IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 21, Issue 1 Ser.10 (January. 2022), PP 35-44
www.iosrjournals.org

A comparative study of evaluation of Immunization Coverage in catchment areas of Urban & Rural Health Training Centre by Lot Quality Assurance Sampling.

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Abstract:
Background*: Immunization is one of the major public health interventions for the protection of children from life-threatening conditions, which are preventable. Immunization is one of the most successful and cost-effective public health interventions of the 21st century preventing 2–3 million deaths from common childhood illnesses including diphtheria, pertussis, tetanus, and measles per year. Despite this, 22.6 million children are still not reached by routine immunization services. To evaluate immunization coverage in small health areas LQAS technique is most suitable for continuous programme monitoring as part of supervisory activities. Using this method it should be possible to identify the areas with lower immunization coverage, and thus to direct increased attention to these areas.* ***Materials and Methods****: In this cross sectional study, Lot Quality Assurance Sampling Technique survey was used to evaluate immunization coverage of catchment areas attached to Rural and Urban Health Training Centres of a teaching medical institution with total sample of 525 children. Study was conducted for 18 months amongst 12- 24 months age group of children. A pretested & pre-defined semi structured questionnaire was used for data collection to conduct interview of children's mothers in their vernacular languages after taking their consent to participate in this study.* ***Results****: Immunization coverage at UHTC was only 73.4% & Immunization coverage at RHTC area was 94% (P value <0.05). Main reasons for 'inadequate immunization' in this study were child sickness (12.7%) followed by migration due to lockdown (8.72%), Myths/misconceptions about vaccination (7.63%) & mother was not knowing date of vaccination or place of /onsite vaccination or busy with work on day of vaccination (5.09%) & in RHTC area most common reason for 'inadequate immunization' was child sickness (4.4%) followed by mother was not knowing date/day of vaccination(1.6%).* ***Conclusion:*** *Lot Quality Assurance Sampling method found feasible, convenient to evaluate immunization coverage in small subunits/pockets of both urban & rural areas.*

Key Word*: Evaluation of Immunisation coverage, LQAS methodology, urban rural disparity.*

Date of Submission: 06-01-2022 Date of Acceptance: 18-01-2022

I. Introduction

Immunization is one of the major public health interventions for the protection of children from life-threatening conditions, which are preventable. Vaccines have saved the lives of many children in the world, more than any other medical intervention in the last 50 years.(1) The concerted global effort to use immunization as a public health strategy began when the World Health Organization (WHO) launched the Expanded Programme on Immunization (EPI) in 1974, following the successful global smallpox eradication programme.(2,3) Immunization is one of the most successful and cost-effective public health interventions of the 21st century preventing 2–3 million deaths from common childhood illnesses including diphtheria, pertussis, tetanus, and measles per year.(4)Despite this, 22.6 million children are still not reached by routine immunization services.(5) Despite the significant progress made towards global immunization goals over the last decade, there are wide disparities in immunization coverage across the countries in the world. Limited resources, weak health infrastructure, competing health priorities, and lack of supervision were some of the major contributing factors.(4) The impact of vaccines extends beyond public health, which affects children's educational achievements and national economic growth. Moreover, children suffer from vaccine-preventable disabilities, impaired growth, and cognitive development.(6,7) Lot Quality Assurance Sampling methods, originally developed to detect product manufacturing errors, can be used to identify health areas with poor levels of performance, e.g. low immunization coverage. Methods that assess the 'quality' of outcomes in discrete batches or lots (e.g. health areas), are often referred to as Lot Quality Assurance Sampling (LQAS) methods. Using such methods it should be possible to identify the areas with lower immunization coverage, and thus to direct increased attention to these areas. In addition, since LQAS is stratified random sampling, the results from small health areas can be combined to yield an estimate of immunization coverage for a health region or for the country. We report our experience with the use of LQAS to monitor the coverage resulting from a series of immunization campaigns in rural and urban areas to improve overall levels of coverage.[8–11]

II. Material And Methods

The study was conducted in the catchment areas of Urban & Rural Health centre attached to a tertiary teaching medical institution. Permission was taken from in- charges of both centres to conduct this study. The overall population was 1,03,693 in Urban Health Training Centre & 72,123 in Rural Health Training Centre. There were 31 subunits in UHTC & 29 in RHTC. We have selected 25 lots randomly as per convenience of CHV & ASHA from these subunits as decided by LQAS method. We have excluded 6 subunits in UHTC & 4 subunits in RHTC because they were not satisfying inclusion criteria & lot sample size. Those who have fulfilled inclusion criteria were interviewed using a pretested, semi-structured questionnaire.

