

Project Report

Assessing the impact of Polio Eradication Initiative activities on Routine Immunization in Jigawa, Katsina and Zamfara States, Nigeria

DL Public Health MSc (Public Health)

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Abstract

Background: Nigeria is one of the remaining polio endemic countries. Nigeria's routine immunization (RI) program is weak as is its health system. This study investigates the positive and negative impact of Polio Eradication Initiative (PEI) activities on RI and health systems in three Northern Nigerian states (Jigawa, Katsina and Zamfara) and provides recommendations to strengthen RI during and after PEI.

Method: A literature review was conducted to assess previous studies. An ecological study was then conducted using Demographic Health Survey (DHS) and Demographic Health Information System (DHIS) data to analyze differences in immunization coverage possibly linked to PEI activities.

Results: Both DHS and DHIS show a consistently high coverage of Oral Polio Vaccine and low coverage of other vaccines given through RI. DHS data show that BCG, DPT and measles coverage has remained almost unchanged between 1999-2013. Analysis of DHIS show that PEI activity likely has had a negative impact on RI coverage in LGAs at high-risk of polio transmission and targeted by PEI. There were positive and negative impact of PEI on different elements of RI and the health system.

Conclusions: Nigerian is under pressure to eradicate polio and increase RI coverage. It is therefore difficult to gain a clear picture of immunization coverage. The findings confirm positive and negative impact found in the other studies and provide in-depth results for

Nigeria. The literature also yielded recommendations on strengthening RI in Nigeria by building on PEI experience and addressing systemic weaknesses in RI nationwide.

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Abbreviations and Definitions

Abbreviations

BCG	Bacillus Calmette-Guérin (tuberculosis vaccine)
bOPV	Bivalent oral polio vaccine
CHEW	Community Health Engagement Worker
CHO	Community Health Officer
cVDPV	Circulating vaccine derived poliovirus
DHIS	District Health Information System
DHS	Demographic Health Surveys
DPT	Diphtheria, pertussis, tetanus vaccine
ERC	Expert Review Committee
GPEI	Global Polio Eradication Initiative
HF	Health facility
HR	High Risk
IHME	Institute for Health Metrics and Evaluation
IPV	Inactivated polio vaccine
JCHEW	Junior Community Health Extension Worker
LGA	Local Government Area
LID	Local Immunization Day
NID	National immunization days
NPHCDA	National Primary Health Care Development Agency
OPV	Oral poliovirus vaccine

PEI	Polio Eradication Initiative (Nigeria)
PHC	Primary Health Care
PIRI	Periodic Intensification of Routine Immunization
PRRINN-MNCH	Partnership for Reviving Routine Immunization in Northern Nigeria; Maternal, Newborn and Child Health Initiative
RI	Routine Immunization
SIA	Supplemental immunization activities
SNID	Sub-national immunization day
tOPV	Trivalent oral polio vaccine
UCI	Universal Child Immunization
VHR	Very high risk
WHA	World Health Assembly
WHO	World Health Organization
WPV	Wild poliovirus

Definitions

Circulating Vaccine Derived Poliovirus (cVDPV): Oral Polio Vaccine is a live vaccine and generates vaccine-virus in the intestines which is then excreted. When a population is not sufficiently immunized, this vaccine-virus can survive and change genetically, possibly causing paralysis. This form of the poliovirus is a cVDPV. If a child is fully-immunized with trivalent OPV (tOPV), he/she is protected against all three polioviruses and cVDPV. Most of the existing cVDPV outbreaks are associated with poliovirus 2 and in countries with low routine coverage with tOPV (1).

GPEI and PEI: The Polio Eradication Initiative (PEI) was the initial name of the Global Polio Eradication Initiative (GPEI) and the two names are used interchangeably in the literature and research. For this paper, the author used GPEI to refer to global-level activities and PEI for country-level activities.

Jigawa State: Northern Nigerian state bordering Niger. There are 27 Local Government Areas (LGA) in Jigawa and a population of approximately 4.4 million people. (2)

Incentives: Incentives can be monetary or non-monetary rewards for health workers. They help to encourage motivation and participation in health activities and recognize people's additional work. In Nigeria, health workers and community workers are given monetary incentives to participate in polio SIAs.

Katsina State: Northern Nigerian state bordering Niger. There are 34 LGAs in Katsina and a population of approximately 6 million people (2).

Routine Immunization (RI): Recommended vaccines given at a health facility or through scheduled outreach by a trained health worker. Routine immunization is determined by each country and includes the basic childhood vaccines (BCG, OPV, DPT, measles) and others depending on the country's policy and disease burden.

Routine immunization coverage indicators: Globally, RI indicators are measured to show different strengths or weaknesses in an immunization system. (3) The following were used in this study:

- **BCG (at birth or soon after):** to show access to and initial use of and access to routine immunization services
- **OPV3 (at 14 weeks)** to show access to polio vaccine through routine immunization services
- **DPT3 (at 14 weeks)** to show continued access to routine immunization services and ability of the health system to delivery RI services
- **Measles (9 months)** to show completion of the routine immunization schedule
- **DPT1-DPT3 drop-out rate** to show satisfaction with and continuation of routine immunization services

Supplementary Immunization Activity (SIA): Mass immunization campaigns to quickly reach a large number of people outside of routine immunization services. They are used to catch people who have not been vaccinated, increase immunity and contain disease. In this paper, all mass campaigns will be referred to as “SIA”. Other types of SIAs include:

- **National Immunization Days (NID) and Sub-National Immunization Days:** NID is another term for SIA, used by PEI to provide all children under-5 (regardless of their polio vaccination history) with additional polio drops in order to break transmission and to ensure better protection. SNIDs are used to target specific areas with outbreaks or at risk of outbreaks. This can also include “mop-up” activities, where health workers go door-to-door to vaccinate missed children.

- **Immunization Plus Days (IPD):** An integrated immunization strategy used in Nigeria to provide additional vaccines, health services or health commodities during NIDs. It is a response to community demand for other services beyond polio. In Nigeria, IPD is often used interchangeably with NID, although “pluses” are not always available.

WHO Health system: “A good health system delivers quality services to all people, when and where they need them. The exact configuration of services varies from country to country, but in all cases requires a robust financing mechanism; a well-trained and adequately paid workforce; reliable information on which to base decisions and policies; well-maintained facilities and logistics to deliver quality medicines and technologies”. (4)

Zamfara State: Northern Nigerian state bordering Niger. There are 17 LGAs in Zamfara and a population of approximately 3.3 million people. (2).

I. INTRODUCTION

The World Health Assembly (WHA) approved polio eradication as a global goal in 1988, noting that “efforts to eradicate poliomyelitis serve to strengthen other immunization and health services”. (5) Nigeria is one of the last remaining polio endemic countries, with the disease concentrated in northern states. The Global Polio Eradication Initiative (GPEI) has been supporting polio SIAs in Nigeria since 1996 and after 18 years of peaks and dips in the number of cases, Nigeria is historically close to eliminating polio with only six cases this year. (6) But Nigeria has not experienced an associated increase in routine immunization (RI) coverage. Nigeria’s immunization program is weak (7-11) and the 2013 Nigerian Demographic Health Survey (DHS) reports that only 38% of Nigerian children have received a third dose of Diphtheria, Pertussis, Tetanus (DPT3) vaccine– a standard measure of RI performance. (12) Without a strong RI program, Nigerian children are at higher risk of vaccine-preventable diseases and the country may not maintain polio elimination once it is achieved.

Since the start of the GPEI, the debate on the impact of the Polio Eradication Initiative (PEI) on RI and health systems remains unresolved. This paper investigates the impact of PEI on RI in three Northern Nigerian states (Jigawa, Katsina and Zamfara) by reviewing published and grey literature and conducting an ecological study to identify differences and impact on RI coverage at State and Local Government Areas (LGA) levels, bringing new country evidence to the global debate. The research relied heavily on experience from the Partnership for Reviving Routine Immunization in Northern Nigeria; Maternal, Child and Newborn Health Initiative (PRRINN-MNCH), a UK Department for International Development and Norwegian

Government funded project from 2006-2014. (13) This paper will also identify strategies for improving RI during and after PEI activities in Northern Nigeria.

II. BACKGROUND

Poliomyelitis (or polio) is an infection caused by wild poliovirus (WPV) and spread through oral-fecal transmission. Polio replicates in the intestines and can attack the central nervous system, leading to paralysis in approximately 1 in 160-200 people. Because polio is a largely asymptomatic, one case of paralysis could mean others are infected and infectious, but they remain healthy and undetected. Polio is excreted in the stool of carriers and people vaccinated with OPV shed the vaccine-virus into water and sewage systems, which can passively immunize others against polio, especially in areas of poor sanitation. A person can excrete poliovirus over a long-term (< 5 years but >6 months) or, in rare cases, chronically (shedding poliovirus for >5 years). (14)

There are two polio vaccines: oral polio vaccine (OPV) a live, attenuated vaccine and inactivated polio vaccine (IPV) which is injected. The GPEI chose OPV for its eradication efforts because the vaccine is effective; inexpensive; easy to administer and can quickly prevent person-to-person transmission. In countries at less risk of polio transmission, IPV is used to provide individual protection, not community protection like OPV. The World Health Organization (WHO) recommends at least three doses of OPV for prevention and building herd immunity. Until global polio eradication is achieved, countries that have eliminated polio must maintain high OPV/IPV coverage (at least 80%) to prevent possible outbreaks and circulating vaccine derived poliovirus (cVDPV).

The GPEI was established in 1988 and receives funding and support from WHO, Rotary International, US Centers for Disease Control and Prevention, UNICEF, the Bill and Melinda Gates Foundation and most WHO member states, including Nigeria. At the start of GPEI, an estimated 350,000 children were paralyzed by polio each year in 125 countries. (15)

Afghanistan, Nigeria and Pakistan are the remaining endemic countries, recording 158 cases in September 2014. (6) While strengthening RI is essential for eradication, GPEI's key strategy depends on frequent supplementary immunization activities (SIAs) in addition to RI to stop transmission.

