

## Retrospective assessment of routine immunization (RI) accessibility after a decade of intervention in an urban settlement of Nepal

Nirmal Kumar Jha<sup>1\*</sup>, Vikram Karna<sup>2</sup>, Indra Karna<sup>1</sup>

<sup>1</sup>Community for Social Development Center, Biratnagar, Nepal

<sup>2</sup>WHO Programme for Immunization Preventable Diseases, Nepal

*Corresponding Author: Nirmal Kumar Jha Email: njha2@hotmail.com*

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### ABSTRACT

This longitudinal retrospective study describes the process of urban routine immunization strengthening interventions and reviews the progress for a decade analyzing administrative immunization coverage outcomes in Janakpur Municipality, Nepal.

This intervention was based on local need following available guidelines to improve immunization coverage in Janakpur. The strategies were designed to ensure an effective community involvement through establishing female community health volunteers (FCHVs) network, activation of municipal health unit with human resources, increase immunization service providing sites, improving vaccine and logistics supply mechanism, supportive supervision and monitoring including improved reporting and use of data for action.

Over a decade, the vaccination coverage was improved significantly which shows that the accessibility problem was addressed efficiently, however, to solve the dropout problem is a long-term process. This process invites more efforts through raising awareness and knowledge of parents to improve the utilization of the available services. The high immunity level is highly important to achieve and maintain to develop a protective shield against vaccine-preventable diseases.

**Keywords:** urban routine immunization, female community health volunteer, Janakpur.

## INTRODUCTION

The 'pioneer of vaccination', Dr Edward Jenner carried out the first documented case of cowpox inoculation on 14<sup>th</sup> May 1796. The journey of preventive treatment through vaccination begun from anti smallpox vaccination. In the present world, many highly safe and effective vaccines are either available or in pipe-line (in development).<sup>1,2</sup>

The childhood immunization programme is highly successful and one of the most cost-effective among the public health-related interventions. Between 2–3 million deaths are prevented every year, by immunization against vaccine-preventable diseases (VPDs) with 86% global coverage of routine immunization since 2010.<sup>3</sup>

More than 3.9 billion people currently live in cities, which would reach to 6.3 billion by 2050, with over 90% of the growth occurring either in low- income countries or in middle-income countries. The high birth rate, densely populated living conditions, and in-migration from far remote areas of new susceptible children, who are less likely to be fully immunized, makes favourable conditions for disease spread, increasing the risk of being infected from communicable diseases, including vaccine-preventable diseases, in the urban communities. Cities are expected to deliver better immunization services. The speed of urbanization due to different reason in a different context, can increase the probability of social unrest and add the challenges for health workers to provide routine immunization.<sup>4-7</sup>

The national immunization programme (NIP) in Nepal, is one of the highly successful, the priority 1 (P1) programme.<sup>8</sup> This is established and performing well in the rural areas called

village development committees (VDCs) with at least one public health service outlet and a functional community network through mother groups and female community health volunteers supporting the local health facilities to serve them,<sup>9,10</sup> the district public health office (DPHO) also focus on rural areas.

Janakpur, a historical place, the capital city of rich Mithila culture and the birthplace of Sita,<sup>11,12</sup> located in, also the administrative headquarters of Dhanusha district of central Terai region, as well as temporary capital of newly formed Province number 2, is the pride of Nepal.

This city comes under one of the old cities, lies between 26°41'47" N to 26°45'9" N and 85°05'4'9" E to 85°05'22" E and situated at a distance of 390 km (about 123 km air distance), elevation 74 m to the southeast of Kathmandu.<sup>13,14</sup>

The municipal extension of Janakpur covers an area of 100.20 square kilometres; there has been an increase in the area and population of Janakpur during last decade. As of 2015, the city had a population of 173,924 ( density 1,700/km<sup>2</sup> ), which makes it the seventh-largest city in Nepal.<sup>13,15</sup>

The local self-governance act 1999, made municipal authorities responsible for providing public health service in their territories, which are considered urban areas. In urban areas like municipalities, the programme has faced difficulties in absence of an adequate and well-defined structure, no micro plan for immunization services, lack of grass root level community network, ownership issues, poor resource allocation, absence of smooth coordination between district health office, municipality and private sectors.<sup>16</sup>

There was only one fixed immunization site providing immunization

service, 2 days in a week for the whole municipality area with very poor coverage. Lack of outreach immunization service was the major cause of low coverage in the municipality. The importance of a community network of female community health volunteers (FCHVs) and availability of outreach services were realized and municipal immunization coordination committee (MICC) decided to develop them.

This longitudinal retrospective study was conducted in Janakpur, Nepal. This is a case study, describes the process of interventions in 2006 and review the progress over the next nine years of its implementation from 2007 to 2016.

## METHODS

To ensure an effective community involvement a network of female community health volunteers (FCHVs) was very important, the municipal health unit was supposed to be re-activated to expand the outreach services in order to strengthen the routine immunization services.

### *The process of intervention*

The MICC decided to have a municipal network of permanent, trained and responsible volunteers according to the national guidelines<sup>17</sup> and availability of outreach services. The MICC also endorsed the technical and financial proposal of the intervention, prepared by the technical task force in January 2006.

The following major activities were planned to be conducted:

1. To develop detail plan to expand the RI services up to ward level (the smallest administrative unit of a municipality) including mapping of outreach sites, required human resource, logistics, supply mechanism, supervision and monitoring process.
2. To create a community network through FCHVs.
3. Re-activation of the municipal health unit.
4. To ensure availability of health staff in the health unit.
5. To improve community awareness and mobilization.
6. To establish timely reporting and use the reported data for action.

The components, issues and related interventions are described in Table 1.