Study Design: Cross-sectional study

Study Location: The field practice areas Rural Health Centre & Urban Health Centre attached to a tertiary teaching medical institution.

Study Duration: The current study was conducted for 18 months from May 2019 to March 2020 and from October 2020 to Feb 2021.

Sample size: 525 children (275 in Urban & 250 in Rural).

Sample size calculation: (Ministry of Health & Family Welfare Booklet 2011)

1. Selection of Lots : Can select maximum number of Lot i.e. 25 Hence,25 lots were selected to study in both Rural & Urban Health Training Centres.
2. Level of confidence level and Accuracy : At 95% confidence level and 6% desired level of accuracy sample size would be 267.
3. Calculation of target population : Target population would be 3% of total population. -Total population (RHTC):72123 ; Target population: 2164 for RHTC - Total population (UHTC): 103693 ; Target population: 3110 for UHTC
4. Sampling fraction = For Rural =Total sample size/target population=267/2164*100=12%
For Urban=Total sample size/target population=267/3110*100=8%

-For rural sampling fraction coming more than 10% hence its showing large sample size for that we have to revise sample size by following formula

-Revised sample size = Total sample size/1+sampling fraction=267/1.12=238 , its sampling fraction coming within limit of sampling fraction i.e. 10%

5. Calculation of sample size in each lot : Total sample size/ no. of lots = 238/25=10(For Rural) Total sample size/ no. of lots=267/25=11(For Urban)
6. Sample size for Rural & Urban would be 250 & 275

Sampling method: Lot Quality Assurance sampling method

Subjects: Children of 12-24 months

Procedure methodology:

Lot Quality Assurance Sampling (LQAS) is the most appropriate evaluation method in this context as it has been used successfully in past evaluations of vaccination coverage (Dubray et al., 2006; Tawfik et al., 2001). LQAS provides both a city wide estimate and estimates for geographic subunits. The limitation of the method is that a specific estimate for each subunit cannot be evaluated, but they are classified as having ‘acceptable’ or ‘unacceptable’ vaccination coverage based on upper (>85%) and lower cut-offs (<70%) defined for the specific survey (Hoshaw Woodard 2001).

The areas were divided into 25 non-overlapping Lots based on administrative neighbourhoods with well known boundaries. In one lot sample size was taken according to target population of that area. A lower threshold of 70% vaccination coverage below which a lot was considered to have ‘unacceptable’ vaccination coverage and an upper threshold of 85% above which a lot was considered to have ‘acceptable’ vaccination coverage.

• To select households within each of the 25 lots, a systematic sampling planning done.

1. List of all households in villages/ wards were taken from both the centres.
2. Household in each lot randomly selected and from this point moved to next house until we get desired sample size in one lot.
3. Only one target child and one mother selected for survey. If they didn’t fill inclusion criteria moved to next house.
4. If more than one child of same mother found then target randomly selected from them.

Inclusion criteria:
1. Children receiving routine immunization & fall in age group of 12-24 months.
2. Having immunization card with them or record with health care worker.

Exclusion criteria:
1.Not having immunization record

Statistical analysis:

Data was analyzed using SPSS version 22 & MS Excel. Chi square test & multinomial logistic regression test applied to see association between variables & immunization coverage.

III. Result

A total of 525 children were included in study. Out of them 275 children were included from Urban Health Training Centre area & 250 children were included from Rural Health Training Centre area belonging to 12-24 months of age. Out of 275 children, 138 (50.1%) were males & 137 (49.9%) were females from Urban Health Training Centre & out of 250 children, 132 (52.8%) were males & 118 (47.2%) were females from Rural Health Training Centre.

