Assessment of vaccine coverage and associated factors among children in urban agglomerations of Kochi, Kerala, India

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ABSTRACT

Context: Urban population in India is growing exponentially. The public sector urban health delivery system has so far been limited in its reach and is far from adequate. **Aims:** This study aims to estimate routine immunization coverage and associated factors among children (12–23 months and 60–84 months) in the urban Kochi Metropolitan Area of Kerala. **Settings and Design:** A cross-sectional study was conducted in Kochi Metropolitan area. **Materials and Methods:** A cluster sampling technique was used to collect data on immunization status from 310 children aged between 12 and 23 months and 308 children aged between 60 and 84 months. **Statistical Analysis:** Crude coverage details for each vaccine were estimated using percentages and confidence intervals. Bivariate and multivariate analysis were conducted to identify factors associated with immunization coverage. **Results:** Among the children aged 12–23 months, 89% (95% CI 85.5%-92.5%) were fully immunized, 10% were partially immunized, and 1% unimmunized. Less than 10 years of schooling among mothers (OR 2.40, 95% CI 1.20–4.81) and living in a nuclear family (OR 1.72, 95% CI 1.06–3.14) were determinants associated with partial or unimmunization of children as per multivariate analysis. The coverage of individual vaccines was found to decrease after 18 months from 90% to 75% at 4–5 years for Diphtheria Pertussis Tetanus (DPT) booster. Bivariate analysis found lower birth order and belonging to the Muslim religion as significant factors for this decrease. **Conclusion:** Education of the mother and nuclear families emerged as areas of vulnerability in urban immunization coverage. Inadequate social support and competing priorities with regard to balancing work and home probably lead to delay or forgetfulness in vaccination. Therefore, a locally contextualized comprehensive strategy with strengthening of the primary health system is needed to improve the immunization coverage in urban areas.

Keywords: Children, immunization coverage, Kerala, urban area

Introduction

Urban population in India has been growing exponentially over the last few decades and now constitutes approximately one-third of the total population. The population projections indicate that about 800 million Indians will be living in the cities by 2045.[1]

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Unlike rural areas that have a dedicated public healthcare system, urban areas in many states of India do not have such structures. The public-sector urban health delivery system has so far been limited in its reach and far from adequate.[2,3] In 2013, India introduced the National Urban Health Mission to focus on urban health. The mission aimed to provide access to basic healthcare facilities to the urban poor.[3]

Kerala, a state in southern India, with a population of 34.1 million, has made impressive improvements in indicators of

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health and social development, such as the human development index (0.84), life expectancy at birth (75 years), infant mortality rate (06/1000 live births), sex ratio (1084 females to 1000 males), and female literacy rates (92.07%), comparable to those of many developed countries.[4] Nearly half of the population in Kerala now lives in urban areas, a higher percentage compared to most states in India.[5]

There has been a surge in vaccine preventable disease cases reported from Kerala in recent years.[6] Vaccine-preventable diseases have higher potential transmission rates in urban areas than that in rural areas. While disease transmission can be interrupted with a lower immunization coverage rate in less densely populated rural areas, the coverage rate will need to be much higher in urban areas to achieve the same effect.[7] Moreover, significant disparities exist in immunization coverage in urban areas with lower coverage observed in the urban poor in many countries.[8] There are limited systematic studies describing vaccination coverage specific to urban areas in Kerala.

Assessing immunization coverage is essential for planning immunization programmes, identifying vulnerable groups that require targeting of increased resources, and predicting likely vaccine-preventable disease epidemics. Hence, the objectives of the current study were to estimate the level of routine immunization coverage as per the Universal Immunisation programme (UIP) among children in Kochi Metropolitan Area of Ernakulum district, and to identify the factors associated with it.

Materials and Methods

Kochi Metropolitan Area (Kochi Urban Agglomeration) which falls under Kochi and Kanayannur Taluks of Ernakulum district consists of Municipal Corporation of Kochi, 9 municipalities, 14 Panchayats, and parts of 4 Panchayats. It has a population of 2,117,990, making it the largest urban agglomeration in Kerala. Kochi Metropolitan Area is referred to as the economic capital of Kerala and is recognized as one of the major industrial cities in India. The average literacy rate is 96.3%. Around 5% of the population resides in slums. Children less than 6 years constitute 9% of the total population. Infant mortality rate is consistently reported at less than 6 per 1000 live births.[9]

A cross-sectional study was conducted during August and October 2017. Children aged between 12 and 23 months and 60 and 84 months (5–7 years) were included in the study, irrespective of the residence status. Children without valid date of birth records and where mothers/primary caregivers were not available were excluded.