A review of GPEI's history shows shifting eradication goals; fluctuating case counts; and increasingly high funding. (6; 14-23) Globally, polio eradication cost almost \$10 billion between 1988 and 2012 (14); the GPEI budget for 2013-2018 is programmed at US\$5.5 billion. (6)

There is an on-going concern about the potential damage of GPEI to RI. In 1997, Taylor et al (24) first questioned GPEI's strategy of high immunization coverage through SIAs and incentives for poorly paid health workers, highlighting that it could divert funding and human resources from national RI for a global objective and undermines sustainability.

Mogedal and Stenson (25) assessed the impact of PEI on health systems in Nepal, Laos and Tanzania in 1998-1999. Similar to later studies, theirs was inconclusive on the overall effect of polio SIAs, but they found that countries with weaker health systems would have greater difficulties in eradicating polio and would need to strengthen their RI systems. (25)

As part of a WHO evaluation of GPEI in 2001, (16) Steinglass listed several field observations of the negative impact of GPEI activities, including inflated coverage data; unsustainable incentives; little commitment to RI; and poor cold chain and stock management practices that damaged OPV and other vaccines.

In 2012, Closser et al designed a mixed qualitative and quantitative methodology to measure positive and negative impact of GPEI on RI and primary health care (PHC) in countries with different levels of PEI SIA intensity. (26, 27) Their research evaluated contextual variables by using qualitative data gathered from health workers involved in PEI SIAs and comparing against immunization coverage. One Northern Nigerian LGA was assessed. PRRINN-MNCH modeled this study in 2014 to expand the research and measure PEI impact on RI and PHC in 15 LGAs in Jigawa, Katsina and Zamfara, gaining a larger Nigerian perspective. (28)

Aims and Objectives

During the PRRINN-MNCH project, there were reports of SIAs being disruptive to RI (9, 10), but with little measurable evidence. This study seeks to provide evidence by reviewing the literature on GPEI, RI and health systems and comparing it with immunization coverage data from Jigawa, Katsina and Zamfara States to learn the impact of SIAs and to provide solutions to strengthen RI in Northern Nigeria. The study's aims and objectives are:

Aims

- To assess the impact of PEI SIAs on RI services in three Northern Nigerian states (Jigawa, Katsina and Zamfara)
- To identify strategies to strengthen RI in Northern Nigeria during and after eradication activities

Objectives

- To compare trends in RI coverage in Jigawa, Katsina and Zamfara
- To analyse whether PEI activities positively or negatively affect RI in the three states
- To assess the programmatic impact of polio SIAs on crucial elements in RI including cold chain, community demand and human resources.
- To recommend strategies for strengthening RI during and after polio eradication efforts.

III. METHODS

The author conducted a literature review and an ecological study to answer the following questions:

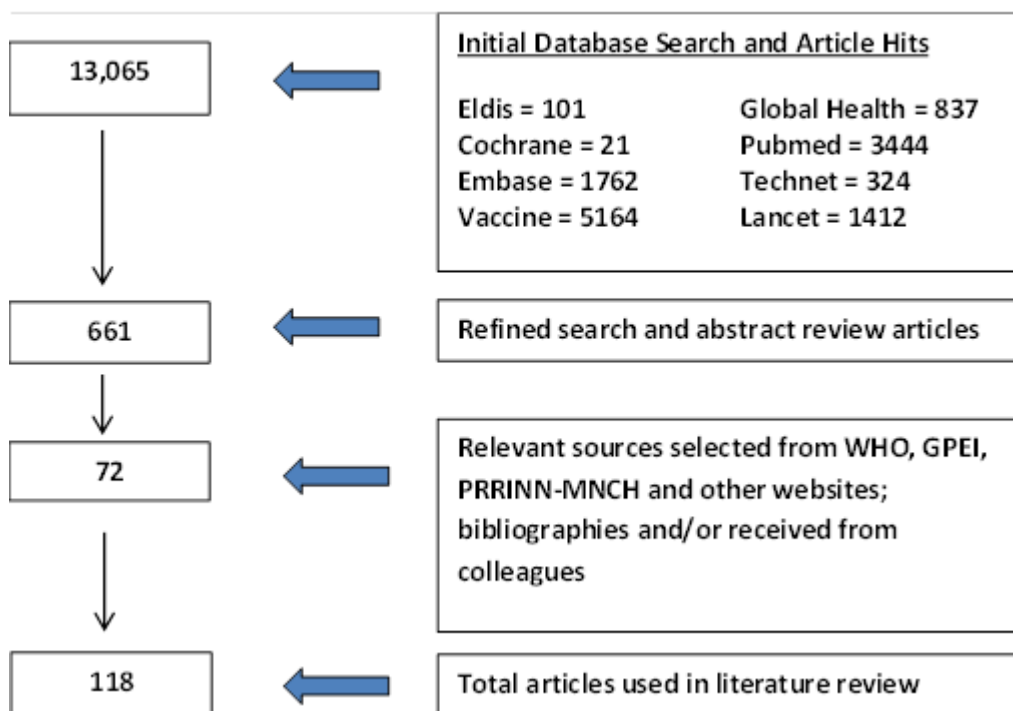
- What are the positive or negative impacts of PEI on RI in Northern Nigeria?
- Do changes or differences in immunization indicators in Jigawa, Katsina and Zamfara show an impact of PEI on RI coverage?
- What are effective strategies for strengthening RI during and after polio eradication?

A. Literature Review

Search strategy

A scoping review was done on Eldis and Global Health databases to assess literature availability and test Boolean combinations of key words (polio; health system; vertical program; Nigeria; disease control; evaluation; quantitative/qualitative research; and campaign). These same Boolean combinations were then used in different databases and journals but yielded very broad results. Search criteria were refined to generate a more focused search using Boolean combinations of key words: “Nigeria”, “polio”, “immunization”, “health systems”, “evaluation” and “qualitative/quantitative research”.

Figure 1: Literature review process



Articles were reviewed in chronological order and for relevance. Selected articles included:

- GPEI evaluations

- studies on health system impact of GPEI or other vertical programs
- reports on immunization programs and polio eradication in Nigeria
- immunization and polio data
- strategies for post-polio eradication

Excluded articles were:

- publications prior to 1988 (before GPEI)
- highly contextual publications on PEI in other endemic countries
- scientific articles on polio and vaccine characteristics
- articles written, published or funded by key stakeholders in GPEI that showed bias

B. Ecological Study

Ecological studies are used to analyze and compare data in different population groups to identify differences and impact of health interventions. They can also be used to test hypotheses for further research. For this study, a multiple-time series analysis was conducted using Nigerian Demographic Health Surveys (DHS) from 1999-2013 and Nigerian Demographic Health Information System (DHIS) administrative data from 2012-2013. This allowed for State and LGA immunization coverage data to be assessed at different times and to measure outcomes before and after PEI activities.

PRRINN-MNCH worked in four Northern Nigeria states including Jigawa, Katsina and Zamfara. Immunization data from these three states were selected to correspond with a study on the impact of PEI on RI and PHC. In each state, analysis was done according to the

risk of polio transmission at LGA level, as determined in the National Polio Emergency Plans.

(29-31)

Data analysis

- Show overall BCG, OPV, DPT and measles coverage in Nigeria using DHS data from 1999 to 2013 to identify coverage differences in Jigawa, Katsina and Zamfara and compare with PEI activities.
- Show and compare differences in BCG, OPV, DPT and measles coverage using DHIS administrative data from Jigawa, Katsina and Zamfara states and LGAs from 2012 to 2013 and compare with PEI activities.

Data were analyzed in Excel.

C. Ethical Considerations

All administrative and survey data used for this study are anonymous, non-identifiable and public. None of the published or grey literature contained personal or identifiable information and were publically available.

PRRINN-MNCH studies and surveys used in this study were anonymous. The study on PEI impact on RI and PHC was approved by Health Research Ethics Committees in Jigawa, Katsina and Zamfara states. (28)

IV. FINDINGS

A. Literature Review

The literature review assessed positive and negative impacts of PEI on RI and different elements of the health system that supports RI.

Polio and routine immunization in Northern Nigeria

Nigeria began its PEI activities in 1996 and is the last endemic country in Africa. The number of cases peaked at 1143 in 2006 and only six cases have been recorded as of August 2014. (6)

Routine immunization coverage must be at least 80% to strengthen immunity, prevent reintroduction and maintain polio elimination. Countries that are polio-free have done so on the back of a strong RI program. But immunization systems in Northern Nigeria are weak, compounded by many factors including hard-to-reach and underserved communities; unreliable electricity for the cold chain; lack of funding; community distrust and competition from PEI. (7-11; 32-34) Since 1999, DPT3 coverage in the Northwest Zone has never gone above 20%. (12; 35-37) Because of low RI coverage, polio remains, transmission of pertussis has never been broken (38) and there are yearly outbreaks of measles. (39)

In 2005, FBA gave a critical assessment of the Nigeria's immunization program highlighting the near collapse of RI in Nigeria in the early 2000s. (7) While improvements have been

made, a 2012 vaccine audit in 21 states found fluctuating vaccine supply, lack of funds for vaccine collection and distribution and poor data management. (33) The 2013 National Routine Immunization Strategic Plan also reported low demand for RI, weak governance, insufficient funding for RI and poor service delivery. (34) Mangal et al found that in 2012, 24% of the polio cases investigated had received no OPV. (40) Stock-outs have continued and in early 2014, almost all routine vaccines were at low levels nationally. (41)