**Table 1:** Components of strategic interventions

Components	Issues	Interventions
Access to RI services	Only one immunization clinic was run by DPHO, 2 days in a week	Outreach services extended having at least one session in every ward, to identify the place for those session sites and make a session calendar.
Human resource	borrowed rural manpower in the vaccination centre run by DPHO	Municipal health unit to be re-activated and at least one auxiliary nurse midwife (ANM) was hired to conduct outreach vaccination in each ward of municipality.

**Table 1:** Components of strategic interventions (cont.)

Components	Issues	Interventions
Supplies	Adequate (on demand)	Requirements were estimated and supply mechanism finalized.
Social mobilization to increase demand for services	No FCHVs in the municipality to conduct social mobilization activities	To divide the municipality into clusters, to select at least one FCHV per cluster, selected by the mother's groups formed in the cluster, to have trained and motivated FCHVs in the municipality to conduct routine mothers group meeting, social mobilization and other related activities
Supportive supervision	No supervision at the urban vaccination site	Periodic supervision by the municipality health unit, DPHO and other stakeholders
Monitoring for action	No data analysis and feedback	Report collection at municipality and DPHO, supported by WHO Programme for Immunization Preventable Diseases (WHO-IPD) for data analysis and feedback.
Interest of stakeholders	Poor interest in urban vaccination activities	Interest increased.

In the beginning, the detailed plan of the intervention was drafted which included the estimated numbers of outreach sites, required human resource and logistics, supply mechanism and schema of supervision and monitoring. Each ward in the municipality, the smallest administrative unit, were defined as a coverage/catchment area.

As the municipality was divided into 35 clusters, mother's groups were formed in each cluster. Total 37 FCHVs were selected against 35 FCHVs planned (2 FCHVs who received 24 days basic training for FCHVs, were found and selected by mother's groups), Those FCHVs were also supposed to play the role of secretary of

respective mother's groups. Those mother's groups met once in a month, usually one or two days before the outreach activities in their neighbourhood, which was also the opportunity of social mobilization.

The basic training for FCHVs for newly 35 FCHVs was conducted in two phases (1st phase in January and 2nd phase in April 2007).

#### ***Expand the outreach services***

Based on the target population (Table2), a total of 17 outreach immunization sites in a month were planned. One auxiliary nurse midwife (ANM) was hired by the municipal

authority, trained and deployed to conduct the outreach sessions. At least one session was in the schedule in a ward and all 16 wards on different dates in a month. One separate session was at municipal health

unit making 17 sessions, starting from the first day of each Nepali calendar month in ascending order. This way it was easy to remember and communicate.

**Table 2:** Demographic information of Janakpur municipality (2006).

Ward Number	Total Population	Under 1 Population	Under 5 Population	Expected Pregnancies
1	6332	240	1099	288
2	4784	170	932	204
3	1954	36	256	43
4	10923	271	1341	325
5	2136	61	289	73
6	3570	114	601	137
7	4232	173	967	208
8	6713	265	1317	318
9	5099	132	762	158
10	3370	119	336	143
11	3323	109	646	131
12	2988	150	746	180
13	3306	200	787	240
14	6699	195	1011	234
15	3141	84	458	101
16	5922	210	1126	252
<b>Total</b>	<b>74492</b>	<b>2529</b>	<b>12674</b>	<b>3035</b>

Similarly, the outreach sites were at easily accessible public places such as at ward offices, or nearby public schools.

The DPHO cold store had vaccine storage facilities. The delivery of vaccine and other logistics to session sites and return back to the DPHO with session reports and unused items at the end of every session were managed by the ANM.

The outreach immunization intervention became operational in May 2007.

The head of the municipal health unit and district immunization officer

oversaw the overall management including supportive supervision. Supervisors from the other stakeholders also visited the session sites. Periodic review meetings were organized to discuss the problems and progress. The DPHO ensured proper investigation of any reported incidents of adverse events after vaccination and vaccine-preventable diseases.

The accuracy of data was crucial, monthly reports were collected, then verified by ward secretaries, compiled at the municipal health unit, and shared with DPHO and WHO-IPD, Janakpur field office

to be used for corrective action during reviews.

## RESULTS

The result of the intervention was very impressive, despite a million obstacles in the process. The key achievements were as follows:

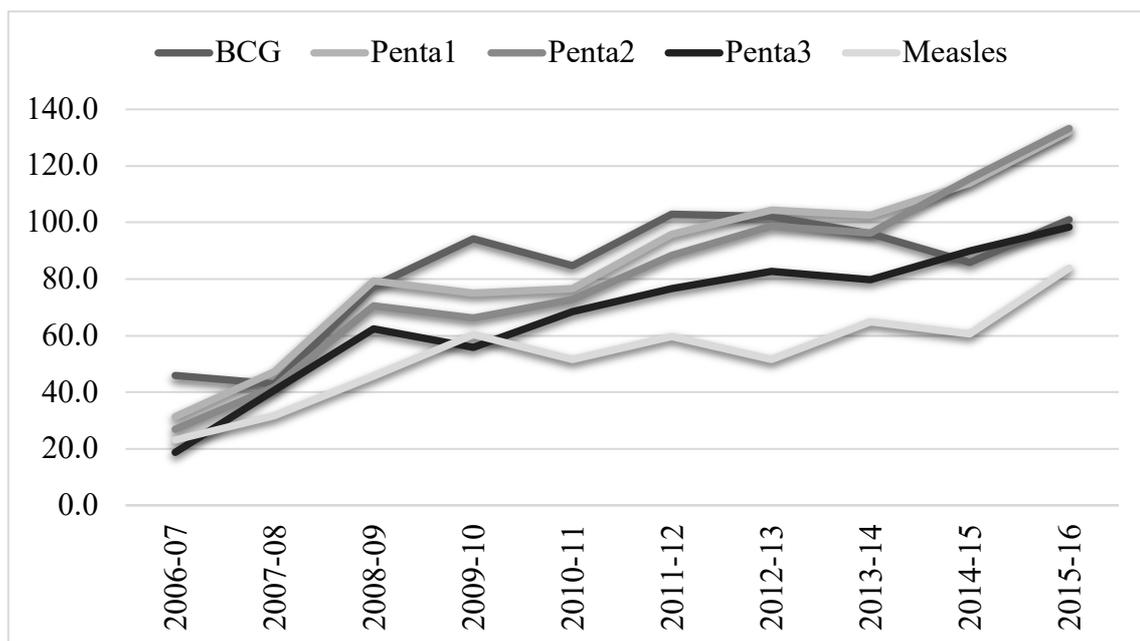
1. A community network with 37 FCHVs was created backed by the mother’s groups of each cluster.
2. The municipal health unit became functional.
3. The outreach immunization sessions were conducted and the coverage was improved.

