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Expanding and improving urban outreach immunization in Patna, India

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Abstract

OBJECTIVES We conducted a case study of an urban immunization outreach strategy to determine the feasibility of the intervention and to measure administrative immunization coverage outcomes.
METHODS A multipronged strategy for improving immunization coverage in Urban Patna, India, was implemented for 1 year (2009/2010). The strategy was designed to increase immunization sites, shift human resources, plan logistics, improve community mobilization, provide supervision, strengthen data flow and implement special vaccination drives.
RESULTS Over 1 year, the coverage of all primary vaccines of the Universal Immunization Program improved by over 100%.
CONCLUSION Coverage can be rapidly improved through outreach immunization in low socioeconomic areas if existing opportunities are carefully utilized.

keywords urban, immunization, outreach, Patna

Introduction

Immunization is one of the most cost-effective public health interventions available (Hadler *et al.* 2008; Clements *et al.* 2008). Beginning with the Expanded Program of Immunization (EPI) (Sokhey *et al.* 1989) in 1978 and strengthened further by several national programmes, including the comprehensive National Rural Health Mission (NRHM) (National Rural Health Mission, 2005–2012) launched in 2005, the states of India have endeavoured to vaccinate and protect children from tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus and measles. Newer and underutilized vaccines, such as those against Hepatitis B, Japanese encephalitis, rubella, typhoid and mumps, have been introduced in certain states and districts, and *Haemophilus influenzae*, pneumococcal and rotavirus vaccines are also being considered for inclusion in the Indian national immunization schedule (National Technical Advisory Group on Immunization, 2008).

India continues to have the largest number of unvaccinated and partially vaccinated children globally (Unicef and WHO publication, 2011). While the NRHM has brought about a steady increase in immunization coverage in many rural areas Ministry of Health and Family Welfare, 2010, poor urban health infrastructure coupled with an increasing trend in urbanization has created areas of high risk for vaccine-preventable disease transmission and outbreaks, particularly in the growing urban slums and lower socio-economic urban classes. According to the web page of the World Health Day 2010 theme,the majority of the population growth over the next 30 years will be in urban areas. Urbanization is a challenge for several reasons: the urban poor suffer disproportionately from a wide range of diseases and other health problems; and they are at increased risk of violence and chronic and communicable diseases such as tuberculosis and HIV/AIDS. WHO further noted that 'the major drivers, or social determinants, of health in urban settings are beyond the health sector, including physical infrastructure, access to social and health services, local governance, and the distribution of income and educational opportunities'.

Patna is the fifth (Citymayors.com, http://www.citymayors.com/statistics/urban_growth1.html) fastest growing city of India with an estimated annual growth of 3.72%. It provides a case study where good governance, improving access to social and health services, appropriate use of new technology and flexibility in planning of immunization sessions created an opportunity for implementing a new urban immunization outreach intervention. Before the

intervention, public sector immunization delivery was limited to the public hospitals in urban Patna. The outreach immunization intervention was developed in 2009 to expand access to services beyond the hospitals. Infrastructure and staff problems were solved within the existing health systems and resources. A combination of ongoing programmes and recent developments related to immunization provided excellent opportunities to implement the urban outreach immunization intervention.

The first opportunity was the growing presence in urban Patna of the Integrated Child Development Services scheme (ICDS) Bihar, (http://icds.bih.nic.in/), focusing on early childhood development. In the preceding 2 years, the ICDS scheme in Patna had grown, leading to the establishment of 691 ICDS centres (also called the Anganwadi centres) from an earlier 156 Status of Anganwadi Centers in ICDS Projects (Bihar), (http://icds.bih.nic.in/DetAWC1.htm). The ICDS centres were generally located in lower socio-economic residential areas and served an average population of 1500 persons. Each ICDS centre was assigned at least one paid Anganwadi worker to provide pre-school education, nutrition and health services.

The second opportunity was the Polio Eradication Program, which instituted a well-operating system of house-to-house vaccination complemented by a network of social mobilization coordinators and field volunteers engaged in mobilization, planning and monitoring of the house-to-house vaccination campaigns. Although the Polio Eradication Program functioned well, it could not provide other vaccinations, because oral polio vaccine was administered house-to-house by volunteers, whereas the other vaccines provided through the Universal Immunization Program were injectable and required trained nurses (World Health Organization, Ministry of health and family welfare, 2007).