In 2009, an independent evaluation of the GPEI found that Nigeria's RI program was detached from polio and needed to be strengthened. (17) In 2012, the Nigerian Expert Review Committee on Polio (42) also called for improved RI as part of an emergency response to polio. In each of the 2012, 2013 and 2014 Nigerian Polio Eradication Emergency Plans (29-31), part of the strategy is to boost RI coverage and population immunity through Periodic Intensified Routine Immunization (PIRI) [or "intensified outreach" or Local Immunization Days (LID)] to stop the spread of cVDPV, increase immunization coverage and prepare the country for IPV introduction. (30) These activities however, are largely funded by GPEI and donors (30, 31) and risk diverting staff and resources from routine systems. (43)

In the PRRINN-MNCH study on the impact of PEI on RI and PHC in Jigawa, Katsina and Zamara, while the majority of respondents felt that PEI has had a positive impact on RI, the study also found that many of the systematic issues important to RI (vaccine storage, vaccine distribution, waste management) are still weak. (28) Only 25% of health facilities had the capacity to store their own vaccines and 80% of health facility staff reported collecting vaccines at the state cold store, similar to WHO findings in 2012. (28, 33)

A long-term outbreak of cVDPV in Nigeria reflects the danger of low RI coverage. Wassiliak et al (44) analyzed the incidence of cVDPV in Nigeria and found that it is one of the consequences of SIAs in areas with low RI. In 2006, Nigeria began using monovalent OPV1 and introduced monovalent OPV3 into campaigns in 2007 to more effectively target WPV1 and WPV 3. (44) Between 2006 and 2009, trivalent OPV (tOPV) (against WPV1, 2 and 3) use in SIAs was more than halved in favor of monovalent vaccines. (44) Because of low RI coverage, children had only been protected against WPV2 through SIAs and when use of tOPV in SIAs dropped, children were not sufficiently protected through RI. Using monovalent vaccines increased the risk of cVDPV (1; 44-46) resulting in 408 cases of cVDPV since 2006. (6, 39)

Wassilak et al (44) recommended that SIAs vary use of OPV formulations in campaigns, which has since happened. The cVDPV outbreak continues and as of August 2014, there are more cases of cVDPV than WPV (19 cVDPV and 6 WPV). (6, 39)

As part of its “endgame” strategy, GPEI recommends that countries strengthen their RI coverage and then introduce at least one dose of IPV into their immunization schedules to reduce the risk of cVDPV. Countries will replace tOPV with bivalent OPV (bOPV)(against WPV1 and 3), but this depends on elimination of cVDPV transmission. (47, 48) OPV will be eventually phased out in favor of IPV to prevent cVDPV outbreaks, but countries will need to maintain high coverage of IPV to protect against possible importation from other countries or by chronic excretors. (48)

Health system

A functioning health system supports RI by ensuring that vaccines are stored at safe temperatures, delivered to adequately staffed health facilities and given to children according to the national schedule.

Vertical programs (independent, disease-focused activities) like GPEI, can positively or negatively affect a country's health system and its ability to run routine services. The argument against vertical programming is that it leaves the overall health system neglected and unable to provide the underlying infrastructure to support horizontal, cross-cutting programs (e.g. PHC). Donors often support vertical programs because of the fixed objectives, short-term achievable goals and as a way of getting results in difficult health systems while avoiding the complicated bottlenecks that need long-term solutions. (49, 50, 51, 52)

The literature showed positive and negative aspects of vertical programming, not just for immunization, but for other disease-specific initiatives. (25; 50-58) Common findings were that vertical programs:

- Improve coordination and collaboration between governments and donors.
- Strengthen surveillance, training, supervision and disease awareness.
- Do not often adapt programming to a country's context, policies or health priorities.
- Need to incorporate activities that will strengthen the health system.
- Miss the population's greater health needs.
- Divert time, funding and skills away from routine services.
- Create parallel structures.

These findings are similar to the findings on PEI health system impact in Northern Nigeria (27, 28) including:

- PEI provides high quality surveillance, but has separate tools and reporting for polio.
- Increased, high-level supervision for PEI by National, State and LGA officials has increased motivation and accountability.
- SIA planning often takes precedent over planning for other initiatives.
- Microplanning, a tool to identify and access communities, is used just for PEI.
- Coordination between programs for integrated campaigns is complicated by funding and availability of commodities.
- The Nigerian Government, States and LGAs contribute significant budget and staff for PEI.
- Health services are often interrupted due to SIA activity.

Nigeria's PHC system has declined since the 1990s. (32, 59) In the PRRINN-MNCH study, only 21% of respondents felt that PEI has had a positive influence on PHC. (28) Weaker health systems are more disrupted by vertical programs than stronger ones (25), but where infrastructure is poor, vertical programs may be the only way of reaching people with health services. (25-27; 50, 53, 54)

Integrating other health services into SIAs can expand services, but success is difficult when building on an already weak health system. (50, 53, 55, 56) In Nigeria, Immunization Plus Days (IPD) provide other vaccines, anthelmintics and vitamin A during PEI SIAs, but funding for "pluses" is often insufficient and medical commodities are often replaced by sweets,

buckets or cloth. (27, 28) Attempts to integrate bednet distribution were often unsuccessful because of poor coordination and insufficient bednets, which in turn, had a negative impact on the PEI SIA with people refusing OPV unless they received a bednet. (28) Integrated campaigns, even horizontal ones, can divert staff and take focus away from the PHC system in Nigeria.

Cold chain

Provision of cold chain equipment is often seen as a positive impact of PEI. (25, 27, 28)

Refrigerators, cold boxes and freezers are essential to the cold chain and are visible purchase for governments and donors to support RI. But RI requires different equipment than PEI. Polio and other SIAs depend heavily on freezers to make ice packs. Polio, a freeze-resistant vaccine, can be stored in freezers, but most RI vaccines are freeze-sensitive and require refrigerators for storage at +2° to +8°C. (9) If the overall cold chain system is not considered, a country may end up with too many donated freezers and not enough refrigerators to safely store vaccines for RI.

The grey literature shows that polio and other SIAs place a significant burden on the Nigerian national cold store. In 2012, in addition to PEI SIAs, Nigeria ran measles, meningitis, tetanus and yellow fever campaigns, which, in addition to RI vaccines, amounted 375 million doses of vaccine, delivered in 87 shipments of vaccines into Nigeria in 2012. (33) An Effective Vaccine Management Assessment in Nigeria in 2011 (60) found that storage space at the national cold store was already insufficient and such an increase in storage needs for SIAs likely

resulted in vaccines being damaged or being quickly pushed to lower-level stores that also have insufficient space. (60)

In the PRRINN-MNCH study (28), respondents at all levels widely reported that PEI has had a positive impact on the cold chain. However, States and LGAs regularly purchase non-WHO qualified domestic refrigerators for vaccine storage. (11) In Jigawa, Katsina and Zamfara, 22% of LGAs respondents reported that their LGA buys refrigerators, which were mostly domestic. (28) States and LGAs provide co-funding for PEI SIAs and purchasing domestic refrigerators may be a part of their contribution, but domestic refrigerators do not safely store vaccines.

Closser et al (27) found that PEI provided funds for maintenance and fuel for SIAs. PRRINN-MNCH (9, 28) also found that maintenance and fueling are available for polio SIAs only, therefore not contributing to the long-term strengthening of the cold chain or RI.

Human resources

One key reported impact of SIAs is on human resources. (7, 16, 24, 25, 27, 28, 34, 53, 55, 61, 63) From August-December 2013, there were 5-7 polio rounds in in Jigawa, Katsina and Zamfara and health workers reported working between 6-12 days per round. (28) In Northern Nigeria, there is already insufficient medical staff; using health workers on SIAs creates staff shortages or absences at facilities with no staff to replace them. (28, 34) Closser et al found that when there were more SIAs, health worker motivation declined

because of workload. (27) In the PRRINN-MNCH study, respondents also reported campaign fatigue and too many polio rounds. (28)

Globally, GPEI has trained thousands of people. Closser et al found in their case studies, that most people were trained specifically on polio, except in Rwanda and Nigeria where campaigns and training were integrated. (27) Other studies found that training during vertical programs helps to build skills, but that multiple frequent trainings also divert health workers from their jobs and do not contribute to overall gaps in health worker knowledge. (28, 51, 53) The PRRINN-MNCH study found training to be a motivating factor for many health workers. (28)

In Nigeria, health workers receive monetary incentives for work on SIAs. Not only do incentives influence people's decision on how they spend their time (64), incentive use sets a potentially unsustainable precedent for other health programs. Health priorities could be made based on the availability of funding and incentives (64); health services without incentives could be neglected. (24)

The use of incentives for PEI is widespread in Jigawa, Katsina and Zamfara:

- 68% of State respondents receive incentives for PEI
- 89% of LGA respondents receive incentives for PEI
- 76% of health facility-level respondents receive incentives for PEI
- 62% of ward respondents receive incentives PEI. (28)

Using the Human Resource Information System (M. Siebert 2014. Personal communication 14 April; 21 July) for health worker salary rates and taking the average amount of incentive received per round (28), it is estimated that in Jigawa, Katsina and Zamfara, community workers can earn up to 79% of their salaries in incentives on PEI; nurses, up to 113% of their salaries and doctors up to 58% of their salaries (See Annex 1). These findings are similar to measles SIAs where health workers also earn significant supplemental income in incentives. (53)

Akwataghibe et al found that 56% of Nigerian health workers in two states gave priority to activities where they could earn per diem. (64) When analyzed by type of health worker, Akwataghibe et al found that 28.5% of nurses/midwives, 50% of community health officers and 59% of community health engagement workers prioritized activities where they could earn per diems as supplementary income. (64)

Community engagement

Northern Nigerians have historically been distrustful of government-driven health initiatives (32) and PEI has won and lost community support. The most significant rejection of PEI was a boycott of polio activities in 2003-2004 resulting in an increase in cases and transmission to other countries. (39) The boycott exposed the importance of community acceptance of PEI and the underlying cultural and social reasons why Northern Nigerians refuse polio vaccine and distrust their government (32, 59).