### *Review of routine immunization over the nine years after the intervention*

The administrative data for routine immunization at the DPHO and municipal health unit were used for this study of the interventions.

Data from the reporting year, 2006-2007 to 2015-2016 were reviewed. The administrative data of the year 2006-2007 (before interventions) was considered as baseline data. The new urban immunization strategy to strengthen routine immunization services was implemented in the year 2007-2008.

Administrative data shows that the interventions for outreach immunization contributed positively to the improvement of immunization coverage of all antigens (Figure 1). The progress was encouraging.



**Figure 1:** Routine immunization coverage (2006-2007 to 2015-2016)

Coverage of Penta3 was 18.7% in the baseline year, increased to 47.5% in the first year after the intervention, and was in increasing trend and reaches to more than 90% in years 2015-2016.

The number of doses of all the antigens, administered at every session was reported. The coverage for BCG, the 3 doses of diphtheria–pertussis–tetanus- hepatitis B- Haemophilus influenza B (DPT-HepB-HiB

also called as Penta) and measles vaccines were calculated.

Coverage was calculated in per cent of administered vaccine doses reported divided by the given target population. The estimates of vaccination targets were provided annually by the health

management information system (HMIS).<sup>18</sup>

Coverage of other antigens are also in the increased, however, there were some significant fluctuations every year. The highest coverage for measles was 83.9% in the study period (Table 3)

**Table 3:** Routine immunization coverage from the year 2006-2007 to 2015-2016.

Year of activity	Particulars	BCG*	Penta $\diamond$ 1	Penta 2	Penta 3	Measles
2006-07 (2063-64)	Doses administered	1163	792	680	473	584
	Target population	2529	2529	2529	2529	2529
	Coverage percent	46.0	31.3	26.9	18.7	23.1
2007-08 (2064-65)	Doses administered	1086	1197	1056	1031	803
	Target population	2529	2529	2529	2529	2529
	Coverage percent	42.9	47.3	41.8	40.8	31.8
2008-09 (2065-66)	Doses administered	1963	2005	1781	1580	1153
	Target population	2529	2529	2529	2529	2529
	Coverage percent	77.6	79.3	70.4	62.5	45.6
2009-10 (2066-67)	Doses administered	2383	1899	1673	1414	1528
	Target population	2529	2529	2529	2529	2529
	Coverage percent	94.2	75.1	66.2	55.9	60.4
2010-11 (2067-68)	Doses administered	2145	1938	1839	1734	1302
	Target population	2529	2529	2529	2529	2529
	Coverage percent	84.8	76.6	72.7	68.6	51.5
2011-12 (2068-69)	Doses administered	2603	2425	2232	1937	1507
	Target population	2529	2529	2529	2529	2529
	Coverage percent	102.9	95.9	88.3	76.6	59.6
2012-13 (2070-71)	Doses administered	2267	2315	2190	1837	1142
	Target population	2220	2220	2220	2220	2220
	Coverage percent	102.1	104.3	98.6	82.7	51.4
2013-14 (2071-72)	Doses administered	2134	2277	2139	1770	1441
	Target population	2220	2220	2220	2220	2220
	Coverage percent	96.1	102.6	96.4	79.7	64.9
2014-15 (2072-73)	Doses administered	1905	2528	2562	1995	1347
	Target population	2220	2220	2220	2220	2220
	Coverage percent	85.8	113.9	115.4	89.9	60.7
2015-16 (2073-74)	Doses administered	2240	2932	2958	2184	1861
	Target population	2220	2220	2220	2220	2220
	Coverage percent	100.9	132.1	133.2	98.4	83.8

\*Bacille Calmette-Gue´rin vaccine.

$\diamond$  Diphtheria–pertussis–tetanus- hepatitis B- Hemophilus influenza B (DPT-HepB-HiB also called as Penta) vaccine; numbers refer to 1st, 2nd and 3rd doses of Penta.

The information about the frequency and efficiency of service delivery were obtained from the monthly reports. The indicators related to them were calculated such as percentage sessions held against the planned sessions and injection load per session/per day.