Table 1. Immunization coverage of study subjects at UHTC & RHTC Areas:

	UHTC	RHTC	Chi square value	P value
CI (completely immunised)	202 (73.4%)	235 (94%)	38.16	<0.0000001
PI (Partially immunised)	73 (26.6%)	15 (6%)		

Table 1 shows distribution of immunization coverage at UHTC & RHTC area. Immunization coverage at UHTC was only 73.4% &Immunization coverage found better at RHTC area more than required WHO criteria & that was 94% . This difference is very much significant. (P value <0.05 is considered as significant.)

Table 2. Immunization coverage of each vaccine at UHTC & RHTC Area

Vaccine name	**Coverage at UHTC**	**Coverage at RHTC**
BCG	100%	100%
OPV0	172 (62.5%)	234 (93.6%)
Hep B	163 (59.2%)	203 (81.2%)
OPV1/PV1/IPV1	266 (96.7%)	100%
OPV2/PV2	255 (92.7%)	100%
OPV3/PV3/IPV2	247 (89.8%)	249 (99.6%)
MR1/Vit A1	237 (86.1%)	246 (98.4%)
DPT1/OPVB/MMR/Vit A2	143 (out of 191)-74.8%	149(out of 170)-87.6%

Table 2 shows immunization coverage for each vaccine in both areas. For each vaccine immunization coverage was low in UHTC area as compared with RHTC area except BCG vaccine. Coverage for OPV1/PV1/IPV1, OPV2/PV2 & OPV3/PV3/IPV2 at UHTC was 96.7%, 92.7% & 89.8% respectively and at RHTC 100%, 100% & 99.6% respectively. Coverage for MR1 at UHTC & RHTC 86.1% & 98.4% respectively. Coverage for DPT1/OPVB/MMR/VitA2 at UHTC & UHTC was 74.8% & 87.6% respectively. Immunization coverage was lower for OPV0 (62.5%), Hep B (59.2%), DPT1/OPVB/MMR/Vit A (74.8%) as compared to other vaccines in UHTC area & Hep B (81.2%), DPT1/OPVB/MMR/Vit A (87.6%) in RHTC area as compared to other vaccines.

Fig. 1 Bar diagram showing Immunization coverage for each vaccine at UHTC & RHTC Area

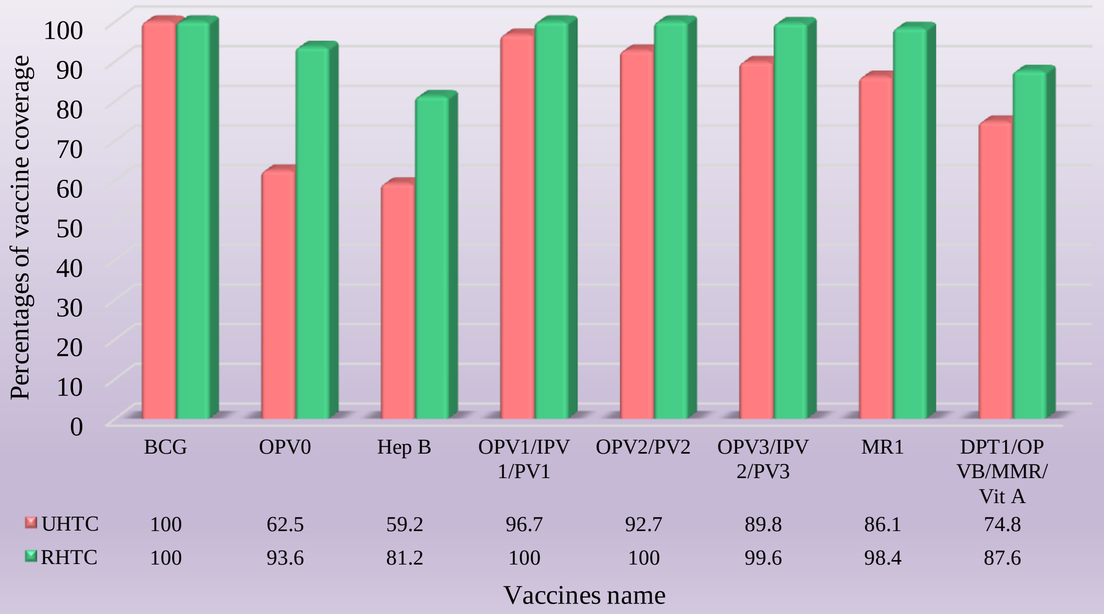

Table 2. Reasons for inadequate vaccination at UHTC & RHTC Area

Reasons for Inadequate immunization	**UHTC Area**	**RHTC Area**
Child was sick	**35 (12.7%)**	**11 (4.4%)**
Mother was not knowing/busy with work	**14 (5.09%)**	**4 (1.6%)**
Myths/misconception	**21 (7.63%)**	**-**
migration due to lockdown	**24 (8.72%)**	**-**