The third opportunity was an innovative approach supported by the NRHM resources throughout the state of Bihar called *Muskaan ek Abhiyaan,* (Goel *et al*., 2011) a strategy consisting of tracking beneficiaries needing immunization and providing performance-based incentives for mobilizers of beneficiaries and vaccinators. NRHM also provided resources for alternate vaccine delivery (i.e. couriers to deliver vaccines to outreach sites, and take unused vaccines and administrative coverage reports to the hospital after sessions), alternate vaccinators and district-level computer operators for the immunization programme. Before the implementation of the urban outreach vaccination strategy, *Muskaan ek Abhiyaa* had been restricted to rural areas.

The objectives of the urban outreach immunization activity were to expand and improve immunization coverage in urban Patna, despite a deficient health infrastructure and inadequate manpower. We conducted a retrospective case study of the intervention, to assess its feasibility and measure administrative immunization coverage outcomes.

Methods

Within the framework of these three ongoing programmes and recent developments, multiple strategies were used to implement the outreach immunization services in urban Patna: increasing immunization sites, ensuring sufficient staff for providing injections, planning required logistics, improving community mobilization, providing supervision, using reported data for action and supporting special complementary vaccination drives (Table 1).

Strategies for urban outreach immunization services

The newly expanded ICDS centres in urban Patna provided monthly immunization sessions, extending the services beyond public hospitals. Based on the target population and number of planned outreach immunization sessions, it was calculated that each of the 691 ICDS centres would provide an average of 27 injections during each monthly outreach immunization session.

With the deficiency of urban health posts in Patna, there was also a corresponding shortage of nurses to carry out urban outreach vaccination. Through the introduction of NRHM, most of the health subcentres in rural areas had two nurses and could spare one of the nurses twice a week during lower workload days when the health subcentre could be managed by one person. Forty-five nurses were selected and trained to administer routine immunizations using the standard health workers handbook Ministry of Health and Family Welfare, 2007 and deployed twice a week to conduct urban outreach immunization services. Each nurse had to cover one to two ICDS centres a day for 8 days a month to provide coverage for the 691 outreach sites.

The nine hospitals in urban Patna had vaccine storage facilities referred to as vaccine depots. The polio eradication house-to-house campaigns were managed through these depots, and to ensure all areas were visited during the campaign, each depot had a well-defined coverage/catchment area called the urban vaccination area. Satellite imagery and geographic information system (GIS) technology were used to create accurate paper maps delineating the urban vaccination area boundaries. A logistics distribution plan for the urban outreach vaccination activity was constructed to align with these urban vaccination area boundaries. To ensure further precision, surveyors used hand-held global positioning system (GPS) instruments to

Table 1 Grouping of strategic interventions used to improve vaccination coverage in Urban Patna in 2009–2010

Categorization	Challenges	Interventions
Improving geographic access	Limited access, as only 9 urban hospitals providing free vaccination services.	Outreach services extended from these 9 hospitals to 691 outreach sites
Staffing	Limited manpower in 9 urban hospitals, not available to visit outreach sites	45 nurses identified for deployment to urban vaccination areas on low-work days in their place of posting
Vaccine and logistics supply	Need to reach about 90 sites on each vaccination day and 691 sites a month with different locations and routes. Meticulous planning needed to ensure efficiency of limited manpower delivering vaccines.	Provision for alternate vaccine delivery personnel made available through NRHM resources. Used GPS instruments to locate ICDS centres and attached to nearest distribution points. Clusters of session sites allotted to each vaccinator and delivery person.
Increasing demand for services	Need for introducing vaccines to beneficiaries residing in temporary settlements, low socio-economic areas. Need to increase awareness and demand for vaccines.	Identified community-link workers (from ICDS) used to mobilize community. Used annual survey followed by monthly preparation of due lists, tracking and house-to-house visits for reminding. Incentives given to community mobilisers. Community Mobilization Coordinators for polio eradication initiative trained on basics of routine immunization and equipped with flip chart to address women's gatherings.
Supportive supervision	No provision for health supervisors to visit vaccination sites. Doctors and paramedical personnel engaged in curative services in the 9 urban hospitals.	Nodal officer identified from nearby Primary Health centre for coordination of supervision. Medical officers from 9 hospitals given responsibility only for managing adverse effects and investigating vaccine-preventable diseases. Block Mobilization Coordinators and Field volunteers placed for polio eradication efforts given an additional responsibility of monitoring session sites on outreach immunization days
Monitoring for action	No provision for report collection, analysis and action	The same vaccine delivery person used to bring back reports from outreach session sites each day after completion of the day's activity. Data compiler identified in each distribution point. Block Mobilization coordinators and Field volunteers assisted Nodal officers in data analysis and corrective action through monthly meetings.
Sustaining interest of stakeholders	Tendency of interest of stakeholders to wane	Children's day and subsequent special days identified for periodic intensification efforts. Media focus on slum activity and intensified communication drive helped in generating and sustaining interest.