The most commonly used, the following five indicators were calculated:

- (i) 'BCG versus measles dropout' percentage, i.e. the infants who received BCG, but did not return to complete Measles. BCG to Measles dropout rate  $[(\text{BCG}-\text{Measles}) / \text{BCG} \cdot 100]$
- (ii) 'Penta1 versus Penta3 dropout', i.e. infants who received Penta1, but did not return to complete Penta3  $[(\text{Penta1}-\text{Penta3}) / \text{Penta1} \cdot 100]$ ,

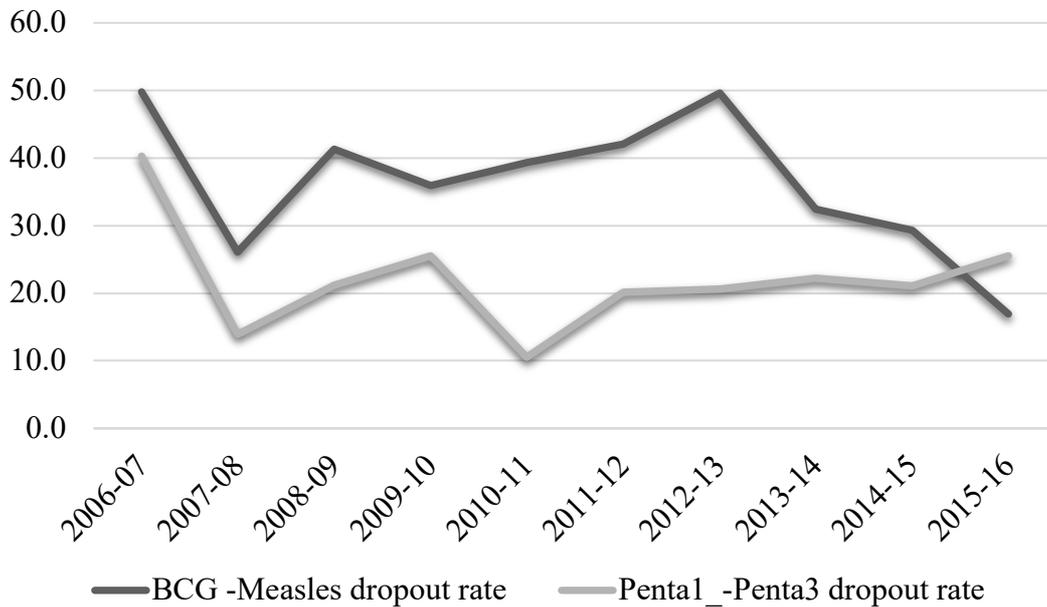
- (iii) 'missed' infants in percentage, i.e. children who did not receive the first dose of Penta, in percentage  $[(\text{target population} - \text{Penta1 doses administered}) / \text{target population} \cdot 100]$ ,
- (iv) 'incomplete Penta', i.e. children who did not receive Penta3 in percentage  $[(\text{target population} - \text{Penta3}) / \text{target population} \cdot 100]$ .
- (v) 'incomplete measles'  $[(\text{target population} - \text{Measles}) / \text{target population} \cdot 100]$ .

The numbers of unvaccinated eligible (target) children were significantly decreased (Table4) as the coverage increased, but dropouts remained a problem in every year of study

**Table 4** Routine immunization programme indicators, the year 2006-2007 to 2015-2016.

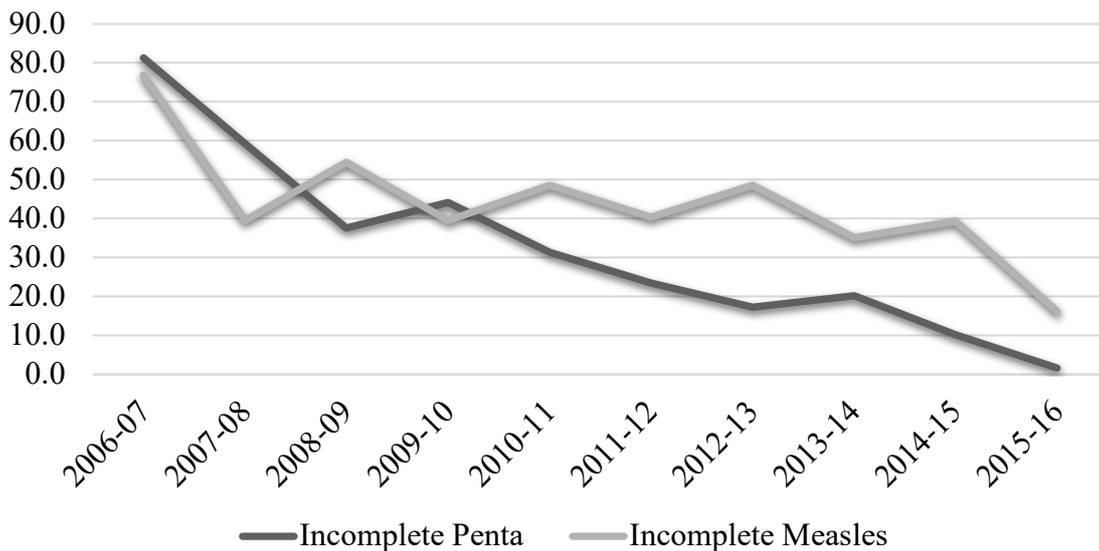
Indicators	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
BCG - Measles dropout rate	49.8	26.1	41.3	35.9	39.3	42.1	49.6	32.5	29.3	16.9
Penta1_- Penta3 dropout rate	40.3	13.9	21.2	25.5	10.5	20.1	20.6	22.3	21.1	25.5
'missed' infants	68.7	52.7	20.7	24.9	23.4	4.1	-4.3	-2.6	-13.9	-32.1
Incomplete Penta	81.3	59.2	37.5	44.1	31.4	23.4	17.3	20.3	10.1	1.6
Incomplete Measles	76.9	39.6	54.4	39.6	48.5	40.4	48.6	35.1	39.3	16.2

The BCG Vs measles dropout rate is remaining as a problem, there was a big reduction of around 25% in the dropout rate during the first year after the intervention, but later it is around 40% and above in consequent years. In 2015-2016 the dropout is 16.9%, the lowest after the intervention but higher than the acceptable level of <10% (Figure 2).