With an anticipated coverage among 12–23 months as 90% with 5% absolute precision at 95% confidence, an effective sample size of 139 was required. With an Intra cluster correlation (ICC) of 0.13, with 10 children per cluster, effective sample size was multiplied with a design effect of 2.2 to obtain a total sample size of 306.[10] Thus, 31 clusters were chosen. The primary

sampling unit (PSU) was ward/division (lowest political division). Thirty-one PSUs were selected by probability proportionate to sampling technique from a total of 433 PSUs. A map of the selected cluster was obtained and its geographic centre was visited, and then a random direction was chosen by "spin a bottle" method. In the chosen direction, the first household was selected randomly in each cluster and every next household was studied in a sequence till 10 eligible respondents in both selected age groups (12–23 months and 5–7 years) were included in the study. The parent of the child/available reliable caregiver were interviewed and the information provided was corroborated with the mother and child protection (MCP) card/Immunization card of the child.

A pretested, structured questionnaire was used to collect information from mothers regarding sociodemographic parameters, status of immunization of their child, and reasons for noncompliance. Data collection was preceded by a training session to medical interns who conducted the interview. Age was confirmed by birth certificate or immunization card or delivery discharge summary details, and when not available, by asking the mother. Socioeconomic status was assessed using Kerala's nine-point poverty scale index.[11] The child was considered as immunized or not based on the immunization/MCP card. For those without an immunization card, information from the mother/caregiver in the family stating that the child has been immunized was considered.

Public health sector provides pentavalent vaccine (Diphtheria Pertussis Tetanus (DPT), Hemophilus influenza b (Hib), and hepatitis B) in Kerala. Fully immunized was defined as per the 1998 World Health Organization (WHO) guideline, i.e., receipt of one dose of Bacillus Calmette Guerin (BCG) vaccine, three doses of DPT and Oral Polio Vaccine (OPV) vaccines, and one dose of measles vaccine by children in the age group of 12–23 months. No vaccination/immunization was defined as failure of a child to receive even a single dose of the vaccines listed above. Partial/incomplete vaccination was defined as children in receipt of any one of the vaccine doses mentioned above but not all. Complete immunization was defined as a child between 5 and 7 years who has received, in addition to the above vaccines, two booster doses of DPT and Polio.

The study was conducted after obtaining ethical approval from the Institutional Ethical Committee (IEC). Informed written consent was also obtained from the respondent. The collected data were numerically coded and entered in Microsoft Excel 2007, and then analyzed using SPSS Inc. Version 18.0., Released 2009, PASW Statistics for Windows, (SPSS Inc, Chicago, USA). Crude coverage details for each vaccine were estimated using percentages and confidence intervals. Bivariate and multivariate analysis were conducted to identify factors associated with immunization coverage.

Table 1: Sociodemographic characteristics of children			
Characteristics	Categories	12-23 months (*n*=310) Frequency (%)	5-7 years (*n*=308) Frequency (%)
Gender	Male	149 (48.1%)	171 (55.5%)
	Female	161 (51.9%)	137 (44.5%)
Birth Order	1	167 (53.9%)	189 (61.4%)
	2	128 (41.3%)	101 (32.8%)
	3	15 (4.8%)	18 (5.8%)
Religion	Hindu	137 (44.1%)	157 (51%)
	Christian	97 (31.3%)	82 (26.6%)
	Muslim	76 (24.5%)	69 (22.4%)
Education of Father	Primary	6 (1.9%)	4 (1.3%)
	Middle	14 (4.5%)	25 (8.4%)
	High school	111 (35.8%)	124 (40.3%)
	High secondary	51 (16.5%)	42 (13.6%)
	Diploma/Universityity	128 (41.3%)	112 (36.4%)
Education of Mother	Primary	4 (1.2%)	5 (1.6%)
	Middle	12 (3.9%)	12 (3.9%)
	High school	38 (12.3%)	76 (24.7%)
	High secondary	58 (18.7%)	57 (18.5%)
	Diploma/University	198 (63.9%)	158 (51.3%)
Socio Economic Status	APL	230 (74.2%)	232 (75.3%)
	BPL	80 (25.8%)	76 (24.7%)
Type of family	Joint	114 (36.8%)	145 (47.1%)
	Nuclear	105 (33.9%)	93 (30.2%)
	Three generation	91 (29.4%)	70 (22.7%)

Results

Immunization and sociodemographic details of 310 children between the age group 12 and 23 months and 308 children between the age group of 5 and 7 years were collected. Sociodemographic details of the participants are shown in Table 1.