gather coordinates for all 691 ICDS sites. Following the survey, each ICDS site was allotted the particular depot within whose urban vaccination area it was located. Vaccine delivery was thereafter arranged through local couriers who were deployed on immunization days to deliver vaccines and logistics (e.g. syringes, safety boxes) to session sites and return to the depots with session reports and unused vaccines. Detailed microplans and maps were prepared.

Two groups were utilized to provide social mobilization activities. Following the strategic guidelines of *Muskaan ek Abhiyaan,* ICDS community-link workers called *Anganwadi* workers were trained in effective mobilization strategies. They conducted an initial survey of their areas and identified all beneficiaries for immunization; each beneficiary's name was listed in a tracking register, and prior to the immunization session day, they prepared due lists of beneficiaries eligible for vaccination. Banners were

displayed at the ICDS centres during immunization days, and beneficiaries were reminded to take their due vaccines. The mobilizers were then paid incentives based on the number of beneficiaries they mobilized. The Polio Eradication Program Community Mobilization Coordinators were also trained in routine immunization. As they had been identified to work in underserved areas and in areas where communities did not accept polio vaccine, their involvement was particularly important to ensure effective community mobilization. Like the *Anganwadi* workers, the Community Mobilization Coordinators also belonged to the community they served and addressed community gatherings, mothers meetings and counselled families refusing vaccination.

A medical officer was identified to assist the District Immunization Officer in overall management of the urban immunization activity. With the support of a child survival unit, a block health manager and an accountant, the medical officer was to coordinate with the various urban hospitals managing the immunization and the various rural subcentres providing the nurses. He was also to ensure availability of and regular payment of funds for the couriers and the mobilisers. The medical-officer-in-charge of each vaccine depot ensured proper investigation of adverse effects and vaccine-preventable diseases in his area in addition to the management of the overall programme. Field volunteers and block mobilization coordinators for polio eradication efforts visited session sites for supportive supervision in order to ensure effective service delivery and mobilization. Supervisors and officers from the ICDS department also visited the session sites to mentor and help their workers. Periodic meetings were organized to review problems and progress in the immunization programme.

As the need to ensure correct data on coverage and mobilization (mobilizers would be paid incentives based on number of beneficiaries accepting vaccination) was crucial, daily session reports, rather than monthly reports, were collected through the couriers and compiled at the vaccine depots. The health staff usually engaged in managing polio campaign reports was identified to compile the outreach immunization coverage reports. The quality of correctness of these reports was also verified by supervisors during their session visits, and during each session, five beneficiaries would have to validate the vaccine received by signing on the beneficiaries list (part of tally sheet). The reports were analysed and used for corrective action during monthly reviews at district meetings.

To complement the urban outreach services, during the three winter months, a series of 1-day slum vaccination campaigns were planned and implemented. These campaigns helped rejuvenate the motivation of the workers, improve coverage, identify pockets of resistance to vaccination and provide opportunity to counsel them and gain oversight and involvement of the highest stakeholders in the state. Intensified communication activity and media attention helped in generating public interest and sustaining those of the stakeholders.