**Figure 2:** Percentage of dropped out children (2006-07 to 2015-16)

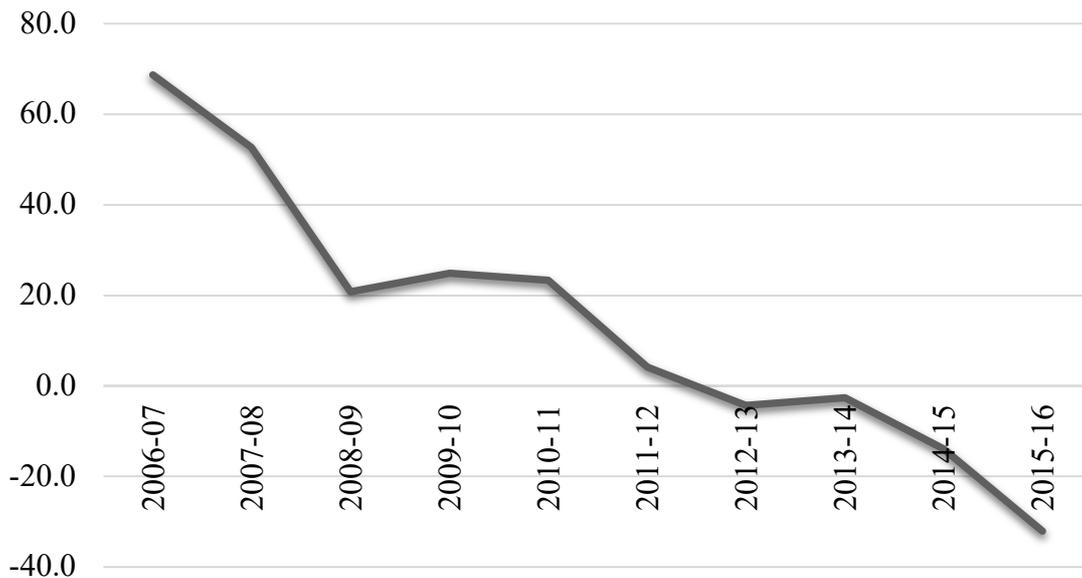
The Penta1 Vs Penta3 dropout rate is a persistent problem, which was 40.3% in baseline year and reduced to 13.9% during the first year after the intervention, increased again to 21.2%, similarly, fluctuations were observed over the years, it is, however, still 25.5%, in the year 2015-2016 (Figure 3).



**Figure 3:** Percentage of children with incomplete Penta and measles (2006-07 to 2015-16)

In fact, the number of children brought to vaccination sites was higher than expected. The percentage of children who did not receive Penta3 decreased from 81% to 1.6%, also a more than 70% reduction with some fluctuations in the years following the intervention.

The indicators of routine immunization indicated noteworthy progress in the number of children who started the Penta series vaccination and completed it. The children who did not complete the immunization series were due to they did not start the Penta series (missed infants), rather than children that dropped out in the initial year. The percentage of ‘missed infants decreased from 68.7% to -32.1%, a more than 70% reduction (Figure 4).



**Figure 4:** Percentage of missed infants (2006-07 to 2015-16)

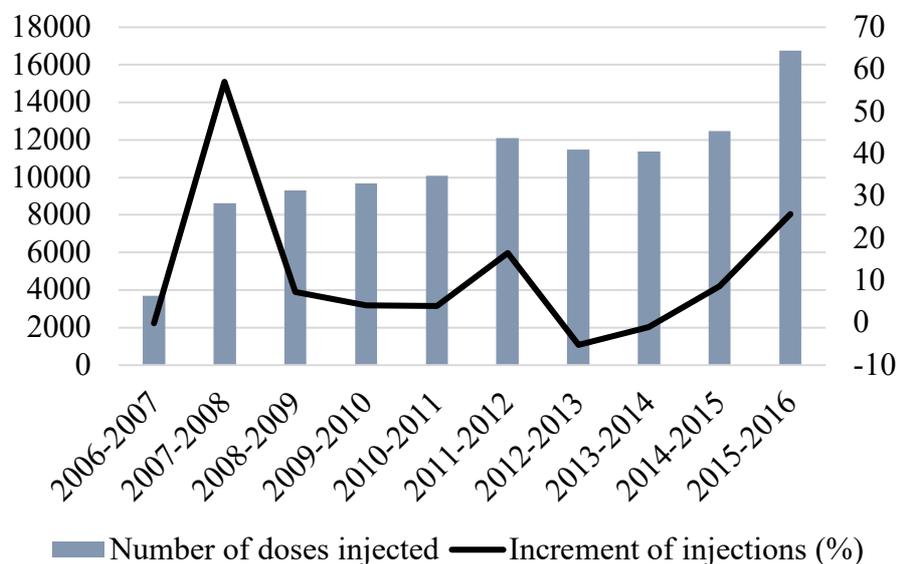
The number of outreach sessions held against sessions planned were monitored to understand the community support and demand for immunization services the sincerity of vaccinator to achieve the results. The planned number of sessions was increased by almost 10 times, after the intervention, 204 sessions were planned in a year throughout the study period, in comparison to 40 fixed sessions before the intervention. Every year, several outreach sessions were cancelled during the study period due to official holidays and absence of ANM, although more than 85% of sessions were conducted (Table5).

