Reporting immunization coverage inequalities in Pakistan
Nicole Bergen,1 Grace Zhu 1 and Katherine Kirkby 2

1University of Ottawa, Ottawa, Canada. (Correspondence to: N. Bergen: nicolebergen@gmail.com). 2World Health Organization Headquarters, Geneva, Switzerland.

Abstract

Background: Immunization coverage in Pakistan is unequally distributed. Understanding the current status of reporting of immunization coverage inequalities in Pakistan can help to identify gaps and opportunities for strengthened monitoring and reporting.

Aims: To assess the published literature on immunization coverage inequality measurement and reporting in Pakistan.

Methods: We performed a literature search in PubMed in April 2019 to obtain articles reporting inequalities in immunization coverage in Pakistan. A data extraction rubric was applied to collate information about data sources, immunization indicators and dimensions of inequality.

Results: We included 42 studies in our analysis. Most studies reported data from household surveys or research studies. Dimensions of inequality reflected geography (primarily provinces/territories), economic status, place of residence, education level, sex and occupation. District-level comparisons were featured in 5 studies that were subnational in scope.

Conclusions: Expanded monitoring at district level is warranted as a major way forward in characterizing immunization inequalities in Pakistan.

Keywords: Pakistan, inequality, immunization coverage

Introduction

Despite recent national improvements to immunization coverage in Pakistan (1), the country has not yet realized the full benefits of immunization. The reasons why Pakistan trails behind in terms of immunization can be traced to political, geographical and sociocultural forces, which are experienced differently throughout the country (2,3). As a result, Pakistan has high levels of immunization coverage inequality, with marked differences according to parental education, household economic status, subnational region and other factors (4,5).

Health inequality monitoring methods can be used to measure and track immunization coverage differences between subgroups within a target population (6,7). Inequality monitoring can help to identify where immunization coverage inequalities exist, and the characteristics of disadvantaged subgroups. Among other factors, the inequality monitoring process is premised on data availability and the identification of population subgroups that reflect relevant (and actionable) dimensions of inequality.

A comprehensive overview of how inequality monitoring efforts have assessed immunization coverage in Pakistan is warranted to characterize the current scope of monitoring, reveal gaps in monitoring, and indicate opportunities to strengthen and expand monitoring. Here, we report the results of a systematic survey of published literature about immunization coverage inequality in Pakistan between 2000 and 2019, with a focus on data sources and dimensions of inequality. The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated.

Methods

Two of the authors performed a systematic literature search on PubMed (Medline) in April 2019. The search strategy used Boolean operators, Medical Subject Headings terms and title/abstract keywords to search for articles on Pakistan and immunization. Filters were applied to refine the search criteria according to language (English) and date (after 2000) of publication. The search results were screened in 2 stages: first by title and abstract, and then by full text. The following inclusion criteria were applied: (1) full text of article available online; (2) article pertained to humans; (3) article reported immunization coverage for Pakistan; (4) article contained disaggregated data for immunization coverage in Pakistan; (5) article stated the data source; and (6) article reported monitoring of immunization coverage according to demographic, sociocultural or geographic factors, or other perceived sources of systemic discrimination. Articles that evaluated the impact of an intervention or trial were not included. A data extraction rubric was used to extract key information from articles included at the full-text review stage. The rubric collected standardized and freeform information, including: publication details, target population, data sources, immunization indicators, disaggregation criteria and...
population subgroups. Both authors contributed to article screening and data extraction, and incongruities were resolved through discussion and consensus. Detailed information about the search strategy and data extraction rubric is available from the authors upon request.

Results

Characteristics of included articles

The literature search yielded 42 relevant articles (Table 1). The included articles were published in international (n = 28), regional (n = 6) or national (n = 8) journals, and predominantly reported on the national population (n = 24) or geographically determined subnational populations (n = 15). The majority of articles were original research studies (n = 31), followed by reports (n = 8) and reviews (n = 3). A complete list of included articles is available in Appendix 1. The articles reported coverage of single vaccines, including polio (n = 17), diphtheria, tetanus, and pertussis (n = 7), measles (n = 7) and hepatitis B (n = 5), or coverage of multiple vaccines (n = 13).