Fig 2. Bar diagram showing Reasons for inadequate vaccination at UHTC & RHTC Area

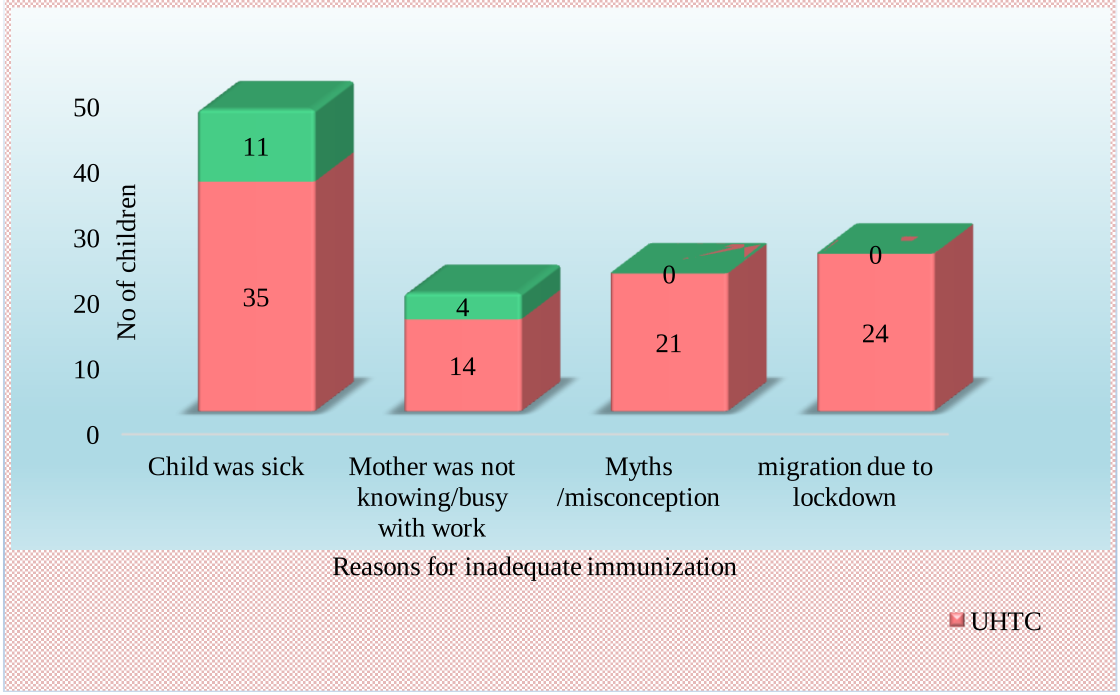

Table 2 shows reasons for inadequate immunization.Main reasons for ‘inadequate immunization’ in this study were child sickness (12.7%) followed by migration due to lockdown (8.72%), Myths/misconceptions about vaccination (7.63%) & mother was not knowing date of vaccination or place of vaccination or busy with work on day of vaccination (5.09%). In RHTC area most common reason for ‘inadequate immunization’ was child sickness (4.4%) followed by mother was not knowing date/day of vaccination(1.6%)