**Table 5:** Session held against the planned, and workload of injection per session.

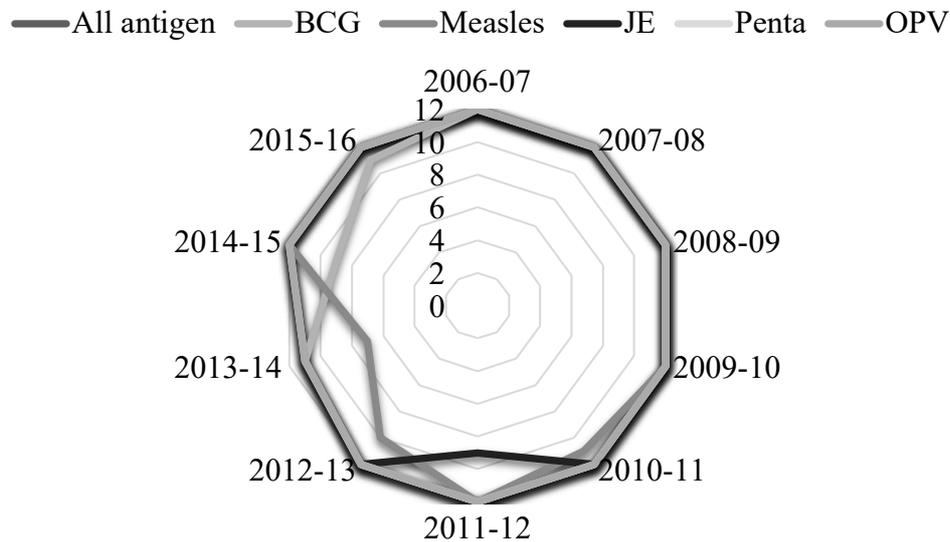
Vaccination sessions	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Sessions planned	102	204	204	204	204	204	204	204	204	204
Sessions held	80	170	180	184	183	182	182	181	182	180
% sessions held of planned	78	83	88	90	90	89	89	89	89	88
Number of doses injected**	3692	8611	9297	9691	10090	12093	11491	11373	12460	16765
Per session	46	51	52	53	55	66	63	63	68	93
Increment of injections (%)		57.1	7.4	4.1	4.0	16.6	-5.2	-1.0	8.7	25.7

\*\* includes all injectable vaccine doses according to immunization schedules.

The efficiency of the ANM in outreach sessions was assessed through injection load (administered number of injectable vaccines), which showed an increment of 57.1% injections in first years of intervention but increment was around 7 to 25% in following years. In the years 2012 to 2014, the growth was negative (-5.2%), however the per session injection load increase significantly (25.7%) in the year 2015-2016 (Figure 5).

**Figure 5:** Increment of injection load (2006-07 to 2015-16)

Shortage of vaccine supply was observed in some months of the study period. Supply of vaccines and logistics were reviewed in the store records and the monthly coverage reports. The details of vaccine shortage by month of the year is summarized in Figure 6.



**Figure 6:** Vaccine shortage by antigen

Program quality during the intervention period was generally high, sessions held, vaccinator available, FCHVs were mobilizing beneficiaries, vaccine and logistics were delivered efficiently accept measles and BCG for few months in some years. Moreover, the interventions provided a great opportunity to implement outreach immunization services.

## DISCUSSION

### *Community network through female community health volunteers (FCHVs)*

The FCHVs in Nepal are respected in the community due to their involvement in public health service delivery such as community-based integrated management of childhood illness (CBIMCI), supplementary immunization activities (SIAs), social mobilization for routine immunization, resupply of contraceptive

pills and condoms in their catchment areas. The establishment of community network through mother's group and FCHVs demonstrated high effectiveness for the intervention to increase the RI coverage boosting its utilization.<sup>17, 19-21</sup>

The improvement of both indicators of routine immunization, accessibility and utilization after the interventions in Janakpur, are suggestive to increase in outreach sites and social mobilization through mothers group and FCHVs, however, the dropout problem remains and it indicates that more continuous efforts required.

### *Improved routine immunization (RI) services*

The finding of this study illustrates that immunization coverage of children under their first birthday or less was improved significantly between 2007-08 and 2015-16 in comparison to the year

2006-2007, which was taken as the baseline year for the interventions in Janakpur.

The overall immunization coverage of Dhanusha district was highly encouraging. The available data shows BCG coverage 97% to 126%, Penta 3 coverage 81% to 121% and Measles coverage 91% to 103% for the years 2009-10 to 2015-16,<sup>10, 22-27</sup> compelling to think that the accessibility could be the problem for being persistent low coverage in Janakpur, which was the only municipality with urban nature of settlements.

However, a study conducted to analyze the trend of full immunization coverage using country demographic and health survey data of Nepal shows a decreasing trend in Province no.2 after 2011, from 79.3% in 2011 to 65.2% in 2016. The similar trend is observed in Terai region, 84.8 (2011) to 71.2% (2016) by geographic division and in urban areas from 90.0% (2011) to 78.5% (2016).<sup>28</sup>

Despite different methodology and study area, the trend can give sight for detailed periodic review and close monitoring of the activities to find out the gaps and solutions for its improvement.

#### ***Monitoring RI services for action***

Since 2007, when intervention took place, the stakeholders and partner agencies closely monitored all the activities. The data reviewed in this study shows that the accessibility to the services in Janakpur is increased, as the coverage was increased upon the availability of the services in the neighbourhood. As a result, the outreach services could cover more than 50% more children in comparison to the period before the intervention. At the same time, the volume of children not completing their 3 doses of Penta, decreased by >30%, which

indicates a considerable improvement of accessibility to the vaccination services as the sessions were increased from 40 fixed sessions to 204 outreach sessions.

The Penta1 Vs Penta3 dropout rate is a persistent problem, which was 40.3%, which is fluctuating over the years; it is, however, still 25.5%, in the year 2015-2016, due to inadequate utilization of those services.

Use of periodically updated monitoring chart, activities related to raising awareness in the community, defaulter-tracing techniques such as sending reminder cards, text reminders via SMS, and social mobilization through FCHV and mothers groups can support to reduce the dropout rates.<sup>29, 30</sup>

#### ***Population growth and adequacy of human resource***

The workload of the ANM was increased to 57.1% injections in the first years of intervention, which was increased by 7% to 25% in the following years. The population of the municipality is increased from 74,492 in 2006 to 173,924 in 2015,<sup>13</sup> but the given target population was not adjusted, leading to over 100% of coverage and significantly increased workload.