Data sources

The data used to measure inequalities in immunization coverage were sourced from international or national household surveys (n = 16) or collected as part of a research study (n = 16), with 10 additional articles reporting World Health Organization/United Nations Children’s Fund (WHO/UNICEF) modelled estimates based on official country estimates. Household survey sources included 2 prominent international surveys: the Pakistan Demographic and Health Survey (PDHS) (n = 11) and the Multiple Indicator Cluster Surveys (MICS) (n = 1). While articles using PDHS data were national in scope, the PDHS excludes certain geographical areas [e.g. the 2012–2013 PDHS did not include Azad Jammu and Kashmir (Pakistan-administered Kashmir) and Federally Administered Tribal Areas]. Since 2010, MICS has been conducted on a rotating basis by province/territory. The article using MICS data reported on subnational populations in Balochistan and Punjab. Other household surveys included the Pakistan Social and Living Standards Measurement (n = 4), Pakistan Integrated Household Survey (or Pakistan Integrated Economic Survey) (n = 3), Expanded Programme on Immunization surveys (n = 2), National Nutrition Survey (n = 1) and Maternal and Child Health Program Indicator Survey (n = 1). Articles that reported data collected as part of a research study (n = 16) all represented populations within specific provinces or territories: Sindh (n = 7), Khyber Pakhtunkhwa (n = 6), Balochistan (n = 1), Azad Jammu and Kashmir (n = 1) and multiple provinces (Sindh, Khyber Pakhtunkhwa and Punjab) (n = 1).

Dimensions of inequality

Over half of the articles disaggregated immunization coverage by subnational region (n = 25). Other major dimensions of inequality included: economic status (n = 18), rural–urban place of residence (n = 18), education level (n = 16), sex (n = 15) and occupation (n = 9). Of the 25 articles that reported subnational region as a dimension of inequality, data were most often disaggregated by provinces and territories (n = 20). These articles drew from WHO/UNICEF estimates (n = 10), PDHS (n = 5) or national household surveys (n = 5), and were national in scope. Five articles, subnational in scope, reported district or subdistrict inequalities in coverage (Table 2).

Discussion

This literature review demonstrates the scope of immunization inequality reporting in Pakistan. Although many studies were national in scope, some geographical regions were not covered by major household surveys and thus not reported in the studies. It is a concern that conflict-affected and unstable areas are not included in regular data collection, as they are also areas where vac-

| Stage of search/review | Reason for exclusion (no. of articles) | No. of articles |
|------------------------|---------------------------------------|----------------|
| Titles identified through database searching | Articles published outside of specified timeframe (n=184) | 1231 |
| Applied filter: articles published since 2000 | (n=192) | 1047 |
| Duplicates removed | (n=192) | 855 |
| Applied filter: articles published in English | Articles published in Spanish (n=5), Danish (n=2), French (n=2), Japanese (n=2), Dutch (n=1), German (n=1), Serbian (n=1) or Swedish (n=1) | 840 |
| Removed items catalogued as “Species: other animals” for content unrelated to humans | Article did not contain information about human subjects* (n=103) | 734 |
| Title and abstract review | Articles did not contain information about human subjects; did not report immunization coverage for Pakistan; did not contain disaggregated data for Pakistan; did not disaggregate data by relevant demographic, socioeconomic, cultural, or geographic factors (n=650) | 87 |
| Full-text review | Article did not report immunization coverage for Pakistan (n=40) | 42 |
| | Article did not disaggregate data by relevant demographic, socioeconomic, cultural, or geographic factors (n=3) | |

*These titles were reviewed for potentially relevant articles, and one article was retained.
Cine-preventable diseases are likely to be more prevalent or problematic. The transmission of wild poliovirus, for instance, originates from regions, including Federally Administered Tribal Areas, where surveillance systems are suboptimal and immunization activities, routinely compromised (8).

The results indicate a reliance on household survey and research data, with low use of data from administrative sources (records from routine encounters with the health system, which are taken into account in the WHO/UNICEF modelled estimates). Administrative data have important potential for inequality monitoring, as they can provide timely information gathered from all members of a population, with high geographical precision. The quality of administrative data, however, relies on accurate and coordinated reporting systems as well as denominator estimates (typically generated through censuses) (9). Unfortunately, Pakistan's health information system lacks capacity (10), and therefore immunization coverage estimates derived from this system tend to be discrepant from survey-derived estimates (11).

Given the decentralization of the health system in Pakistan since 2011 - which devolved national responsibilities to provincial and district-level officials, raising equity concerns (10,12) - and the practical importance of area-based inequality monitoring (13), geographical monitoring is particularly important to close coverage gaps. To date, published inequality analyses conducted at the district or subdistrict level are small in number, and appear to be primarily undertaken for specific research purposes rather than as part of routine inequality monitoring. Notably, however, coverage estimates within districts of the same province were variable, and thus provincial data did not necessarily reflect the situation within a particular district (14). No study included in this analysis reported district-level inequalities across the entire country.

