP3) containing vaccine and (2) within-country inequalities in DTP3 coverage in 45 countries supported by Gavi, the Vaccine Alliance.
Methods: We used data from the most recent Demographic and Health Surveys (DHS) conducted between 2005 and 2014. We measured national DTP3 coverage and the slope index of inequality in DTP3 coverage with respect to household wealth, maternal education, and multidimensional poverty. We collated data on country health systems, health financing, governance and geographic and sociocultural contexts from published sources. We used meta-regressions to assess the relationship between these country-level factors and variations in DTP3 coverage and inequalities. To validate our findings, we repeated these analyses for coverage with measles-containing vaccine (MCV).
Results: We found considerable heterogeneity in DTP3 coverage and in the magnitude of inequalities across countries. Results for MCV were consistent with those from DTP3. Political stability, gender equality and smaller land surface were important predictors of higher and more equitable levels of DTP3 coverage. Inequalities in DTP3 coverage were also lower in countries receiving more external resources for health, with lower rates of out-of-pocket spending and with higher national coverage. Greater government spending on heath and lower linguistic fractionalization were also consistent with better vaccination outcomes.
Conclusion: Improving vaccination coverage and reducing inequalities requires that policies and programs address critical social determinants of health including geographic and social exclusion, gender inequality and the availability of financial protection for health. Further research should investigate the mechanisms contributing to these associations.

1. Background

Every year, vaccines help prevent an estimated 2.5 million child deaths and they have the potential to prevent many more, as new vaccines are introduced against some of the main causes of child mortality, including pneumonia, diarrhea and malaria [1,2]. However, many children worldwide still do not receive the basic childhood vaccines that were developed several decades ago [3]. Although progress has been made, important inequalities remain in vaccination coverage between and within countries.

Coverage with the third dose of diphtheria-tetanus-pertussis-containing vaccine (DTP3) has reached an average of 96% in high-income countries, but remains at 78% across low-income regions [4]. Some countries face even worse coverage levels. In Guinea, only 51% of children receive DTP3 in their first year of life [4]. Coverage may be even lower among certain population groups. For example, education, geographic location, household wealth and multidimensional poverty are important determinants of child

* Corresponding author at: Department of Epidemiology, Biostatistics and Occupational Health, McGill University, 1020 Pine Avenue West, Montreal, Quebec H3A 1A2, Canada.
E-mail address: catherine.arsenault@mail.mcgill.ca (C. Arsenault).

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vaccination that contribute to social inequalities in coverage within countries [5–8].

Gavi, the Vaccine Alliance is a global public-private partnership that emerged from a global recognition of the need to address inequalities in access to vaccines. Improving coverage and equity is thus at the core of Gavi's strategy for 2016–2020 [9]. Understanding why some countries achieve higher and more equitable levels of coverage is crucial to the development of strategies to redress these inequalities. In this study, we explored the country-level factors associated with (1) DTP3 coverage and (2) within-country inequalities in DTP3 coverage, across 45 Gavi-supported countries. To our knowledge, this is the first study to explore the role of national health systems, health financing, governance, and geographic and sociocultural factors on the degree of within-country inequalities in vaccination coverage.

2. Methods

2.1. Data sources

We used data from the Demographic and Health Surveys (DHS). The DHS are nationally representative household surveys that have been conducted in most low- and middle-income countries (LMIC) since 1984. The DHS collect data on a wide range of population health indicators with a strong focus on maternal and child health [10]. Trained interviewers and standardized questionnaires help to ensure that the data collected is comparable across countries [11]. Vaccination status is ascertained by looking at vaccination cards and through maternal recall. We limited our analyses to Gavi-supported countries with recent (2005–2014) DHS containing data on vaccination, leading to a sample of 45 countries. Data on health systems, health financing, governance and geographic and sociocultural contexts were obtained from the World Bank's World Development Indicators database, the WHO's Global Health Expenditure database, the World Bank's Worldwide Governance Indicators project, the United Nations Development Program's (UNDP) Human Development Report and from Alesina et al. (2003) [12–16].