This achievement of high coverage can be helpful to protect children from vaccine-preventable diseases but the high dropout rate of BCG vs measles and penta1 vs penta3 would dilute it. The unchanged or increasing dropout rates are inviting additional efforts and strategies also can be aligned with Reaching Every District (RED) strategies such as mapping the catchment area especially focusing the high-risk areas, listing and tracking of dropped out children, to reach and remind the parents of beneficiary children to bring

them back to the vaccination sites for all required vaccine doses also communicate to them about location and time of immunization sessions, maintain a reliable supply of vaccines and logistics, and ensure the quality of services supported by supervision and monitoring, modified and made suitable to the local context.<sup>29,31</sup>

The results of those innovative surpluses to the interventions done so far will lead to a certain level of immunity in the community that can be a protective shield against VPDs.

### ***Scope and the way forward***

The accessibility and utilization of immunization services are two major measurable components of the vaccination programme. These components are explained as knowledge and awareness of parents on its purpose and benefits for immunization service utilization. The availability of services, its location and time is important for accessibility to the services.<sup>32</sup>

Herd immunity is achieved immunizing a significant portion of the population, that can protect individuals who cannot be vaccinated due to illness, who have not developed immunity or vulnerable people such as newborn babies, elderly people.<sup>33</sup> In order to get herd protection in the community, a certain threshold has to be achieved. However, it cannot be recommended as an alternative to the vaccination.

The national immunization program (NIP) in Nepal uses eleven antigens—BCG, DPTHePBBHib (Penta), PCV, OPV (bOPV), Measles and Rubella (MR) and Japanese Encephalitis. Total 16,000 vaccination sites vaccinate children under 1 year of age through fixed, outreach and mobile sessions. Government of Nepal

(GoN) funds for BCG, OPV, Td, JE, measles/rubella procurement. The GAVI supported vaccines such as DPTHePBBHib, PCV and measles component of MR2 are also partially funded by GoN.<sup>34,35</sup>

The vaccination supports the nation's development not only directly through medical savings but also through other types of indirect economic benefits such as cognitive development, enhancement in education, increment in labour strength etc. A Johns Hopkins University study (for 94 lowest-income countries), which was published in Health Affairs (2016), calculated that every dollar investment for vaccination gives US\$ 44 in return in terms of savings in costs for healthcare, loss of wages and productivity due to illness and death and social values of living healthier and longer without the burden of disability.<sup>36,37</sup>

The Constitution of Nepal (2015) has change structures of every level from the center to local government, having the vision of establishing strong local governments (LGs) and the other systems including public health-related structures are yet to be composed.<sup>38</sup> This will definitely increase the catchment area resulting to a bigger population will be taken care by the existing infrastructures and human resources of health services, at the same time, ambiguity about the provision of additional trained human resources would create confusion them.

In the process of adaptation of new structural changes due to the restructuring of the state and liquidation of the DPHOs, an approach such as creating a comprehensive urban health centre would be able to address issues related to urban immunization services.

## CONCLUSION AND RECOMMENDATIONS

Our findings present the process of interventions and the progress of urban routine immunization services for a decade after interventions to strengthen it. As the dropout is appeared to be a chronic problem, it invites more efforts towards community engagement. All the associated aspects and the barriers such as shortage of vaccine and other logistics, availability of required trained service providers, provision of more accessible outreach services, periodic comprehensive programme review by local authorities has to be focused.

The population growth and in-migration have significantly increased the workload and the relevant measures should be taken to solve the issues that will contribute to for long-term sustainability of the programme.

Similarly, enhancement of awareness of mothers and caregivers about the importance and availability of immunization services will improve the utilization resulting in a decrease in the dropout problem. After all investment in children's health will pay back in the future by reducing the burden of health care systems.

## ACKNOWLEDGEMENT

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## REFERENCES

1. St Andrews Special Collections in Anniversaries MC, Muniments Collection, Rare Book Collection. EDWARD JENNER AND THE SMALLPOX VACCINE WordPress.com: University of St Andrews; 2018
2. World Health Organization. Vaccines and diseases 2018 [Available from: <http://www.who.int/immunization/diseases/en/>].
3. UNICEF/WHO Jnr. 1 in 10 infants worldwide did not receive any vaccinations in 2016. Media centre, WHO. 2017;Sect. Media centre News releases: 2017.
4. Nations U. World Urbanization Prospects: 2014 Revision, Highlights. New York: United Nations. 2014. <https://doi.org/10.18356/e59eddca-en>
5. Baker , Judy L. 2008. Urban poverty : a global view (English). Urban Papers ; no. UP-5. Washington, DC: World Bank. <http://documents.worldbank.org/curated/en/954511468315832363/Urban-poverty-a-global-view>.
6. Cutts FT. Strategies to improve immunization services in urban Africa. World Health Organization; 1991.
7. Awoh AB, Plugge E. Immunisation coverage in rural-urban migrant children in low and middle-income countries (LMICs): a systematic review and meta-analysis. Journal of Epidemiology and Community Health. 2016;70(3):305-11. <https://doi.org/10.1136/jech-2015-205652>
8. Ministry of Health and Population N. National-immunisation-programme Kathmandu: <http://www.mohp.gov.np>; 2016 [Available from: <http://www>].