A wider survey of publicly available grey literature (i.e., published online by the Government of Pakistan Ministry of National Health Services, Regulation and Coordination, and organizations involved in promoting immunization) presented some district-level disaggregation of immunization coverage, although detailed background documents about these analyses were not readily available (15,16). Consultations with national and international immunization experts have revealed that immunization data at a district level (aligning with national administrative units) were preferred by country-level immunization experts, and that small-area estimations were ranked as a top research priority (17). Participants in that consultation, however, also noted the costly nature of collecting data with district-level granularity, and cited quality and logistical complexities.

Overall, the results of this preliminary analysis suggest an international and national interest in monitoring immunization inequalities in Pakistan, with a predominant focus on geographically defined inequalities (noting that other dimensions are also
monitored). Expanded monitoring at district level is a major way forward in characterizing immunization inequalities and targeted responses, and should be pursued on a national scale, especially including geographical areas that are less well represented in prominent data sources. Additionally, further studies are warranted to expand upon the methods used in this preliminary analysis, including multiple databases and handsearching of relevant unindexed journals. The results of this analysis draw attention to the continued need for regular inequality monitoring of immunization coverage as a central part of national efforts to ensure the full benefits of immunization for all.

Funding: None.

Competing interests: None declared.
## Appendix 1: Articles included in the review (n = 42)

| Authors | Article Title | Year Published | Journal | Article Type | Population |
|---------|---------------|----------------|---------|--------------|------------|
| Ali M et al. | Hepatitis B vaccination coverage in medical students at a medical college of Mipur-Pet. | 2011 | J Pak Med Assoc | Research | National |
| Mirza S et al. | Factors associated with non-utilization of child immunization in Pakistan. | 2012 | BMC Public Health | Research | National |
| Khan T et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, January 2012–September 2013. | 2012 | MMWR Morb Mortal Wkly Rep | Report | National |
| Khan T et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, January 2010–September 2011. | 2010 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, 2008. | 2008 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, January 2009–February 2010. | 2010 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, January 2006–September 2007. | 2007 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, January 2005–September 2006. | 2006 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, January 2004–September 2005. | 2005 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, 2003. | 2003 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, 2002. | 2002 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, 2001. | 2001 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, 2000. | 2000 | MMWR Morb Mortal Wkly Rep | Report | National |
| Ali M et al. | Progress toward poliomyelitis eradication – Afghanistan and Pakistan, 1999. | 1999 | MMWR Morb Mortal Wkly Rep | Report | National |

### Notes:
- The table includes articles on various topics related to public health, epidemiology, and immunization programs in Pakistan and Afghanistan.
- The articles cover a range of years from 1999 to 2012, with a focus on the progress towards poliomyelitis eradication and related vaccination programs.
- The studies are published in journals such as *BMC Public Health*, *MMWR Morb Mortal Wkly Rep*, and *J Pak Med Assoc*.
- The population of interest includes medical students, healthcare workers, and the general population of Pakistan and Afghanistan.
Appendix 1  Articles included in the review (n = 42) (concluded)