Table 3. Association of variables with immunization coverage at UHTC & RHTC Area

Sr No	Variable		UHTC		RHTC		P Value	
			CI	PI	CI	PI	UHTC	RHTC
1.	Gender	M	100	38	123	112	0.406 (Non-significant)	0.37 (Non-significant)
		F	102	35	9	6		
2.	Age	<1 year	20	11	57	4	0.163 (Non-significant)	0.46 (Non-significant)
		>1 year	182	62	178	11		
3.	Types of family	Nuclear family	106	47	74	7	0.03 **(Significant)**	0.17 (Non-significant)
		Joint family	96	26	161	8		
4.	Mothers education	Primary	148	61	139	12	0.144 (Non-significant)	0.277 (Non-significant)
		Secondary	23	7	62	2		
		Graduation	31	5	34	1		
5.	Mothers occupation	Housewife	168	63	192	11	0.91 (Non-significant)	0.09 (Non-significant)
		In service	7	1	19	0		
		Others	27	9	24	4		
6.	Fathers education	Primary	149	59	137	12	0.42 (Non-significant)	0.22 (Non-significant)
		Secondary	26	8	50	1		
		Graduation	27	6	48	2		
7.	Fathers occupation	Labourer	158	66	128	11	0.03 **(Significant)**	0.14 (Non-significant)
		In service	17	5	31	0		
		Others	27	2	99	4		
8.	Birth order	1	90	24	110	5	0.24 (Non-significant)	0.02 **(Significant)**
		2	70	34	97	5		
		3	30	12	21	5		
		>3	12	3	6	0		

Table 3 shows association between variables &immunization coverage. Association seen in between immunization coverage & Type of family , Mothers occupation, fathers occupation & birth order(P value <0.05). There was no association seen in gender, age, mothers education & fathers education where P value was >0.05.

Table 5. Multinomial logistic regression analysis for the associations of immunization coverage with sociodemographic & other relevant factors: at 95% CI, df-1.

VARIABLE	**UHTC**		**RHTC**	
	Full Immunization	Inadequate Immunization	Full Immunization	Inadequate Immunization
	Odds ratio(95% CI)	Odds ratio(95%CI)	Odds ratio(95% CI)	Odds ratio(95% CI)
1. Birth order (first to sixth)	0.94 (0.41- 2.16)	1.05 (0.46- 2.41) **(Significant)**	2.49 (0.26- 23.4) **(Significant)**	0.40 (0.04- 3.75)
2. Type of family (NF & Joint Family)	1.13 (0.97- 1.33) **(Significant)**	0.87 (0.75- 1.02)	1.01 (0.79- 1.27) **(Significant)**	0.98 (0.78- 1.25)
3. Mothers education (primary to postgraduation)	1.47 (0.87- 2.48) **(Significant)**	0.67 (0.40- 1.14)	1.36 (0.45- 4.06) **(Significant)**	0.73 (0.24- 2.18)
4. Mothers occupation (Housewife/others/Inservice)	0.98 (0.50- 1.91)	1.02 (0.52- 1.99) **(Significant)**	0.93 (0.28- 3.09)	1.07 (0.32- 3.54) **(Significant)**
5. Fathers education (primary to postgraduation)	0.88 (0.51 -1.51)	1.13 (0.65- 1.95) **(Significant)**	0.98 (0.35- 2.77)	1.01 (0.36- 2.84) **(Significant)**
6. Fathers occupation (labourer/others/In service)	1.54 (0.85- 2.80) **(Significant)**	0.64 (0.35- 1.17)	2.20 (0.70- 6.9) **(Significant)**	0.45 (0.14- 1.42)

In the above table no.5, shows Multinomial logistic regression analysis for the associations of immunization coverage with socio demographic & other relevant factors at 95% CI. Type of family (OR 1.13, 0.97- 1.33), mothers education (1.47, 0.87- 2.48), fathers occupation (OR 1.54, 0.85- 2.80) were significantly associated with full immunization coverage in UHTC area. While factors related with inadequate immunization were birth order (OR 1.05, 0.46- 2.41), mothers occupation (OR 1.02, 0.52- 1.99) & fathers education (OR 1.13, 0.65- 1.95).

In RHTC area birth order (OR 2.49, 0.26- 23.4), type of family (OR 1.01, 0.79- 1.27), mothers education (OR 1.36, 0.45- 4.06) & fathers occupation (OR 2.20, 0.70- 6.9) were significantly associated with full immunization coverage. While factors related with inadequate immunization were mothers occupation (OR 1.07, 0.32- 3.54) & fathers education (OR 1.01, 0.36- 2.84) .