Monitoring the outreach outcomes

Administrative routine immunization data from the Ministry of Health were utilized to measure the outreach immunization intervention. Data from the reporting year, April 2008 to March 2009 (prior to the introduction of the outreach strategies), were considered baseline data; we refer to this time period as the baseline period. The baseline data were compared with data from April 2009 to March 2010, the year in which the strategies were implemented; we refer to this as the intervention period. The number of doses administered for each vaccine was reported. Vaccination coverage was calculated and compared between baseline and follow-up for BCG vaccine, the three diphtheria–pertussis–tetanus (DPT) vaccine doses, measles vaccine and tetanus vaccine for pregnant women. Coverage was calculated as the per cent of vaccine doses reported to be administered divided by the estimated target population. The estimated vaccination target for the areas covered by the immunization outreach services was calculated using the estimated population of the hospitals (lower- and middle-income areas of the city with ICDS service sites) based on the 2001 census multiplied by the estimated birth rates of urban Bihar SRS Bulletin, 2008. In addition to doses administered and coverage, three additional indicators were calculated: (i) per cent 'dropout', i.e. infants who received DPT1, but dropped out before completing DPT3 [(DPT1-DPT3)/DPT1 × 100], (ii) per cent of 'left-out' infants, i.e. the per cent of children who did not receive the first dose of DPT [(target population – DPT1 doses administered)/target population × 100], and (iii) infants 'incompletely vaccinated', i.e. did not received DPT3 [(target population – DPT3)/target population × 100]. Indicators of service delivery process including immunization session frequency (per cent of planned sessions held) and efficiency (number of injectable vaccines administered per session /per day) were reported. Additionally, monitoring data were routinely collected by Community Mobilization Coordinators and field volunteers engaged by the Polio Eradication Program. During supervisory visits at 247 conveniently selected immunization session sites, they filled a monitoring checklist from which several qualitative indicators were derived. Data were analysed to assess the quality of the urban outreach immunization services.

Results

Administrative data demonstrated that the outreach immunization intervention in urban Patna in the intervention period showed marked improvement in immunization coverage for all vaccines in comparison to the baseline year (Table 2). For all doses of vaccines provided through the immunization programme, the coverage increased more than 100%. However, there continued to be considerable numbers of uncovered eligible (target) beneficiaries (Table 2). Furthermore, the steady decline of beneficiaries accepting successive doses of vaccines (i.e. dropouts) remained a problem in the intervention year. Between the baseline and intervention year, there was only a marginal reduction of 16% (four percentage points) in the dropout rate (Table 3).

Other indicators also indicated significant improvement in the number of children both starting the DPT vaccination series as well as completing. The percentage of 'left-out' children dropped from 72% to 38% between baseline and follow-up, a 47% reduction (Table 3). The percentage of children not getting DPT3 decreased from 79% at baseline to 51% at follow-up, a 35% reduction (Table 3). Fifty-one percent of children did not complete the immunization series, much of which was because of children not starting the DPT series (the 38% of children that were 'left out'), rather than children that dropped out.

The number of outreach sessions planned and sessions held were monitored to understand the various inputs that went into achieving the results. The number of sessions planned increased by 203%. While 7996 sessions (fixed and outreach) were planned for the intervention year in comparison to the 2642 fixed sessions planned during the

Table 2 Doses administered, vaccination target populations, and per cent of target population vaccinated, 2008–2009 and 2009–2010, Urban Patna, India

	Vaccine						
Year of activity	BCG*	DPT1†	DPT2	DPT3	Measles	TT 1‡	TT 2
2008–2009							
Doses administered§	6983	6668	5568	4983	5606	4016	2686
Target population¶	24046	24046	24046	24046	24046	26450	26450
Coverage per cent	29	28	23	21	23	15	10
2009–2010							
Doses administered§	15853	15491	14102	12287	12765	8991	7345
Target population¶	24941	24941	24941	24941	24941	27434	27434
Coverage per cent	64	62	57	49	51	33	27
% change between years**							
Doses administered	127	132	153	147	128	124	174
Coverage per cent	121	121	148	133	122	120	170

*Bacille Calmette-Guérin vaccine.
†Diphtheria–pertussis–tetanus (DPT) vaccine; numbers refer to 1st, 2nd and 3rd doses of DPT.
‡Tetanus toxoid vaccine; numbers refer to 1st and 2nd doses of TT.
§Administrative data.
¶2001 census with a annual growth rate factor of 3.72% (the estimated annual growth rate of Urban Patna Ministry of Health and Family Welfare, 2008).
**Per cent increase calculated as: (2009–2010)–(2008–2009) / (2008–2009) × 100.