| Authors                     | Article title                                                                 | Year published | Journal                                   | Article type   | Population        |
|-----------------------------|-------------------------------------------------------------------------------|----------------|-------------------------------------------|----------------|-------------------|
| Khowaja AR et al.           | Routine EPI coverage: subdistrict inequalities and reasons for immunization   | 2015           | Asia Pac Journal of Public Health         | Research       | Subnational       |
|                             | failure in a rural setting in Pakistan.                                       |                |                                           |                |                   |
| Kols A et al.               | Provincial differences in levels, trends, and determinants of childhood       | 2018           | East Mediterr Health J                    | Research       | National           |
|                             | immunization in Pakistan.                                                    |                |                                           |                |                   |
| Malik SM, Ashaif N.         | Equity in the use of public services for mother and newborn child health     | 2016           | Int J Equity Health                       | Research       | National           |
|                             | care in Pakistan: a utilization incidence analysis.                           |                |                                           |                |                   |
| Mitchell S et al.           | Equity and vaccine uptake a cross-sectional study of measles vaccination in   | 2009           | BMC Int Health Hum Rights                 | Research       | Subnational       |
|                             | Lasbela District, Pakistan.                                                   |                |                                           |                |                   |
| Murtaza F et al.            | Determinants of nonimmunization of children under 5 years of age in Pakistan.| 2016           | J Fam Commun Med                          | Research       | National           |
| Naeem M et al.              | Coverage and causes of missed oral polio vaccine in urban and rural areas of | 2011           | J Ayub Med Coll Abbottabad               | Research       | Subnational       |
|                             | Peshawar.                                                                     |                |                                           |                |                   |
| Naeem M et al.              | Coverage and causes of missed Haemophilus influenzae type B vaccination       | 2011           | J Ayub Med Coll Abbottabad               | Research       | Subnational       |
|                             | in urban and rural areas of Peshawar.                                        |                |                                           |                |                   |
| Naeem M et al.              | Coverage and factors associated with tetanus toxoid vaccination among         | 2010           | J Ayub Med Coll Abbottabad               | Research       | Subnational       |
|                             | married women of reproductive age: a cross sectional study in Peshawar.       |                |                                           |                |                   |
| Naeem M et al.              | Factors associated with low hepatitis B vaccination; a user and provider     | 2011           | J Pak Med Assoc                            | Research       | Subnational       |
|                             | perspective study in Peshawar.                                                |                |                                           |                |                   |
| Noh JW et al.               | Factors affecting complete and timely childhood immunization coverage in     | 2018           | PLOS one                                  | Research       | Subnational       |
|                             | Sindh, Pakistan: A secondary analysis of cross-sectional survey data.          |                |                                           |                |                   |
| Owais A et al.              | Pakistan’s expanded programme on immunization: an overview in the context   | 2013           | Vaccine                                   | Review         | National           |
|                             | of polio eradication and strategies for improving coverage.                   |                |                                           |                |                   |
| Raza O et al.               | Differential achievements in childhood immunization across geographical      | 2018           | Int J Equity Health                       | Research       | National           |
|                             | regions of Pakistan: analysis of wealth-related inequality.                   |                |                                           |                |                   |
| Rehman SU et al.            | Coverage and predictors of routine immunization among 12–23 months old      | 2017           | Int J Health Sci                           | Research       | Subnational       |
|                             | children in disaster affected communities in Pakistan.                       |                |                                           |                |                   |
| Riaz A et al.               | Reasons for non-vaccination and incomplete vaccinations among children        | 2018           | Vaccine                                   | Research       | Subnational       |
|                             | in Pakistan.                                                                  |                |                                           |                |                   |
| Shah M et al.               | Resistance of polio to its eradication in Pakistan.                          | 2011           | Virology J                                | Research       | National           |
| Shaikh S et al.             | Coverage and predictors of vaccination among children of 1-4 years of age in | 2010           | J Coll Physicians Surg Pak                | Research       | Subnational       |
|                             | a rural subdistrict of Sindh.                                                 |                |                                           |                |                   |
| Siddiqui N et al.           | Assessment of EPI (expanded program of immunization) vaccine coverage in     | 2007           | J Pak Med Assoc                            | Research       | Subnational       |
|                             | a peri-urban area.                                                           |                |                                           |                |                   |
| Siddiqui NT et al.          | Ethnic disparities in routine immunization coverage: a reason for persistent | 2014           | Asia Pac J Public Health                  | Research       | Subnational       |
|                             | poliovirus circulation in Karachi, Pakistan?                                 |                |                                           |                |                   |
| Singh PK, Parsuraman S.     | Sibling composition and child immunization in India and Pakistan, 1990–2007. | 2014           | World J Pediatrics                       | Research       | National           |
| Yousafzai MT et al.         | Hepatitis B vaccination among primary health care workers in Northwest        | 2014           | Int J Health Sci                           | Professional group |                   |
|                             | Pakistan.                                                                    |                |                                           |                |                   |
| Zaidi SM et al.             | Coverage, timeliness, and determinants of immunization completion in           | 2014           | Hum Vaccin Immunother                     | Research       | National           |
|                             | Pakistan: evidence from the Demographic and Health Survey (2006–07).         |                |                                           |                |                   |

CDC = Centers for Disease Control and Prevention; HBV = hepatitis B virus.
References

1. WHO vaccine-preventable diseases: monitoring system. 2019 global summary [website]. Geneva: World Health Organization; 2019 (https://apps.who.int/immunization_monitoring/global_summary/estimates?c=PAK, accessed 16 June 2020).

2. Bhutta ZA, Hafeez A, Rizvi A, Ali N, Khan A, Ahmad F, et al. Reproductive, maternal, newborn, and child health in Pakistan: challenges and opportunities. The Lancet. 2013 Jun 22;381(9884):2207–18. http://dx.doi.org/10.1016/S0140-6736(12)61999-0 PMID:23684261

3. 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 Jul 19;31(28):3313–9. https://doi.org/10.1016/j.vaccine.2013.05.015

4. State of inequality: childhood immunization. Geneva: World Health Organization; 2016 (https://www.who.int/gho/health_equity/report_2016_immunization/en/, accessed 16 June 2020).