Before the boycott, Northern Nigerian communities were concerned about internationally driven-health programs following an unauthorized antibiotic trial during a 1996 meningitis outbreak in Kano. (59) Rumors about vaccines, infertility and war against Islam were being spread by traditional, religious and political leaders. Communities were angry at the decline in health services and the focus on polio and they felt neglected by the federal government. (32, 59)

After the boycott, PEI launched a greater effort to engage the community to overcome their dissatisfaction with SIAs and address cultural issues around polio. (32, 65) The introduction of IPDs responded to the community demand for other health services and they were successful in gaining community support (23, 27, 66), but when the funding for IPDs was reduced, there were fewer “pluses” and people began refusing polio vaccine again. (27, 32, 66)

Health workers in Jigawa, Katsina and Zamfara reported that PEI has expanded community engagement and increased community members’ involvement in PEI activities, including health education, finding unvaccinated children and answering questions, which in turn builds trust. They were also involved in active surveillance. These community workers began with PEI, but have since expanded their role to other health issues. (28) Despite the effort, community resistance and refusal of polio vaccination still occur. In early 2103, 1.3 million children in Northern Nigeria had not been vaccinated because of caregiver refusal. (67)

Across their case studies, Closser et al found that social mobilization was largely polio focused, but that it has helped to build trust between the community and health workers.

The study also found that communities felt other health services were still being neglected, which in turn led to a distrust of polio SIAs. (27) The Nigeria case study, as well as the PRRINN-MNCH study, reported community frustration with the number of SIAs. (27, 28)

Mangal et al's found a high-level of caregiver refusal of SIAs (50.9%) but only a 21% refused RI. (40) This is similar to the PRRINN-MNCH study (28) where 30% of health workers had faced resistance to PEI, but only 9% encountered resistance to RI suggesting that parents who refuse polio vaccine may have a higher trust of RI and will vaccinate their children against other diseases. (68)

Political resistance

Taylor (57), like Renne and Yahya and others (32, 59, 66, 69, 70), found that resistance to PEI occurs in poor and marginalized communities. Those communities know they are essential to polio eradication and rejecting vaccination is a powerful protest tool against the government. Global initiatives are often coordinated at the central level of government with the expectation that issues and implementation at subnational levels will follow. (57) The top-down nature of PEI reinforces the power of the state over the individual. (57) Local priorities and specific community needs are often overlooked by global programs, but they can be a major barrier to acceptance and implementation.

Campaigns often confront human rights issues and there is a conflict between the global public good of polio eradication versus the individual's right to refuse vaccination. (57) In 2013 and 2014 in Nigeria, state governments threatened to arrest parents who refuse

vaccination and arrested radio journalists for inciting violence when they discussed forced vaccination. (62, 71-74) Arresting non-compliant parents risks increasing community wariness, government distrust and polio refusal.

Renne (32) writes of the political importance and visibility of polio SIAs. Political leaders are often seen promoting polio and launching campaigns. Politics is ever-present in Nigerian culture and elections are often divisive and were a factor in the boycott. (32) The current push by PEI to eliminate polio in Nigeria by the end of 2014, is to avoid any political disruption of SIAs before the 2015 elections. (31, 74) Insecurity in Northern Nigeria is also a concern for PEI (31, 74) and there is a risk of Northern Nigerians associating President Johnathan with polio and their dissatisfaction with his government's handling of Boko Haram in Northern states.

Taylor's article (57) was written in 2009, but many of the issues still apply. He highlighted Northern Nigeria as the biggest challenge to polio eradication because of its social, equity and political situation.

B. Ecological Study

Process

Four data sources were used for this ecological survey:

- Nigeria Demographic Health Surveys (DHS) from 1999 to 2013 (12; 35-37)

- The District Health Information System (DHIS), used by the Nigerian Federal Ministry of Health to manage its administrative health data. Data from Jigawa, Katsina and Zamfara states, LGAs and HF have been available on-line since 2012 (75)
- Nigeria Polio Eradication Emergency Plans and WHO immunization monitoring data and CDC Morbidity and Mortality Weekly Reports (29, 31, 30, 76, 77-91)

Several studies helped to define the ecological study, including:

- Closser et al's analysis of DPT3 coverage data in seven countries (including Nigeria) from 1990 to 2010 to assess the intensity of PEI SIAs with DPT3 coverage (27)
- Verguet et al's study on the impact of measles SIAs on RI showed that analyzing subnational data reveals important differences in coverage and impact of SIAs on RI that are not reflected in national or provincial data (92)
- Lim et al's review of global immunization data from 1986-2006 which found that administrative data were of lower quality than survey data and were also subject to over-reporting when improved coverage is linked to performance-based funding or to the success of larger initiatives (93)
- Bonu et al's 2003 assessment of polio impact on RI by comparing OPV1 and OPV3 coverage rates to RI indicators (3)

Because ecological studies analyze groups, it is not possible to translate findings from a group to the individual. This is the "ecological fallacy" and is a disadvantage to using ecological studies but it is not a factor when looking at subnational immunization coverage.

Bias is a factor in ecological studies and can happen when there is a change in classification or how data are collected or measured. For this study, possible reasons for bias follow.

- In the DHS, parents are asked to recall their children's vaccinations, not specifying if they were given in campaigns or at the health facility. Parent's recall is then confirmed by a child's immunization card. The 2013 Nigeria DHS reported low immunization card confirmation in Jigawa (9.6%); Katsina (5%) and Zamfara (5%). (12) Without confirmation by card, coverage tends to be higher. (94)
- Vaccines given during SIAs are not recorded in the immunization card. Vaccines given during PIRI or LIDs, should be recorded as given during RI. (43) Because PIRIs and LIDs are part of an intensified effort to eliminate polio, they are exceptional and not routine and could also lead to inaccurate or inflated reporting of DPT, measles or OPV. (43) The frequency of PIRIs was not available for this study.
- The third doses of OPV and DPT are normally used to measure use of RI services at a health facility, but OPV, and sometimes DPT, which are given during SIAs are often recorded as OPV3 and DPT3, which could result in higher coverage for RI.

Noise is also a limitation. Because ecological studies examine data over time, it is difficult to monitor varying external influences, when they occurred and when an impact would result. Noise and confounding factors can influence trends in this ecological study.

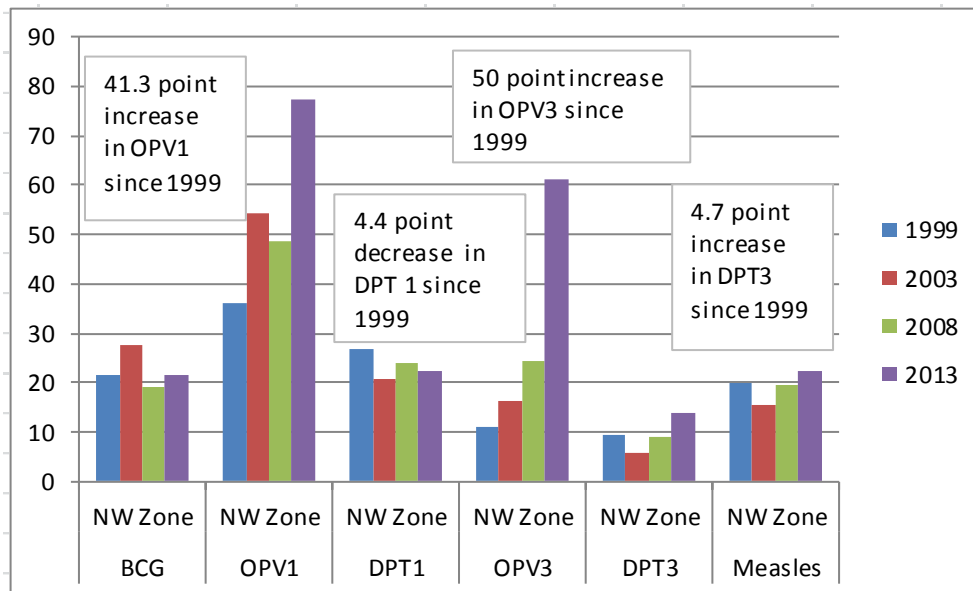
Systemic problems with RI in Jigawa, Katsina and Zamfara are significant confounding factors when analyzing immunization data. Over the course of the PRRINN-MNCH project, there were stock-outs of almost all RI vaccines; poor vaccine management; low demand and

unreliable vaccine distribution, all of which affect coverage rates as well as availability and use of services. In recent years, insecurity has become a factor, deterring parents from vaccinating their children. (7; 9-11; 27, 28, 33) Other confounding factors for this study include:

- polio SIAs, which could increase OPV coverage
- new vaccine introduction, which could generate interest in RI and create increase in coverage
- outbreak response which could be reflected in spikes of OPV and measles coverage
- poor data recording and quality in Nigeria (7, 33, 34, 60, 95)

Demographic Health Survey findings

Figure 2: Comparison of Nigerian DHS immunization coverage data, 1999-2013 (12, 35-37)



Lim et al (93) found survey data to be stronger than administrative data in revealing long-term changes in immunization coverage data. As a first step in this analysis, DHS data were reviewed to identify immunization coverage differences in Nigeria from 1999-2013.

Figure 2, assesses immunization coverage in the NW Zone (which includes Jigawa, Katsina and Zamfara) since 1999. In the years before and during the DHS data collection, there were:

- 4 PEI SIAs between 1998-1999
- 14 PEI SIAs between 2002-2003
- 19 PEI SIAs between 2007- 2008
- 20 PEI SIAs between 2012 and 2013

Figure 2 shows:

- A consistent increase in OPV3 from 1999-2013 with a significant peak in OPV1 and OPV3 in 2013, likely coinciding with an increase in SIAs.
- BCG vaccine is a child's first contact with RI and is given as soon as possible after birth, indicating access to health facilities. (3) The DHS data show that there has been 0% increase in BCG coverage in the NW zone since 1999.
- Measles vaccine coverage shows the completion of the routine schedule (3), and while there was a 12% increase in coverage between 1999-2013, coverage through RI barely rises above 20%.
- On the RI schedule, OPV and DPT are given at the same time, therefore rates for OPV and DPT should be equal, but they are significantly different, showing that SIAs skew the data and coverage for OPV.