Table 3 Immunization programme indicators 2008–2009 compared with 2009–2010, Urban Patna, India

Indicator	2008–2009 (%)	2009–2010 (%)	Percentage point difference	Percentage decrease*
DPT3†-DPT1 dropout rate [(DPT1-DPT3)/ DPT1 × 100]	25	21	4	16
Infants 'left out' [(Target-DPT1)/Target × 100]	72	38	34	47
Infants not completing DPT series [(Target-DPT3)/Target × 100]	79	51	28	35

*Diphtheria–pertussis–tetanus (DPT) vaccine.
†Calculated as: percentage point difference / baseline (2008–2009) × 100.

Table 4 Sessions planned, sessions held and number of injectable vaccines administered per vaccination session load, 2008–2009 and 2009–2010, Urban Patna, India

Vaccination sessions	2008–2009	2009–2010	Difference between intervention and baseline years	Per cent increase (+) or decrease (−)*
Sessions planned	2642	7996	5354	+203
Sessions held	2300	5409	3109	+135
% sessions held of planned	87	68	19	−22
Average number of injectable vaccines administered:				
Per session	15.9	16.1	0.2	+1
Per session day	15.9	32.1	16.2	+102

*Calculated as: difference [(2009–2010)−(2008–2009)]/ baseline (2008–2009) × 100.

Table 5 Quality of programme as per monitoring findings, Urban Patna, India, 2009–2010 (n = 247)

Monitoring findings	Numbers observed by monitor (% of total)
Vaccinator present as per microplan	201 (81)
Anganwadi worker found mobilizing beneficiaries	199 (81)
Logistics delivered through paid couriers	200 (81)
Logistics delivered through other mechanisms	31 (13)
All vaccines and diluents available at session sites	231 (94)
Beneficiary tracking line list updated by ICDS* worker	137 (56)
Due list prepared by ICDS worker for mobilization	167 (68)
Incentive payment made to ICDS worker for mobilization	2 (<1)

*Integrated Child Development Services.

baseline year, a large number of outreach sessions (32%) were cancelled during the intervention year (Table 4). Further analysis of the reasons behind the cancellation of sessions during the intervention year indicated that 6% were because of absenteeism of the nurses, 24% because of holidays and the majority (70%) because of nurses and community volunteers that had to be redeployed for polio eradication activities.

The efficiency of the nurse for each outreach session was assessed through injection load (number of injectable vaccines administered), which showed a session-wise increase in 0.2 injections between the 2 years. However, as two sessions were held in a day, the day-wise efficiency went up considerably (average difference of 16.2 injections) in the intervention year (Table 4).

Program quality indicators collected through questions and observations during supervisory monitoring visits at 247 immunization sessions during the intervention period were generally high, with >80% of observed sessions having a vaccinator present as per the microplan, *Anganwadi* workers were observed mobilizing beneficiaries, logistics delivered by a paid courier, and all vaccines and diluents available at the session. Monitored indicators with <80% coverage included beneficiary tracking (56% of observed sessions), preparation of lists of beneficiaries due for vaccines (68% of observed sessions) and payment to Anganwadi workers for mobilization (<1% of observed sessions) (Table 5).