Table 6. Immunization coverage of Lots in UHTC & RHTC area

IMMUISATION COVERAGE	UHTC	RHTC
>85% (Acceptable lots)	Geetanjali Nagar (100%) Shahu Nagar (100%) Kuttiwadi (100%) Anna Nagar(90.9%) Nabi nagar (90.9%) Kot chawl (90.9%) Ambika chawl (90.9%) Nawab nagar (90.9%)	Vasind-1 (100%) Vasind -2 (100%) Asangaon (100%) Awale (100%) Shei (100%) Bhatsai (100%) Ambivali (100%) Shere (100%) Pali (100%) Dahagaon (100%) Khativali (100%) Madh (100%) Amberje (100%) Kajalivihir (100%) Shubhvastu (90%) Chandroti (90%) Sawroli (90%) Sane (90%) Katbav (90%) Sarmal (90%) Masvane (90%)
< 70 % (Not acceptable Lots)	Sadabar society (36.3%) Jasmin mil (27.2%) Kathiwadi (45.4%) Azad nagar (45.4%) Madinanagar (54.5%) Lala compound (54.5%) Indira nagar (54.5%)	------
71-85%	Kamala Nagar (81.8%) Muslim nagar(81.8%) Magdumiya (81.8%) Ambedkar nagar (81.8%) Prabhakar kunte (72.7%) Tagor society (72.7%) Islampur (72.7%) H. Bilal chawl (72.7%) Shetwadi (72.7%) AKG nagar (72.7%)	Karale (80%) Mahuli (80%) Walshet (80%) Mamnoli (80%)

As shown in table 6, only 8 lots were acceptable in UHTC area as per LQAS criteria (>85% immunization coverage) in contrast to 21 lots were acceptable in RHTC area. In UHTC area 7 lots were not acceptable as per LQAS criteria where immunization coverage was <70% & in RHTC area no lot was unacceptable.

IV. Discussion

A cross sectional study was conducted titled ‘ A comparative study of evaluation of immunization coverage of catchment areas belonging to Rural and Urban Health Training Centres attached to tertiary teaching medical Institution by Lot Quality Assurance Sampling Technique. Lots quality assurance sampling method was used for data collection. A total of 525 children by LQAS method were included in the present study. Out of them 275 children were included from Urban Health Training Centre area & 250 children from Rural Health Training Centre area belonging to 12-24 months age.

Similar age group children were included in a study conducted by **Assefa Desalew et al (2020)**(6) in Ethiopia & a study conductedby **K Punith, K Lalitha et al (2008)**(13)at Mathikere Urban Health Centre, Bangalore which includes children aged 12 months to 23 months with desired sample size. However, a study conducted by **Andrew Clark, Colin Sanderson (2009)**(23) in UK which includes children aged 6 weeks to 36 months. In most of the studies children aged 12 months to 23 months were included.

In this study Immunization coverage at UHTC was only 73.4% & it was better at RHTC area more than required WHO criteria & that was 94% . Urban rural disparity in full vaccination coverage was 20.6%. This difference is very much significant. (P value <0.05) as shown in table 1. Immunization coverage for urban & rural was 71.7% & 74.7% respectively according to **NFHS-5 (2019-2020)**(12). **Xinyi Zhang et al (2018)**(16) observed full vaccination coverage in rural and urban children were 81.5% and 69.4% respectively; this shows urban-rural disparity of 12% & in a study conducted by **Yu Hu, Ying Wang (2019) et al**(14) found full vaccination coverage was 94% in rural areas and 85% in urban areas. The rural–urban disparity in full vaccination Coverage was 9.0%. These findings were almost similar to present study that full immunization coverage is more in rural area than urban area. However, full immunization coverage seen better in urban area than rural areain a study conducted by **Edward Kwabena Ameyaw (2021) et al**[20] in Sub Saharan Africahad observed that more than half of children in urban settings were fully immunised (52.8%) while 59.3% of rural residents were not fully immunised. Similar finding seen in a study conducted by **Mohammad Hardhantyo et al (2020)**[15] in Indonesia had observed incompletely immunized children in urban area were 45.3% and 54.7% were in rural areas with urban rural disparity of 9%.

Immunization coverage was low in for each vaccine in UHTC area as compared with RHTC area except BCG vaccine in this study as shown in table 2. Coverage for OPV1/PV1/IPV1, OPV2/PV2 & OPV3/PV3/IPV2 at UHTC was 96.7%, 92.7% & 89.8% respectively and at RHTC 100%, 100% & 99.6% respectively. Coverage for MR1 at UHTC & RHTC 86.1% & 98.4% respectively. Coverage for DPT1/OPVB/MMR/VitA2 at UHTC & RHTC was 74.8% & 87.6% respectively.