- From 1999-2013 there was a 115% increase in OPV1 coverage; a 450% increase in OPV3 coverage; a 17% decrease in DPT1 coverage and a 51% increase in DPT3.

The DHS began collecting state-level data in 2008. Figure 3 shows the RI coverage data for Jigawa, Katsina and Zamfara between 2008 and 2013.

Figure 3: DHS comparison of data 2008 and 2013 (37, 12)

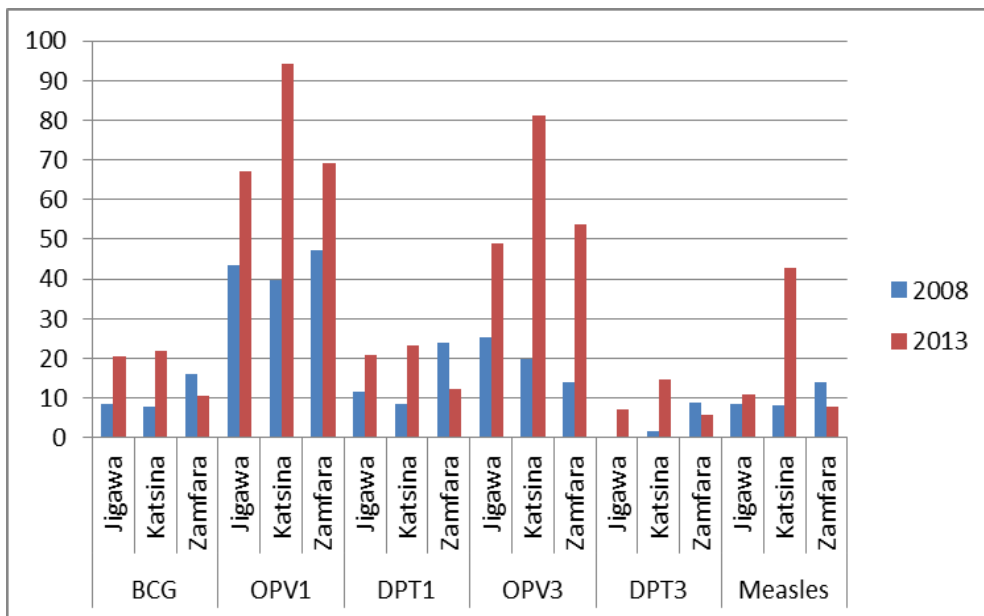


Figure 3 has a similar overall trend as Figure 2. Specifically:

- Low BCG coverage, high OPV1/OPV3 coverage and DPT1/DPT3 coverage significantly lower than OPV 1/OPV3
- Jigawa and Katsina show increasing RI coverage (although too low to prevent disease transmission or outbreaks) and Zamfara shows a decrease
- The increase in measles coverage in Katsina is likely due to an outbreak in 2013.

- A drop off between DPT1 and DPT3 in all three states, possibly indicating dissatisfaction with services or vaccine stock-out
- In 2007 there were 12 PEI SIAs; in 2008 there were 7 PEI SIAs; and in 2012 there were 11 SIAs. As these states are high-risk states, they would have had full coverage with SIAs and likely additional outbreak response, which could explain the increase in OPV since 2008.

While coverage surveys are less reflective of peaks and dips in SIAs and incentivized programs, the DHS shows that there is much more long-term availability and focus on OPV vaccination than others. It also shows Nigeria's consistently low immunization coverage and suggests that the focus on polio elimination and related campaigns have not strengthened RI use and services.

Demographic Health Information System findings

Verguet et al (92), in their study on measles SIA impact on RI in South Africa, reported that national and provincial-level administrative data can hide poor performing districts. They analyzed subnational DHIS data to show the differences in coverage linked with frequency of SIAs. The study found that district-level data showed that measles SIAs could be linked to lower immunization, which was not detectable in national data. (92) This study attempts to show a similar pattern at subnational level in Nigeria.

Nigeria has been using web-based DHIS to record State, LGA and HF administrative health data since 2012. Part of the DHIS approach is to train health information officers in each LGA

and conduct data quality assessments. Results showed that completeness, correctness and consistency of data had all improved since the introduction of DHIS. (95) Completeness of data in Jigawa, Katsina and Zamfara states are all above 80%. (95)

While Lim et al found that administrative data are of lower quality than survey data (93), they do show more of the short-term changes and influences at subnational level, similar to Verguet et al’s findings. For this study, Nigeria’s DHIS data were analyzed to assess any differences at State and LGA level from survey data. Data sets from 2012 and 2013 for Jigawa, Katsina and Zamfara were used.

Figure 4 shows the overall coverage data for the three states.

Figure 4: DHIS 2 State level immunization data (75)

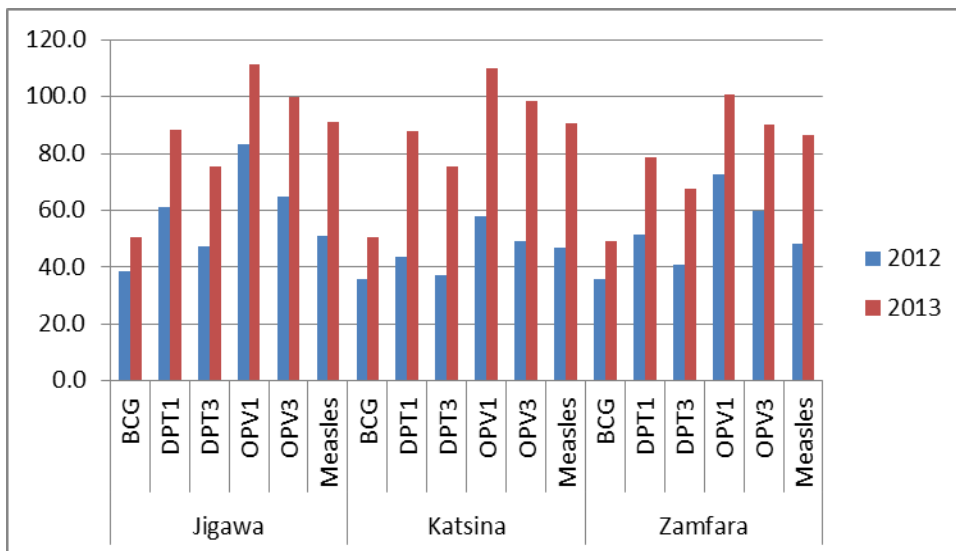


Figure 4 shows the same pattern as the DHS data, notably that OPV1 and OPV3 coverage is higher than any other antigen in 2012 and 2013. Additional observations include:

- DHIS is administrative data and records actual immunizations given, perhaps showing a truer use of RI services for OPV and DPT than the DHS data; or it is influenced by pressure for increased coverage. (93)
- DHIS 2013 data show high levels of OPV1 coverage (over 100%) which could indicate difficulties in calculating denominators. Or, there was more community engagement and more encouragement of RI services at the health facility in 2013, increasing demand and use of facilities for RI. (28)
- The increase in recorded OPV and DPT coverage could reflect PEI's increased use of PIRIs to expand outreach and not use of health facilities. When conducting outreach, OPV doses should be recorded in immunization cards and registers. Outreach is part of RI services, but PIRI/LIDs are PEI's emergency approach to end polio transmission and reduce cVDPV. (29, 30, 31, 43) Increases in DPT coverage in 2013 could reflect the change in approaches.

The DHIS records the drop-out rate between DPT1 and DPT3 as an indicator of service. From 2012 to 2013, in Jigawa, DPT drop-out decreased from 22.9% to 12.8% and in Zamfara, DPT drop-out decreased from 17.3% to 14.8%. Drop-out was unchanged in Katsina.

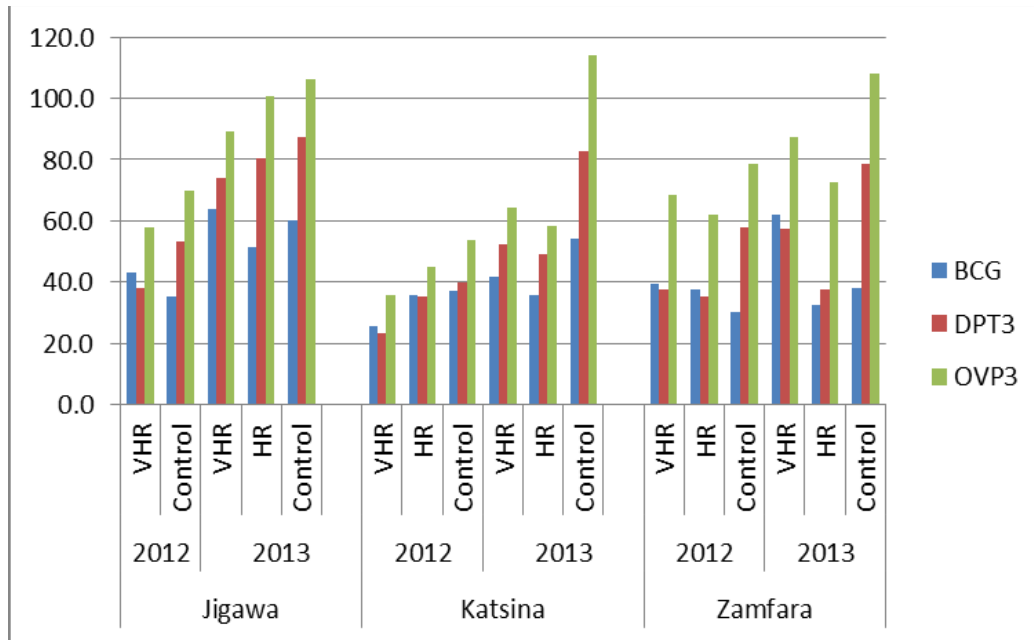
To gain a clearer picture of LGA coverage and possible impact of PEI activities, the author further analyzed data based on an LGA's risk of polio transmission. The National Polio Eradication Emergency Plans for 2012 and 2013 (29, 30) assigned different levels of risk to LGAs in the 11 Northern Nigerian states – either Very High Risk (VHR) or High Risk (HR). Those were LGAs that would receive intensified interventions to reduce the risk of polio transmission and strengthen SIAs. The LGAs not categorized as VHR or HR are defined by the author as “control” LGAs.