Among the children aged 12–23 months, 79.4% reported that they got a government immunization card (MCP card), whereas 3.2% reported that they had never possessed any immunization card. Of the children aged 12–23 months, 89% (95% CI 85.5%- 92.5%) were fully immunized, 10% were partially immunized, and 1% unimmunized.

Coverage of individual vaccines among children 12–23 months were as follows: BCG 98.7%, OPV zero dose 98.7%, hepatitis B zero dose 97.7%, DPT 1 99%, DPT 2 98.7%, DPT 3 98.4%, and measles 95.8%. Vitamin A first dose was reported to be received by 95.2% of the children.

The most commonly cited reason for not completing immunization was postponement due to illness to the child (20.8%) and personal reasons (17.6%), fear of adverse effects (14.7%), and busy parents (11.7%). Mother's education less than 10th standard (OR 3.03, 95% CI 1.39–6.61, adjusted OR 2.40, 95% CI 1.20–4.81) and living in a nuclear family (OR 2.4 95%, CI 1.19–5.02; adjusted OR 1.72 95% CI 1.06–3.14)) were found to be factors associated with partially/unimmunized status of children aged 12–23 months. Results of the univariate analysis among children aged 12–23 months are expressed in Table 2.

Complete immunization coverage among children aged 5–7 years was only 72% and 28% of the children had missed some doses. One-fourth (25%) of the children had not taken booster doses at 4–5 years. Coverage at 18 months was 92.9%. Coverage of individual vaccines was above 90% till 18 months of age. However, the coverage of DPT booster at 4–5 years was only 75%. Lower birth order (OR 0.57, 95% CI 0.34–0.96) and belonging to Muslim religion (OR 2.63, 95% CI 1.28–5.26) were found to be factors associated with incomplete immunization status among children aged 5–7 years [Table 3].

Discussion

The main features of the National Urban Health mission include city-specific planning, rationalizing the available manpower and resources, and partnering with private providers and NGOs for filling gaps and improving access and quality health services. These health reforms include significant reorganization and expansion of the urban healthcare system, public–private partnerships in the delivery of services, and enhanced health system governance.[12] Despite these efforts, universal health coverage, reducing health inequality, and disease burden have continued to challenge India.

Different studies done in urban areas across the country have reported a wide range of variation in immunization coverage rate (20–85%).[13-15] The coverage of immunization in urban areas of Kochi obtained in the current study though much higher when compared to DLHS 4 and NFHS 4 surveys is not much different from the results of recent similar studies done in rural

Table 2: Factors associated with immunization status of children 12-23 months (*n*=310)					
Characteristics	Categories	Immunization status		P	OR (95% CI)
		Partially/un	Fully immunised		
Gender	Male	16 (10.7)	133 (89.3)	0.901	0.95 (0.46-1.95)
	Female	18 (11.2)	143 (88.8)		
Birth order	1	19 (11.4)	148 (88.6)	0.803	1.09 (0.53-2.24)
	2	15 (10.5)	128 (89.5)		
Religion	Hindu	11 (8)	126 (92)	0.123	1
	Christian	10 (10.3)	87 (89.7)		1.32 (0.53-3.23)
	Muslim	13 (17.1)	63 (82.9)		2.36 (1.02-5.57)
Father's education	<10th standard	21 (11.7)	159 (88.3)	0.643	1.18 (0.57-2.47)
	Higher education	13 (10)	117 (90)		
Mother's Education	<10th standard	12 (22.2)	42 (77.8)	0.004	3.03 (1.39-6.61)
	Higher education	22 (8.6)	234 (91.4)		
Socioeconomic Status	APL	21 (9.1)	209 (90.9)	0.079	0.51 (0.24-1.09)
	BPL	13 (16.2)	67 (83.8)		
Type of family	Nuclear	18 (17.1)	189 (92.2)	0.013	2.4 (1.19-5.02)
	Joint and three Generation	16 (7.8)	87 (82.9)		
MCP card	Issued	25 (10.2)	221 (89.8)	0.374	0.69 (0.31-1.56)
	Not issued	9 (14.1)	55 (85.9)		