Immunization coverage was lower for OPV0 (62.5%), Hep B (59.2%), DPT1/OPVB/MMR/Vit A (74.8%) as compared to other vaccines in UHTC area & Hep B (81.2%), DPT1/OPVB/MMR/Vit A (87.6%) in RHTC area as compared to other vaccines. These values supported by **NFHS-5 (2019-2020)**[12] in which immunization coverage for BCG, OPV, Pentavalent & MR vaccine at urban level was 92%, 76.4%, 81.5% & 82.7% respectively and at rural level was 95.1%, 80.9%, 84.8% & 86.2% respectively shows comparatively more immunization coverage in rural area than urban area.

A study conducted by **Abadi Girmay et al (2019)**[17]in Ethiopia observed that vaccination coverage of BCG, OPV1/OPV2/OPV3, Pentavalent1/Pentavalent2/Pentavalent3, MR was 90%, 91.5%/85.3%/78.9%, 90%/84%/77.9% , 80.5% respectively. Similar immunization coverage observed in a conducted by **Bhuwan Sharma et al (2014)**[18] in urban slums of Mumbai for BCG, OPV0, OPV1/OPV2/OPV3, DPT1/DPT2/DPT3, HepB1/HepB2/HepB3, MR was 97.1%, 89.5%, 96.7%/96.2%/93.8%, 96.7%/95.7%/92.9%, 95.2%/91.4%/88.1%, 87.6% respectively. In both the studies highest coverage seen for BCG & lowest for MR vaccine.

Main reasons for 'inadequate immunization' in this study were child sickness (12.7%) followed by migration due to lockdown (8.72%), Myths/misconceptions about vaccination (7.63%) & mother was not knowing date of vaccination or place of vaccination or busy with work on day of vaccination (5.09%). In RHTC area most common reason for 'inadequate immunization' was child sickness (4.4%) followed by mother was not knowing date/day of vaccination(1.6%) as shown in table 3.

A study conducted by **Bhuwan Sharma et al (2014)**[18] in urban slums of Mumbai observed the main reason for noncompliance was given as child's illness at the time of scheduled vaccination followed by lack of knowledge regarding importance of immunization & **C.M. Singh et al (2019)**[19]in Bihar India observed the most common reason for incomplete immunization was unavailability of child on the day of vaccination followed by sickness of the child. Similar factors were observed in a study conducted by **Tim Crocker-Buque (2017) et al**[21], main reasons for inadequate immunization were mother or both parents being too busy; parent returned to home village; parent unaware of place or time of immunization; and lack of awareness for the need for immunization.

As shown in table 5 multinomial logistic regression analysis done to see the associations of immunization coverage with sociodemographic & other relevant factors at 95% CI. Type of family (OR 1.13, 0.97- 1.33), mothers education (1.47, 0.87- 2.48), fathers occupation (OR 1.54, 0.85- 2.80) were significantly associated with full immunization coverage in UHTC area. While factors related with inadequate immunization were birth order (OR 1.05, 0.46- 2.41), mothers occupation (OR 1.02, 0.52- 1.99) & fathers education (OR 1.13, 0.65- 1.95). In RHTC area birth order (OR 2.49, 0.26- 23.4), type of family (OR 1.01, 0.79- 1.27), mothers education (OR 1.36, 0.45- 4.06) & fathers occupation (OR 2.20, 0.70- 6.9) were significantly associated with full immunization coverage. While factors related with inadequate immunization were mothers occupation (OR 1.07, 0.32- 3.54) & fathers education (OR 1.01, 0.36- 2.84).