- mohp.gov.np/content/national-immunisation-programme.
9. Justice MoLa. LOCAL SELF-GOVERNANCE ACT, 2055 (1999) AN ACT MADE TO PROVIDE FOR LOCAL SELF-GOVERNANCE. In: His Majesty's Government of Nepal MoLaJ, editor. Kathmandu: Law Books Management Board; 1999.
  10. Services DoH. Annual Report 2068/69 (2011/2012). In: Government of Nepal MoHaP, Department of Health Services, editor. Kathmandu: Ministry of Health and Ppulation, Department of Health Services; 2013.
  11. Manch BL. Temples of Mithila New Delh: Bihar Lok Manch; 2017 [Available from: <https://www.biharlokmanch.org/cultural-article-24.html>].
  12. Wikipedia tfe. Mithila (region): Wikimedia Foundation, Inc.; 2018
  13. Wikipedia. Janakpur, Nepal en.wikipedia.org: From Wikipedia, the free encyclopedia; 2018 [Available from: [https://en.wikipedia.org/wiki/Janakpur,\\_Nepal](https://en.wikipedia.org/wiki/Janakpur,_Nepal)].
  14. GeoHack - Janakpur N. Global/Transnational services, Wikimedia maps tools.wmflabs.org: GeoHack; 2018
  15. Statistics CBo. National Population and Housing Census 2011 (Village Development Committee/Municipality). In: Secretariat NPC, editor. National Population and Housing Census. Kathmandu: Government of Nepal; 2012.
  16. National Immunization Program N. Reaching Every Child, Comprehensive Multi-Year Plan 2068-2072 (2011-2016) In: Services DoH, editor. Kathmandu: Ministry of Health & Population, Nepal; 2011.
  17. FCHV Section F. National FCHV Program Revised Strategy Kathmandu: HMG/N FHD, MOH; 2003.
  18. Department of Health Services MD. Health Management Information Systems (HMIS) Kathmandu: GOVERNMENT OF NEPAL, MINISTRY OF HEALTH, DEPARTMENT OF HEALTH SERVICES, MANAGEMENT DIVISION; 2016 [Available from: <http://mddohs.gov.np/en/hmis/>].
  19. LAXMI BILAS ACHARYA JC. Maternal and child health services in rural Nepal: does access or quality matter more? health policy and planning, Oxford University Press. 2000;15(2):223-9. <https://doi.org/10.1093/heapol/15.2.223>
  20. MoHP FHD. FCHV Kathmandu: MoHP, Family Health Division; 2016 [Available from: <http://www.fhd.gov.np/index.php/en/2014-03-21-09-41-44/fchv>].
  21. Khatri RB, Mishra SR, Khanal V. Female Community Health Volunteers in Community-Based Health Programs of Nepal: Future Perspective. *Frontiers in Public Health*. 2017;5:181. <https://doi.org/10.3389/fpubh.2017.00181>
  22. Services DoH. Annual Report 2009-2010. Kathmandu: Department of Health Services, Ministry of Health and Population, Government of Nepal; 2011.
  23. Services DoH. Annual Report 2010-2011. Kathmandu: Department of Health Services, Ministry of Health and Population, Government of Nepal; 2012.
  24. Services DoH. Annual Report 2069/70 (2012/2013). Kathmandu: Department of Health Services, Ministry of Health and Population, Government of Nepal; 2014.

25. Services DoH. Annual Report 2013-2014. Kathmandu: Department of Health Services, Ministry of Health and Population, Government of Nepal; 2015.
26. Services DoH. Annual Report 2014-2015. Kathmandu: Department of Health Services, Ministry of Health and Population, Government of Nepal; 2016.
27. Services DoH. Annual Report 2015-2016. Kathmandu: Department of Health Services, Ministry of Health and Population, Government of Nepal; 2017.
28. Acharya K, Paudel YR, Dharel D. The trend of full vaccination coverage in infants and inequalities by wealth quintile and maternal education: analysis from four recent demographic and health surveys in Nepal. *BMC Public Health*. 2019;19(1). <https://doi.org/10.1186/s12889-019-7995-3>
29. Vandelaer J, Bilous J, Nshimirimana D. Reaching Every District (RED) approach: a way to improve immunization performance. *Bulletin of the World Health Organization*. 2008;86(3):A-B. <https://doi.org/10.2471/BLT.07.042127>
30. Haji A, Lowther S, Ngan'ga Z, Gura Z, Tabu C, Sandhu H, et al. Reducing routine vaccination dropout rates: evaluating two interventions in three Kenyan districts, 2014. *BMC Public Health*. 2016;16:152. <https://doi.org/10.1186/s12889-016-2823-5>
31. Reaching Every District (RED), 2017 revision. Brazzaville: World Health Organization; 2017. Licence: CC BY-NC-SA 3.0 IGO
32. Nelson KN, Wallace AS, Sodha SV, Daniels D, Dietz V. Assessing strategies for increasing urban routine immunization coverage of childhood vaccines in low and middle-income countries: A systematic review of peer-reviewed literature. *Vaccine*. 2016;34(46):5495-503. <https://doi.org/10.1016/j.vaccine.2016.09.038>
33. Loving S. Herd immunity (Herd protection) University of Oxford, OX3 7LE: Centre for Clinical Vaccinology and Tropical Medicine, Churchill Hospital; 2016 [Available from: <http://vk.ovg.ox.ac.uk/herd-immunity>].
34. Services DoH. Annual Report 2073/74 (2016/17). In: (DoHS) DoHS, editor. Kathmandu: Government of Nepal, Ministry of Health and Population; 2018.
35. National immunization Programme and EPI schedule of Nepal 2016 [Available from: <http://publichealthinnepal.blogspot.com/2016/06/national-immunization-programme-and-epi.html>].
36. Ozawa S CS, Portnoy A, Grewal S, Brenzel L, Walker D.G. . Return On Investment From Childhood Immunization In Low- And Middle-Income Countries, 2011–20. *Health Affairs*. 2016;35(2):199-207. <https://doi.org/10.1377/hlthaff.2015.1086>
37. GAVI. PUBLIC HEALTH'S 'BEST BUY': GAVI; 2017 [Available from: <https://www.gavi.org/about/value/cost-effective/>].
38. Nepal Go. The Constitution of Nepal. Kathmandu: Ministry of law, justice and parliamentary affairs; 2015.