Discussion

Using opportunities within and outside the health system, effectively expanded and substantially improved the urban vaccination programme. With the introduction of outreach immunization services, administrative vaccination coverage increased over 100% compared with vaccination coverage at baseline. The proportion of both children left out and not completing their DPT vaccination series decreased by >30%, indicating a substantial improvement in vaccination services. This also indicates that the rapid increase in outreach sites and involving local community mobilisers, especially in residential areas of low socio-economic groups, can lead to increased vaccination coverage. The smaller reductions in dropout rates among children and the lower coverage for Tetanus toxoid (TT) among women suggest that additional strategies are needed to reach these groups and mobilize beneficiaries to return for subsequent vaccine doses. The monitoring data indicate that the preparation of due lists, tracking of beneficiaries and incentive payments are still suboptimal, and improvement in these areas may bring better results. Atkinson & Cheyne 1994 observed that EPI has directed efforts principally to rural areas, while urban activities have been delivered through a mainly passive strategy dependent on user demand and uptake. Strategies to reduce dropout should be strengthened, including effective social mobili-

zation, tracking of beneficiaries who are late in getting vaccinated and proper counselling on when to return for vaccination and possible vaccine-related side effects. While community workers (e.g. *Anganwadi* workers) have been observed mobilizing the beneficiaries in >80% of the sessions monitored, their efforts could have been significantly affected by not receiving promised incentive money.

Although managing a large number of outreach sites is more complex than managing a few fixed sites, the combination of good microplanning, the use of GIS for allocating areas and routes for vaccine distribution, and the use of couriers emanating from vaccine depots all have contributed to a successful delivery system. This mechanism worked the majority of the time; and the microplan design with two vaccination sites a day for the congested areas helped optimize the use of the limited manpower available, while still maintaining a reasonable injection load. The only instance of the existing programmes interfering with the newer urban outreach vaccination was the cancellation of a considerable number of sessions during the Polio eradication campaigns.

A number of papers report issues of access, mobilization, motivation and management related to urban vaccination (Groom *et al.* 2010). In a review of strategies to improve urban immunization in Africa, (Cutts 1991) suggest that strategies that can help to improve urban vaccination include making specific action plans for large urban areas, resolving problems through inter-sectoral coordination and making full use of existing health facilities. This case study is an example of a multipronged intervention, which encompassed these strategies. Despite the increase in coverage, there are several facets of the programme intervention that need looking into. Interventions such as the temporary deployment of borrowed rural manpower in urban areas, the use of GIS technology for microplanning and sustaining stewardship and interest of a largely 'curative' facility-based health service–oriented urban hospitals need to be worthwhile, sustainable and further replicable. If not, one needs to consider longer-term approaches such as creating a complete system of urban health centres or posts with auxiliary nurses or paramedics to provide preventive and basic curative services in urban areas with lower socio-economy and overcrowding. Alternatively, the possibility of entering in private and public partnerships to provide such basic services in urban areas can be explored.

The intervention was not designed as a research study, thus there are a number of limitations including the ability to infer causality; however, there are still lessons to be learned around the feasibility of the intervention. Further studies of such approaches should be designed using rigorous methods allowing for better measures of impact. The immunization coverage findings were based on administratively reported doses administered. Administrative data may be less reliable than survey coverage data (Borgdorff & Walker 1998; Murry *et al.* 2003). However, any systematic or significant bias is unlikely, because data-reporting methods were similar during the reporting years. Furthermore, administrative data are readily accessible and less costly than coverage surveys. Programme quality indicators are only available for 1 year, limiting their use in evaluation of the intervention, but will be useful in ongoing monitoring of the intervention.

This intervention demonstrated the feasibility and successful implementation of a multiprolonged strategy to improve immunization coverage in an underserved area in India. Further, it indicated that with carefully planned strategies in the backdrop of several opportunities beyond the regular health systems, it is possible to quickly improve immunization coverage. For longer-term gains and sustainability, the health systems must be geared up to meet the need of increasing urbanization and its growing health demands.

References

Agarwal S, Bhanot A & Goindi G (2005) Understanding and addressing childhood immunization coverage in urban slums. *Indian Pediatrics* **42**, 653–663.

Atkinson SJ & Cheyne J (1994) Immunization in urban areas: issues and Strategies. *Bulletin of the World Health Organization* **72**, 183–194.

Borgdorff MW & Walker GJ (1998) Estimating vaccination coverage: routine information or sample survey? *Journal of Tropical Medicine and Hygiene* **91**, 35–42.