5. Explorations of inequality: childhood immunization. Geneva: World Health Organization; 2018 (https://www.who.int/gho/health_equity/report_2018_immunization/en/, accessed 16 June 2020).

6. Inequality monitoring in immunization: a step-by-step manual. Geneva: World Health Organization; 2019 (https://www.who.int/gho/health_equity/manual_immunization/en/, accessed 16 June 2020).

7. Handbook on health inequality monitoring: with a special focus on low- and middle-income countries. Geneva: World Health Organization; 2013 (https://www.who.int/gho/health_equity/handbook/en/, accessed 16 June 2020).

8. Hussain SF, Boyle P, Patel P, Sullivan R. Eradicating polio in Pakistan: an analysis of the challenges and solutions to this security and health issue. Glob Health. 2016 Oct 12;12(1):63. http://dx.doi.org/10.1186/s12992-016-0195-3 PMID:27729081

9. Victora CG, Ryman TK. Potential approaches to better measure and track equity in immunization using survey and administrative data, and data triangulation. ERG Discussion Paper 02. Equity Reference Group for Immunization; 2018 (https://drive.google.com/file/d/1z6t9P_Av9J1yEpJmATPhTS_PsiGtmE/view, accessed 16 June 2020).

10. Nishtar S, Boerma T, Amjad S, Alam AY, Khalid F, ul Haq I, et al. Pakistan's health system: performance and prospects after the 18th Constitutional Amendment. The Lancet. 2013 Jun 22;381(9884):2193–206. http://dx.doi.org/10.1016/S0140-6736(13)60019-7 PMID:23684254

11. Hussain SF, Boyle P, Patel P, Sullivan R. Eradicating polio in Pakistan: an analysis of the challenges and solutions to this security and health issue. Glob Health. 2016 Oct 12;12(1):63. http://dx.doi.org/10.1186/s12992-016-0195-3 PMID:27729081

12. Bossert TJ, Mitchell AD, Janjua MA. Improving health system performance in a decentralized health system: capacity building in Pakistan. Health Syst Reform. 2015 May 19;1(4):276–84. http://dx.doi.org/10.1080/23288604.2015.1056330 PMID:31519095

13. Hosseinpoor AR, Bergen N. Area-based units of analysis for strengthening health inequality monitoring. Bull World Health Organ. 2016 Nov 19;1(4):856–8. http://dx.doi.org/10.2471/BLT.15.165266 PMID:27821889

14. Cockcroft A, Andersson N, Omer K, Ansari NM, Khan A, Chaudhry UU, et al. One size does not fit all: local determinants of measles vaccination in four districts of Pakistan. BMC Int Health Hum Rights. 2009 Oct 14;9(Suppl 1):S4. http://dx.doi.org/10.1186/1472-698X-9-S1-S4 PMID:19828062

15. Annual progress report 2014. Submitted by the Government of Pakistan. Geneva: Gavi; 2014 (https://www.gavi.org/country/pakistan/documents/aprs/annual-progress-report-pakistan-2014, accessed 16 June 2020).

16. Hafeez A. Case study: improving sustainable immunisation coverage in Pakistan in partnership with the Alliance; Geneva: Gavi; 2017 (https://www.gavi.org/about/governance/gavi-board/minutes/2017/14-june/presentations/07b---improving-sustainable-immunisation-coverage-in-pakistan-in-partnership-with-the-alliance/, accessed 16 June 2020).

17. Danovaro-Holliday MC, Dansereau E, Rhoda DA, Brown DW, Cutts FT, Gacic-Dobo M. Collecting and using reliable vaccination coverage survey estimates: summary and recommendations from the "Meeting to share lessons learnt from the roll-out of the updated WHO Vaccination Coverage Cluster Survey Reference Manual and to set an operational research agenda around vaccination coverage surveys", Geneva, 18–21 April 2017. Vaccine. 2018 Aug 16;36(34):5150–9. http://dx.doi.org/10.1016/j.vaccine.2018.07.019 PMID:30041880

18. Siddiqi NT, Owais A, Agha A, Karim MS, Zaidi AKM. Ethnic disparities in routine immunization coverage: a reason for persistent poliovirus circulation in Karachi, Pakistan? Asia Pac J Public Health. 2014 Jan;26(1):67–76. http://dx.doi.org/10.1177/1010539513475648 PMID:23420055