Table 1: Interventions conducted in VHR, HR or control LGAs (29, 30)

	2012			2013		
	VHR	HR	Control	VHR	HR	Control
Number of SIAs per year	8	8	8	11	11	11
Increased SIAs	✓	✓		✓	✓	
Increased RI outreach/PIRI	✓	✓		✓	✓	
Increased incentives and performance awards	✓	✓				
Increased technical assistance and management	✓	✓		✓	✓	
Improved microplanning	✓	✓		✓	✓	

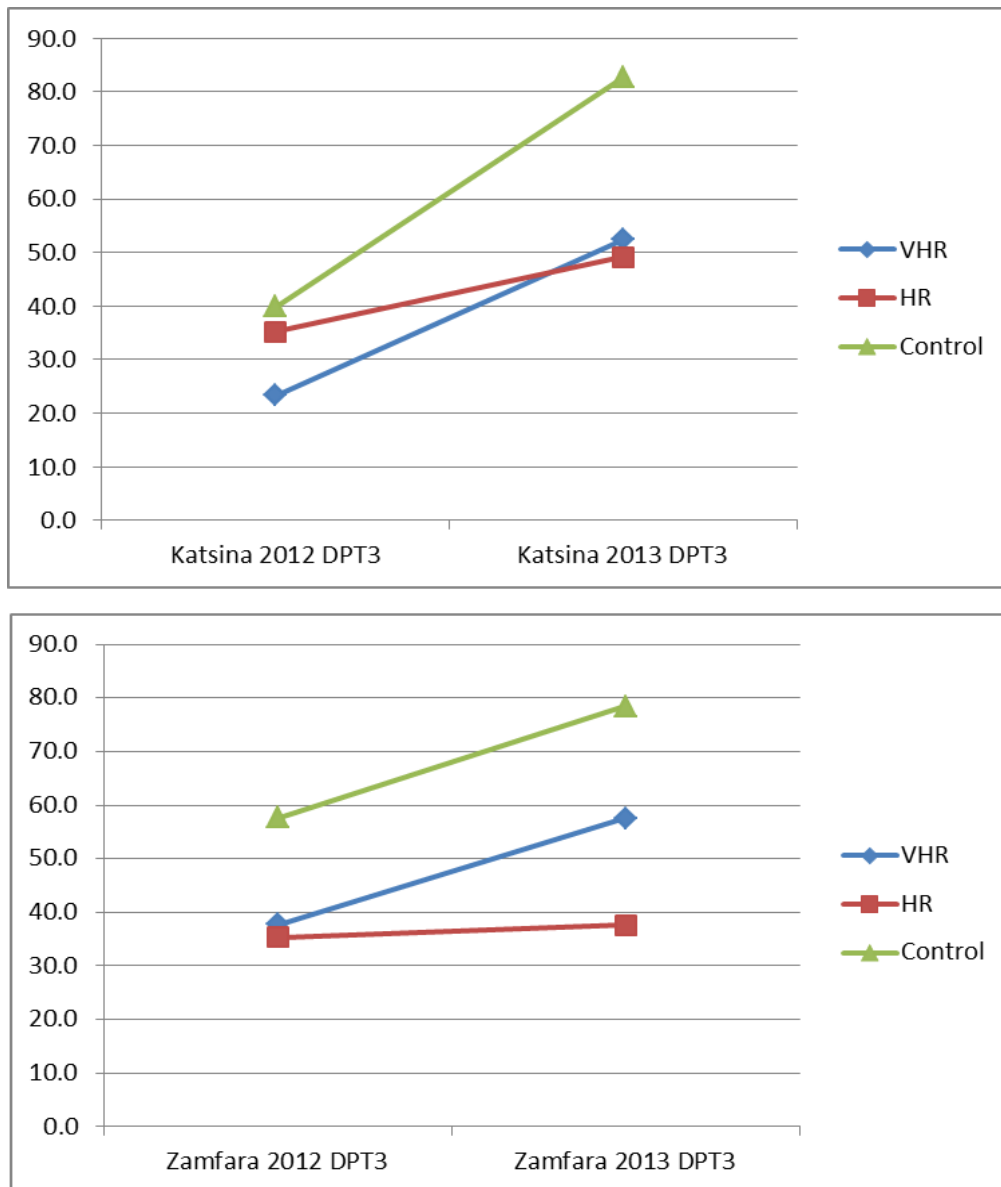
Figure 5 shows the coverage of each antigen as defined by LGAs-risk status.

Figure 5: DHIS data of VHR, HR and Control LGAs in Jigawa, Katsina and Zamfara (75)



The DHIS LGA data show higher coverage of OPV3 than other antigens, but also show an increase in DPT3 coverage in 2013 in most LGAs. However, looking specifically at DPT3 coverage in Katsina and Zamfara, (Jigawa was excluded because there were no HR LGAs to compare in 2013), the results in Figure 6 show that the increase in DPT3 coverage was faster and greater in control LGAs than in VHR or HR LGAs. Closser et al also found that in Nigeria, DHS data showed improvement was lower in areas with high levels of PEI SIAs. (27)

Figure 6: DPT3 coverage in VHR, HR and control LGAs in Katsina and Zamfara (75)



There was a greater increase of OPV3 coverage in Katsina and Zamfara control LGAs than VHR or HR LGAs. If OPV3 coverage in the DHIS is an actual recording of RI coverage, it could indicate more children receiving OPV3 through RI and that VHR and HR is having a negative impact on RI coverage in VHR and HR LGAs. There was no identifiable difference in drop-out rate across VHR, HR and control LGAs.

DHIS findings show stronger RI in control LGAs, which would confirm Verguet et al’s findings that SIA activity in VHR and HR LGAs does affect RI coverage for OPV and DPT. (92)

When comparing DHIS with DHS data, DHIS shows a much greater coverage of all antigens than the DHS.

Figure 7 Comparison of 2013 DHS and DHIS data (12, 75)

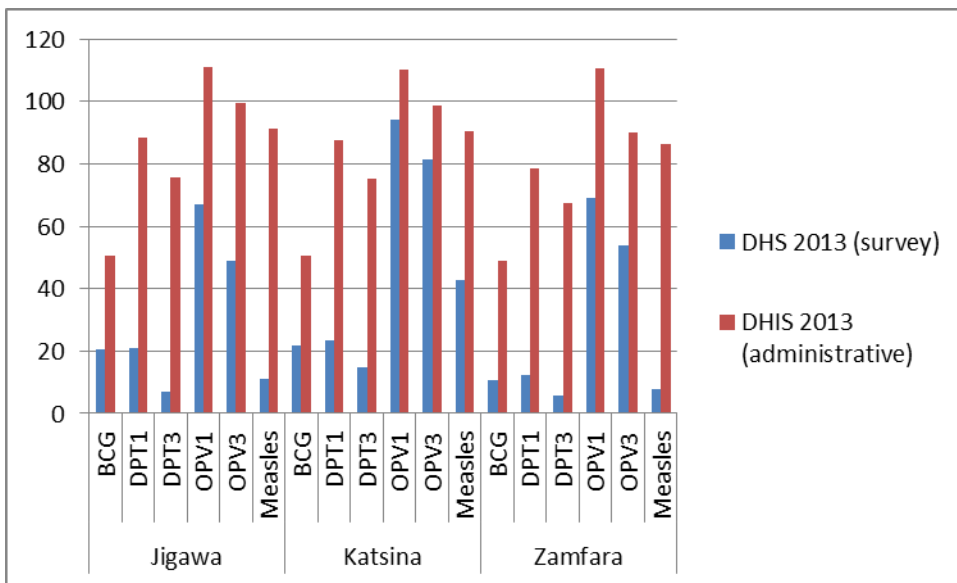


Figure 7 shows that administrative data could be more influenced by pressure to inflate data than survey data and could reflect the impact of PIRIs and other efforts to increase coverage. The fluctuation in the DHIS data could also show the fragility of the immunization program when it is influenced by the effort to eliminate polio and increase coverage.

V. DISCUSSION AND CONCLUSIONS

The results from the literature review and ecological study show a complex picture of PEI activities and RI in Jigawa, Katsina and Zamfara. There are some clear examples of where polio has had either a positive or negative impact, but this is confounded by a poor performing RI system. Much of the impact of PEI is seen within various components of the program and the literature review identified some of the “hidden” impact of PEI on RI, health systems and the community in Northern Nigeria.

A. Key Findings

PEI impact on routine immunization

With the National Routine Immunization Strategic Plan in Nigeria, there is an increased effort to bring RI back to the forefront of PHC. (34) The PRRINN-MNCH project recorded significant improvements in RI demand, increased coverage in project states and increased governance for RI and PHC (13) but strengthening RI takes planning, funding, consistent vaccine supply and community demand. Most of all, it takes time for systems to build and be sustained.