2.2. Measures

2.2.1. Dependent variables

In each country, we constructed four dependent variables: national DTP3 coverage, and three measures of absolute inequalities in DTP3 coverage with respect to the wealth index, maternal education and the multidimensional poverty index (MPI).

National DTP3 coverage was estimated in each country by the proportion of children aged 12–23 months having received DTP3-containing vaccine at the time of the survey. We repeated the analyses for coverage with measles-containing vaccines (MCV) to assess whether the results were consistent. Coverage levels for DTP3 and MCV are widely accepted as standard indicators of immunization system performance [17].

Because the magnitude of inequality can differ considerably across different dimensions of vulnerability, we measured inequalities using three different indicators: the wealth index, maternal education and the multidimensional poverty index [5,6]. We used the wealth index constructed by the DHS, based on a household's ownership of selected assets, housing materials, and access to clean water and sanitation [18]. We also used maternal education, measured by a variable with six levels of educational attainment and completion (no education, incomplete primary, complete primary, incomplete secondary, complete secondary, higher education (attended)). Finally we used the MPI, a measure of overlapping household-level deprivations with respect to health, education and living standards. The MPI is constructed using 10 indicators available in the DHS: child mortality, malnutrition, school attendance, educational attainment, ownership of assets, housing materials, sanitation, water, electricity and cooking fuel. A continuous score for each household is calculated based on the weighted sum of deprivations [19].

We measured absolute inequalities in DTP3 coverage across these three indicators using the Slope Index of Inequality (SII). We focused on absolute rather than relative measures of inequality because the former provide an indication of the total population burden of inequalities by considering absolute number of vaccinated children rather than relative rates [20]. To calculate the SII, households were first ordered from lowest to highest rank and assigned a relative ranking (from 0 to 1) based on their position in the cumulative distribution of each indicator. The SII was obtained by regressing the child's vaccination status on her or his relative rank. We used logistic regression models and post-estimation procedures to obtain the SII. The SII denotes the percentage point difference in the expected DTP3 coverage at the top compared to the bottom of the social dimension measured by each indicator, assuming a linear relationship between rank and vaccination [21]. A SII value of zero means that coverage is, on average, distributed equally across social groups, whereas positive SII values indicate greater coverage among more socially advantaged groups. We applied household-level survey weights provided by the DHS to all regression models.

2.2.2. Country-level predictors

To guide the selection of country-level predictors, we used a conceptual framework developed by the Commission on Social Determinants of Health [22]. We selected 12 characteristics related to country health system, health financing, governance and the geographic and sociocultural context.

Health system

We included the country's national average vaccination coverage (also used as a dependent variable) as a potential predictor of inequalities. We also included the number of nurses/midwives and community health workers per 1000 people [12].

Health financing

We included the amount of government expenditure on health per capita and the per capita amount of external resources for health received by each country [13]. External resources relate to the amount of funds dedicated to health received from non-resident institutional units. These funds are channeled locally through either the government or private sectors [23]. We also included the share of out-of-pocket spending on health, defined as the proportion of a country's total health expenditure that is made directly by households at the point of service [13].

Governance

We included the Worldwide Governance Indicators (WGIs) for political stability and absence of violence, government effectiveness and control of corruption [14]. The WGIs report the views and experiences of citizens and professionals in the private, public and non-governmental sectors, on the quality of various aspects of governance. Estimated in 215 economies, the WGIs are expressed in units of a standard normal distribution, with mean zero and standard deviation of one, with higher values corresponding to better governance.

Geographic and sociocultural context

Finally, we included the country's land area (in millions of square kilometers) and two sociocultural characteristics: the linguistic fractionalization index and the Gender Inequality Index (GII) [12]. Linguistic fractionalization estimates the degree of social