These findings supported by a study conducted by **Abadi Girmay et al (2019)**[17]thathaving antenatal care visit (AOR=2.75, 95%CI: 1.52-5.0), higher level of maternal education (AOR=2.39, 95%CI: 1.06-5.36), mothers' good knowledge on immunization (AOR=3.70, 95%CI: 2.37-5.79), short distance to health facility (AOR=2.65, 95%CI: 1.61-4.36), and being born in health institutions (AOR=2.58, 95%CI: 1.66-3.99) had increased the odds of full immunization coverage while having five and more family size reduced the odds of children's vaccine uptake (AOR=0.62, 95%CI: 0.38-0.99). Similar findings seen in a study conducted by **Anonh Xeuatvongsa et al (2017)**[22] have observed factors relating to family characteristics such as maternal/paternal ethnicity (maternal ethnicity: OR 0.31, 95% CI: 0.18–0.53, paternal ethnicity: OR 0.32, 95%CI: 0.19–0.54), maternal/paternal occupation (maternal occupation: OR 2.60, 95%CI: 1.57–4.33, paternal occupation: OR 2.05, 95% CI: 1.26–3.33), and maternal/paternal education (maternal education: OR 1.66, 95% CI: 1.05–2.61, paternal education: OR 2.16, 95% CI: 1.34–3.48) were associated with full vaccination of the children.

In a study conducted by **Assefa Desalew et al (2020)** [(6)]observed thatmaternal illiteracy (OR = 1.96; 95% CI: 1.40, 2.74) and home delivery (OR = 2.78; 95% CI: 2.28, 3.38) were associated factors that increased incomplete vaccination. However, maternal autonomy (OR = 0.54; 95% CI:0.33, 0.89), maternal knowledge (OR = 0.31; 95% CI: 0.20, 0.47), husband employment (OR = 0.49; 95% CI: 0.35, 0.67), urban residence (OR = 0.61; 95% CI: 0.43, 0.86), ANC visits (OR = 0.30; 95% CI: 0.23, 0.39), postnatal care (OR = 0.39; 95% CI: 0.30, 0.52), and tetanus toxoid vaccine (3+) (OR = 0.42; 95% CI: 0.26, 0.69) were factors that reduced incomplete vaccination.

In the present study as shown in table 6, only 8 lots were acceptable in UHTC area as per LQAS criteria (>85% immunization coverage) in contrast to 21 lots were acceptable in RHTC area. In UHTC area 7 lots were not acceptable as per LQAS criteria where immunization coverage was <70% & in RHTC area no lot was unacceptable.
From this study found out that LQAS sampling method is convenient method to find out immunization coverage of subunits, small pockets of any area so that we can work on that particular area to improvise immunization coverage by finding out factors responsible for inadequate immunization in that area.

A study conducted by **K Punith, K Lalitha et al (2008)**[(13)]&**Singh J, Jain DC, et al (1996)**[(9)]in India found that lot quality assurance sampling is better in evaluating primary immunization than cluster. Considering time & resources allocation lot quality assurance sampling method can be used as a tool to identify the problematic subareas. Similar findings seen in a study conducted by **K.P. Alberti, JP Guthman (2008)**[(10)]in Paris concluded thatLQAS method provides both citywide estimate and estimates for geographic subunits. They are classified as having acceptable/unacceptable vaccination coverage based on upper and lower cut off defined for the specific survey (Hoshaw-Woodard, 2001). In this study they have followed a lower threshold of 70% vaccination coverage below which a lot was considered to have 'unacceptable' vaccination coverage and an upper threshold of 85% above which a lot was considered to have 'acceptable' vaccination coverage.

Similar method were used in a study concluded by **CLAUDIO F LANATA et al (1990)**[(8)]Lot Quality Assurance Sampling methods were used to assess the coverage resulting from three immunization campaigns in rural and urban areas in the mountains of Peru. Lot quality assurance sampling procedures proved useful in identifying small health areas with poorer vaccination performance. This information, combined with further assessment of performance problems and timely corrective action helped the Ministry of Health to improve immunization coverage.

V. Conclusion

Lot Quality Assurance Sampling method found feasible, convenient to evaluate immunization coverage in small subunits/pockets of both urban & rural areas. Considering time & resources allocation LQAS is better method to evaluate immunization coverage & to identify localities within small areas where immunization coverage is inadequate. It will be cost effective in the long run by providing detailed information and enabling better decision-making in microplanning for routine immunization in order to achieve higher immunization coverage.

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Varsha Kadam, et. al. "A comparative study of evaluation of Immunization Coverage in catchment areas of Urban & Rural Health Training Centre by Lot Quality Assurance Sampling." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 21(01), 2022, pp. 35-44.