In the PRRINN-MNCH study, 73% of respondents from Jigawa, Katsina and Zamfara felt that PEI has had a positive impact on routine immunization. However, more specific questions on RI revealed poor distribution of vaccines, little to no funding of operational costs and maintenance and fuel only for PEI SIAs. (28)

Findings from the PRRINN-MNCH study could correspond to increased government effort to improve RI but it could also reflect increased efforts by PEI to intensify outreach and RI in between campaigns. While PIRIs are good for catching missed children (43), they are not indicative of a strong RI program. The Universal Childhood Immunization (UCI) program in the 1980s was a well-funded program that also pushed for rapid, often unreliable, increases in RI coverage and created parallel systems (24), but when funding ended, UCI coverage dropped. (24, 96) With GPEI's final push for polio elimination in Nigeria, increased RI coverage could be rapid; giving a dangerous impression that RI systems in Nigeria have been strengthened. Polio eradication needs consistent high coverage to maintain eradication and to introduce IPV and if performance or coverage is artificially inflated, Nigeria could go backwards.

Circulating Vaccine Derived Poliovirus shows the danger of ignoring RI. When children were not fully vaccinated against all types of WPV, the vaccine-virus was able to circulate and modify, creating a cVDPV. There are now more cases of cVDPV in Nigeria than polio. SIAs should not replace RI; they should be used with RI to boost immunity and reach missed children. If donors and governments become too reliant on SIAs as a way of avoiding systemic difficulties of strengthening RI, there is a risk of increased disease, outbreaks and cVDPV.

The GPEI not only disrupts RI services in countries, it also shifts global priorities. The WHO receives funding for polio and therefore risks prioritizing GPEI over other health initiatives. Eighty-five percent of WHO/AFRO's budget goes to PEI. (63) When considering support for

IPV funding, GAVI was concerned about IPV introduction diverting attention from other vaccine introduction. (97)

In 2013-2014, Syria, Cameroon, Iraq and Equatorial Guinea had polio outbreaks, due to decreases in RI coverage due to war or weak programs. (6) To sustainably decrease disease and eventually maintain eradication, strong RI is essential.

PEI impact on health systems

A country's health system supports all services with staff, infrastructure, distribution systems and funding. Vertical programming often assumes the health system is strong enough to manage additional focused effort on disease prevention. Vertical programs, if well planned, can provide countries with an opportunity to address some of the weaker elements of the system.

The PRRINN-MNCH and Closser et al studies, like previous studies, found that surveillance and supervision have been improved by PEI (25, 27, 28) and could be expanded. Supervision frequency for RI, PEI and PHC has increased in Jigawa, Katsina and Zamfara and with more focus on accountability, supervision is becoming much more important and visible and appreciated by health workers. (28) While supervision still tends to be vertical in the three states, if a culture of supervision has been developed, it could be built on, but needs to be measured and quality controlled. (27, 28)

Microplanning is used heavily for PEI and could be expanded to other services to improve health system. Through microplans, health workers now know their catchment population which can improve access, data management and service planning. The utility of microplanning, however, is often overlooked. Only 26% of health workers in Jigawa, Katsina and Zamfara use microplans for PEI, RI and other health services (28), either due to lack of training or frequent use of microplans through PEI means they are already familiar with their communities.

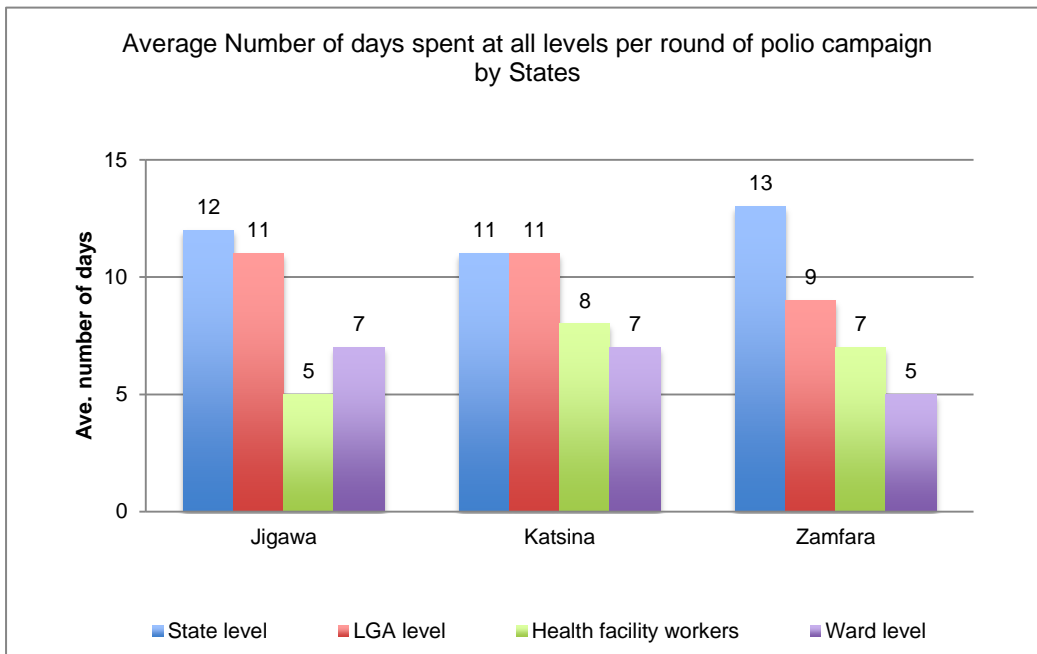
The Government of Nigeria provides financial, human and technical resources for PEI. (18) In 2012 and 2013, the government provided US\$30 million each year to supplement funding from donors and health partners. (70) This amount was increased to US\$ 50 million in 2014 (98), arguably diverting resources from other health programs.

In Nigeria, SIAs have been the norm since 1996, in many cases providing the only health care that neglected populations receive. The risk is that SIAs will become the only way of providing immunization services, with some integration of other health commodities, especially in hard-to-reach areas. With PEI, OPV is given door-to-door and could risk that communities' demand door-to-door health care instead of PHC services at the health facility. In Jigawa, Katsina and Zamfara, 79% of health workers felt that PEI has had a negative impact on PHC services, citing low levels of support and funding. Campaigns are often used to avoid working in difficult health systems to reach objectives (50, 63), but if communities become dependent on campaigns to meet their health needs (defined, perhaps by top-down objectives [24]), they will miss the full services that they can receive through PHC.

PEI impact on human resources

There are positive and negative impacts of PEI on human resources. The majority of health workers in Jigawa, Katsina and Zamara felt that PEI has provided motivation through training, incentives and disease reduction but they were concerned about the number of rounds and time taken away from their jobs (28).

Figure 8: Average number of days spent per PEI campaign (28)



Given the number of days spent on PEI SIAs and the number of campaigns per year (up to 13 in 2014)(28), health workers spend much time focused on PEI. Northern Nigeria already has insufficient medical staff and because health facilities have only one health worker, the impact on service availability is high. Oral Polio Vaccine is used in SIAs because it does not require trained health staff to administer and PEI is able to employ a wide range of people to give polio drops. Other immunization SIAs, however, need trained health workers to do

injections. Increasing immunization SIAs (measles, yellow fever, meningitis, possibly IPV) could have an even greater impact on available human resources.

A system of incentives has been built and expected with PEI. Respondents from Jigawa, Katsina and Zamfara felt that incentives are important for the economy and motivation. Withdrawing incentives could be detrimental. (28) But incentives need donors and/or government funding and risk being unsustainable when funding is no longer available. Incentives can divert attention and priority from other, perhaps more locally urgent, health needs. (24, 64) The table in Annex 1 shows the high level of supplementary income that health workers can make from PEI incentives, and although not documented in the literature, incentives could also serve as a disincentive for public servants to end SIAs.

PEI impact on community engagement

Health workers interviewed in the PRRINN-MNCH study felt that PEI has brought improvements to community engagement. (28) A cadre of community members, initially involved in polio, is now working to promote RI and other health issues. Importantly, community engagement builds trust.

The polio boycott in 2003-2004 was the result of community suspicion of polio SIAs, top-down health programming and distrust in the government. It took time to overcome, but PEI showed that it can adapt to community needs by creating IPDs and by seeking involvement of traditional leaders, religious leaders and local-level politicians. However, parents in Jigawa, Katsina and Zamfara still refuse polio because of rumors, too many rounds and

feelings that other health services are not provided. (28) Yahya (59) and Renne (32) emphasize the importance of understanding cultural perceptions of communities to better understand the communities' experience with PEI and how to build programs that meet their needs.

Community engagement has been largely funded by GPEI partner organizations, including paying incentives which risk being unsustainable when PEI funding ends. "Pluses" are funded by States and LGAs and some health commodities are delivered as part of integrated campaigns. If "pluses" are not available or community demands for other health services are not met, parents refuse polio vaccination. (28)

PEI impact on immunization coverage

The DHS data show that there has been little to no improvement in BCG, DPT or measles coverage in Northern Nigeria since 1999. There were however, major increases in coverage for OPV1 and OPV3. Since campaigns began in 1996, it can be assumed that these increases are because of intensified efforts to eradicate polio. It also shows an immunization program that has failed to reach its population with all vaccines and quality service. Nigeria's RI program could have greatly benefitted from more support from PEI, but PEI itself did not increase harm. Bonu et al (3) found similar results in North India in 2003 where immunization rates were stagnant and had high levels of PEI activity. They concluded PEI did not have a positive impact on RI because there was no improvement in coverage for RI.

The DHS data for Nigeria prove Lim et al's argument that surveys are a more reliable way of measuring long-term trends in immunization coverage. (93) The administrative DHIS data show a much stronger peak in coverage, but it is significantly different from the DHS coverage in the same year. The DHIS data either show an intensification of RI activities in Jigawa, Katsina and Zamfara, or show the pressure on health workers and officials to improve their coverage figures either through performance or fixing data. PEI's call for accountability at LGA level (30, 31, 28) could lead to inflated coverage data.

Closser et al did a multiple regression analysis of WHO/UNICEF and Institute for Health Metrics and Evaluation (IHME) data compared with frequency of PEI SIAs and found inconclusive results. (27) Using DHIS data, this study did find lower DPT3 and OPV3 coverage through RI in VHR and HR LGAs in Katsina and Zamfara states, and could suggest a negative impact of PEI SIAs on health services, but this assumption could be strengthened with further analysis over a longer timeframe.