Table 3: Factors associated with immunization status of children 5-6 years (*n*=308)					
Characteristics	Category	Immunization status		P	OR (95% CI)
		Partially/un	Completely immunised		
Gender	Male	49 (28.7)	122 (71.3)	0.643	1.12 (0.68-1.86)
	Female	36 (26.3)	101 (73.7)		
Birth order	1	44 (23.3)	145 (76.7)	0.033	0.57 (0.34-0.958)
	2	41 (34.5)	78 (65.5)		
Religion	Hindu	38 (24.2)	119 (75.8)		1
	Christian	18 (22)	64 (78)	0.009	0.88 (0.46-1.66)
	Muslim	29 (42)	40 (58)		2.27 (1.24-4.14)
Father's Education	<10th standard	43 (27.9)	111 (72.1)	0.899	1.03 (0.62-1.71)
	Higher education	42 (27.3)	112 (72.7)		
Mother's Education	<10th standard	32 (34.4)	61 (65.6)	0.079	1.63 (0.94-2.72)
	Higher education	53 (24.7)	162 (75.3)		
Socioeconomic Status	APL	66 (28.4)	166 (71.6)	0.559	1.19 (0.66-2.15)
	BPL	19 (25)	57 (75)		
Type of family	Joint and Three Generation	59 (27.4)	156 (72.6)	0.926	1.02 (0.59-1.76)
	Nuclear	26 (28)	67 (72)		
MCP card	Issued	52 (29.1)	127 (70.9)	0.502	1.19 (0.71-1.9)
	Not issued	33 (25.6)	96 (74.4)		

areas in the district.[10,16,17] However, reasons for not completing vaccinations and factors associated with partial immunization are different from the reasons in rural areas. These variations in reasons need to be considered and strategies for improving immunization coverage need to be locally contextualized.

Less than ten years of schooling of the mother was associated with partial immunization status of the child. Another study from the state also has reported that education of the mother improves the vaccination probability of a child.[18] Mothers with lower educational status could be a group for greater care and motivation in this area.

It appears that the urban households with nuclear families need special attention from the providers and primary care practitioners. Most reasons cited for not completing primary immunizations clearly points to the fact that immunization of children slips in the priority list of families struggling to cope without adequate support systems in busy urban life. This finding is consistent with findings from many other studies done in urban areas.[19,20] Urban social interaction often differs from rural through the lack of a common meeting area, fewer extended family connections, and more women engaged in work away from the home, all of which affect the flow of information about health and health services. It is more likely that parents just do not get around to having the vaccinations done on time. Although majority wanted to protect their children, convenience of accessing services might be a major issue. This is something that the health system should work on.

The provision of primary health care also requires additional urban-specific features. The opening hours of public health services may not be convenient for parents who work away from the home. Immunization clinics in public health systems are only on Wednesdays in the state. Parents in nuclear family might keep on postponing vaccination due to inability to take leave to manage common minor adverse events following immunization. Considering shifting immunization days in the public sector to Saturday might be an intervention to improve vaccination in urban areas. Private facilities provide the major part of curative care in urban area, therefore, the potential for integrating immunization activities with private health facilities can be considered. The "supermarket" organization of health services, whereby immunization is always available and children coming for curative care are automatically screened and immunized on arrival or after treatment, has proved successful in urban areas of many countries.[8,21]

One in four children had not taken DPT booster dose at 5–6 years. This finding needs to be viewed seriously in the context of diphtheria outbreaks in the district that happened among older children and adolescents. Those who missed out doses are not the group resistant to immunization, as most of them had taken all other vaccines till 18 months. Hence, a vigilant and effective system could easily ensure a better coverage for DPT booster at 4–5 years. Primary care clinicians in urban areas may consider this as a priority in immunization. However, the design of follow-up schemes can be problematic in immunization in urban areas with high mobility where the population do not know one another well. Reminder/recall systems which have good evidence for effectiveness in high-income countries may be considered a core component of immunization programs in urban areas.[22-24] The potential users of urban immunization services may be more socially heterogeneous than rural populations, and will require both different and a greater variety of motivational strategies.

Possessing a government card is an indicator that the mother is registered and is being tracked. One fifth of the mothers of 12–23-month children had not received a Government card in this area. This clearly points to weakness of the public health system. Having registered in private hospital may not be a reason for not issuing MCP card to mothers. Steps need to be taken to register all pregnancies and issue MCP card to all eligible women.

Further qualitative work is required to better understand the interlinking social and demographic factors that influence immunization coverage in urban areas. Report by the mothers may overestimate the immunization coverage. This study also did not consider the validity of the doses of vaccines child took. Despite these limitations, the study has many public health implications.

Conclusion

To conclude, the vaccination coverage of UIP vaccines among children aged 12–23 months in Kochi Metropolitan Area was 89%.

Mother's education less than 10th standard (OR 3.03, 95% CI 1.39–6.61) and living in a nuclear family (OR 2.4 95%, CI 1.19–5.02) were found to be factors associated with partially/unimmunization status of children aged 12–23 months. Among children aged 5–7 years, coverage of individual vaccines till 18 months of age was above 90%, while the coverage of DPT booster at 4–5 years was only 75%. A locally contextualized comprehensive strategy with strengthening of the primary health system is needed to improve the immunization coverage in urban areas.

Conflicts of interest

There are no conflicts of interest.

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