Citymayors.com. The world's fastest growing cities and urban areas from 2006 to 2020. http://www.citymayors.com/statistics/urban_growth1.html (accessed 7 April 2010).

Clements C, Nshimirimanda D & Gasasira A (2008) Using immunization delivery strategies to accelerate progress in Africa towards achieving the Millennium Development Goals. *Vaccine* **26**, 1926–1933.

Cutts FT (1991) Strategies to improve immunization services in urban Africa. *Bulletin of the World Health Organization* **69**, 407–414.

Goel S, Dogra V, Gupta SK *et al.* (2011) Effectiveness of muskaan ek abhiyan (the smile campaign) for strengthening routine immunization in Bihar, India. *Indian Pediatrics* Epub ahead of print. pii:S097475591000354-1. http://www.indianpediatrics.net/RP15.03.2011/RP-354.pdf (accessed 20 November 2011).

Groom H, Kennedy A, Evans V & Fasano N (2010) Qualitative analysis of immunization programs with most improved childhood vaccination coverage from 2001 to 2004. *Journal of Public Health Management & Practice* **16**, E1–E8.

Hadler SC, Dietz V, Okwo-Bele JM & Cutts FT (2008) Immunization in developing countries. In: *Vaccines*, 5th edn

(eds SA Plotkin, WA Orenstein & P Offit) Elsevier Inc., Amsterdam, pp. 1541–1571.

Health and Science Bulletin (Bangla and English) /Health and Science Bulletin (English) 2009 Improving low child immunization coverage in urban slums of Dhaka, Bangladesh, 7(2).

India Communication Update. http://www.unicef.org/immunization/polio/files/India_Communication_Update_October_2009.pdf (accessed 7 April 2010).

Integrated Child Development Services, Bihar. http://icds.bih.nic.in (accessed 7 April 2010).

Ministry of Health and Family Welfare, Government of India (2007) *Routine Immunization Handbook for Health Workers*. http://whoindia.org/LinkFiles/Routine_Immunization_Immunization_Handbook_for_Health_Workers_English_2011.pdf (accessed 20 November 2011).

Ministry of Health and Family Welfare, Government of India (2008) District Level Household and Facility Survey under Reproductive and Child Health Project (DLHS-3), District Fact sheet for Patna with census 2001 tables.

Ministry of Health and Family Welfare, Government of India (2010) District Level Household and Facility Survey 2007–08. International Institute for Population Sciences (Deemed University), Mumbai, India. http://www.rchiips.org/pdf/INDIA_REPORT_DLHS-3.pdf (accessed 14 November 2011).

Murry CL, Shengelia B, Gupta N, Moussavi S, Tandon A & Thieren M (2003) Validity of reported vaccination coverage in 45 countries. *Lancet* **362**, 1022–1027.

National Rural Health Mission (2005–2012) Mission Document. http://mohfw.nic.in/NRHM/Documents/Mission_Document.pdf (accessed 7th April 2010).

National Technical Advisory Group on Immunization. 16 June 2008 Meeting minutes. http://w.mohfw.nic.in/showfile.php?lid=551 (accessed 14 November 2011).

Sokhey J, Kim-Farley RJ & Bhargava I (1989) Ministry of Health and Family Welfare, New Delhi, India. The expanded programme on immunization: a decade of progress in India. *Annals of Tropical Paediatrics* **9**, 24–29.

SRS Bulletin. 2008, Volume 43. No 1. Sample registration survey, Registrar General, India.

Status of Anganwadi Centers in ICDS Projects (Bihar). http://icds.bih.nic.in/DetAWC1.htm (accessed 7 April 2010).

Unicef and WHO publication (2011) *Immunization Summary, a Statistical Reference Containing Data Through 2009, page 77 India*. Unicef and WHO publication, Switzerland. http://www.childinfo.org/files/32775_UNICEF.pdf (accessed 20 November 2011).

World Health Organization: World Health Day. http://www.who.int/world-health-day/2010/about/en/index.html (accessed 7 April 2010).

World health Organization, Country office for India, Core Program Clusters, Family and Community Health, "Routine Immunization in India.. http://www.whoindia.org/en/Section6/Section284/Section286_506.htm (accessed on 7th April 2010).

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