B. Study Impact and Opportunities

This research draws heavily on information from PRRINN-MNCH and on the author's experience as the project's immunization advisor. Since the start of PRRINN-MNCH, there was anecdotal evidence on the disruptions caused by PEI, but the data were inconclusive. Given the difficult environment for RI and PHC, it was difficult to know whether poor performance was due to PEI SIAs or a weak health system. (9)

The PRRINN-MNCH PEI impact study (28) expanded Closser et al's research from one LGA in Kano State to 15 LGAs in Jigawa, Katsina and Zamfara, interviewing 252 health workers at all levels for their experience with PEI. It confirmed Closser et al's findings (27) on a larger scale and provided a deeper knowledge on the current state of RI and SIAs in Northern Nigeria, which in turn can provide information to the government for IPV introduction.

There are some concerns about bias in the PRRINN-MNCH study. (28) One possible bias was that the research was conducted after pentavalent introduction and intensified efforts to increase RI coverage. Both events may have resulted in more positive response on RI. Another possible bias is the use of incentives. Many health workers in Jigawa, Katsina and Zamfara earn a substantial income from PEI and although respondents were assured confidentiality, they may have been reluctant to respond to questions that could have a negative response. Akwataghibe et al (64) used a randomized response technique to interview health workers about sensitive issues on supplementary income. Using a similar technique may be better for researching health workers honest experience with SIAs incentives.

The numbers of PEI SIAs were available to compare with the data, but many of the state-level interventions (e.g. PIRIs) were not. There was a lot of noise and several confounding factors. The landscape of polio eradication in Nigeria is ever changing, which can influence RI interventions and impact.

The use of LGA data to measure PEI impact in Nigeria is new. Closser et al used WHO/UNICEF and IHME data (27), but DHIS gives a better assessment of subnational activity.

DHIS is relatively new in Nigeria, but by the end of 2014, there will be three full years of data. Data from 2014 could be studied on a month-to-month basis, which could give better information on the impact of PIRIs and increased SIAs. Working closely with Nigerian state and LGA partners could more accurately record the timing of PIRIs and LIDs and to compare monthly impact.

Unfortunately, weak RI is not restricted to Northern Nigeria. National DPT3 coverage in 2013 was 38%; BCG coverage was 51% and OPV3 coverage was 54% (12). Quantitative (using DHIS) and qualitative research to compare Northern Nigeria's experience with SIAs and RI to the experience in Southern Nigeria (where there have been few PEI SIAs, but still low RI) could help to identify nationwide issues in RI services.

VI. RECOMMENDATIONS

This study showed the problems measuring RI coverage in Northern Nigeria. It is difficult to understand the actual state of RI – RI that is not influenced by PEI SIAs and polio emergency plans. Nigeria will need to ensure that its immunization program is as strong as its reported data. Unsustainable programs and inaccurate data were the downfall of UCI, which showed how fragile donor efforts can be. Weak coverage with tOPV led to an ongoing cVDPV outbreak and it is a risk for IPV introduction. Withdrawing OPV and introducing IPV in Nigeria, with the impression that RI coverage is high, could introduce other cVDPV or risk the continued polio transmission.

Nigeria needs sustained high RI coverage and it needs a strong commitment to improving RI and its health system. The Nigerian Routine Immunization Strategic Plan provides a framework to strengthen RI (34) and, with continued political, donor and community support, this plan can lead to a strong cold chain, improved vaccine distribution and quality services. The introduction of IPV is an opportunity to strengthen routine immunization (63, 97) and the Nigerian Government and donors can use IPV introduction to identify the problems with RI and address them in a systematic and sustainable way.

In 2001, Steinglass and Fields provided recommendations to the WHO on how RI could be strengthened within the context of PEI (16), including:

- Expanding social mobilization to include messages about RI.
- Using polio microplans to support RI and other health services.
- Strengthening vaccine management skills.
- Institutionalizing preventative maintenance to strengthen the cold chain.
- Supporting the use of vaccine cards to monitor vaccinations and track coverage.

Other recommendations from the literature (25, 27, 28, 50) include:

- Building on AFP surveillance to improve surveillance skills and outreach for other diseases.
- Ensuring regular RI vaccine supply, operating costs and vaccine distribution.
- Identifying and planning cold chain needs so equipment purchased is appropriate and safe for both RI and PEI.

- Improving data recording and management to gain an accurate measure of RI and PEI coverage; could include identifying better process indicators to measure health system impact.
- Revitalizing microplanning so it can become a tool for RI and PHC planning, budgeting and outreach.
- Reinforcing donor coordination and commitment to health system strengthening in Nigeria so that PHC can benefit fully from vertical investments.

As part of its endgame strategy and legacy, GPEI plans to identify systems they have built and GPEI contributions to immunization as a way of integrating their experience to improve countries' health programs in the future. (6) LaFond et al (99) found four "direct drivers" that, in addition to strong immunization systems and district management, can improve RI. These direct drivers have also been used by PEI and could be built upon to strengthen RI in Nigeria. These direct drivers are:

- 1) **Community health workers**, who build trust, provide information and facilitate outreach in the community with government support and resources (99). PEI community workers have been trained to promote RI and other health programs (27, 28) and their work could be expanded with continued funding after PEI.
- 2) **Community and health system partnership in planning, implementation, performance and reaching hard-to-reach communities**. This effort relied largely on volunteers in the LaFond study and the government helped by linking the community and health system. (99) Extensive planning and partnering has been done with PEI between the different levels of government and community. Access to hard-to-reach

communities has also improved. (27, 28) This partnership can continue after eradication, but again will require funding and a functioning supply system and operating costs to maintain reliability of services.

3) **Performance improvement**, including review meetings, supervision, use of data to monitor performance and meetings with communities and health workers to review the program. (99) In the past year, PEI has increased its accountability and supervision in Northern Nigeria (28) so there is a mechanism for performance improvement that could be expanded to improve RI and PHC. A culture of supervision could spread to the whole health system.

4) **Meet community immunization needs.** Strong programs worked with communities and modified immunization services to better access children for immunization. (99) In Northern Nigeria, PEI is now more focused on meeting community needs with improved availability of services, but there is still lingering refusal. (28) Had community needs been better met at the start of PEI, there might have been a quicker acceptance of polio vaccine. This legacy lesson is essential for future health initiatives.

LaFond et al's direct drivers were dependent on a strong RI program and district health management teams (99). While each State and LGA in Nigeria has its own responsibilities for health, it is still dependent on the Federal Government to set policy, procure vaccines and ensure funding. Nigeria is building State Primary Health Care Development Agencies to encourage more efficient PHC management at the sub-national levels and to help strengthen systems. But a key missing element in the discussion on RI in Nigeria is the governance and

management of the immunization program. Over 15 years there has been little to no improvement in RI in Nigeria. Much more needs to be done to find out why RI has stagnated and why leadership has not been more committed to strengthening RI in Nigeria, especially in the northern states.

Mogedal and Stentson (25) found that stronger health systems face less disruption from PEI which is consistent with other findings. (24, 27, 50, 53, 100) All GPEI partners, including the government, must identify what the strengths and weaknesses are of the Nigerian health system and adapt the final push for polio elimination to sustainably address long-term problems to improve overall health.

Global polio eradication efforts will continue into 2018 and possibly beyond. Polio eradication can provide important lessons as other disease initiatives consider eradication (50, 53, 101), including:

- the importance of community engagement in different cultural and political environments and adapting strategies to meet community needs;
- the risk of unrealistic deadlines, fatigue and impact on a country's own health priorities;
- the risk of incentives and skewing motivation away from providing routine services; and
- the impact of vertical programs on health worker time and health system effectiveness.

Whatever the next target for elimination or eradication, programs and donors need to rethink their strategies for countries with weak health systems and need to carefully assess how they can strengthen health systems with sustainable goals and proud long-term legacies.

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Annexes

Annex 1:

Comparison of salaries and incentives among health workers in Jigawa, Katsina and Zamfara (personal correspondence, Michael Siebert, PRRINN-MNCH Human Resource Technical Advisor 14 April 2014; 21 July 2014; 28)

Staff position & level (state, LGA, HF)	Yearly Scale Avg		Incentive per round		Estimated # of rounds per year	Avg earned in incentives in a year	% of yr salary
	Naira	Dollars	Naira	Dollars			
JIGAWA	Naira	Dollars	Naira	Dollars			
CHO (LGA)	215136	1334	15,608	97	10	968	73
JCHEW (HF)	90157	559	6,828	42	10	423	76
Medical Officer (State)	344374	2135	18,023	112	10	1117	52
sNurse (State)	215136	1334	18,023	112	10	1117	84
KATSINA	Naira	Dollars	Naira	Dollars			
CHO (LGA)	204539	1268	15,608	97	10	968	76
JCHEW (HF)	86580	537	6,828	42	10	423	79
Medical Officer (State)	312322	1936	18,023	112	10	1117	58
Nurse (State)	160083	993	18,023	112	10	1117	113
ZAMFARA	Naira	Dollars	Naira	Dollars			
CHO (LGA)	233212	1446	15,608	97	10	968	67
JCHEW (HF)	97800	606	6,828	42	10	423	70
Medical Officer (State)	413425	2563	18,023	112	10	1117	44
Nurse (State)	233212	1446	18,023	112	10	1117	77

Annex 2: Comparison of DHS and WHO/UNICEF Nigeria National RI coverage**estimates (35, 12, 39)**

		1999	2013
BCG	DHS	54	51
	WHO UNICEF	46	80
DPT1	DHS	47	51
	WHO UNICEF	41	63
DPT3	DHS	26	38
	WHO UNICEF	31	58
OPV3	DHS	25	54
	WHO UNICEF	27	67
Measles	DHS	41	42
	WHO UNICEF	35	59