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Factors affecting full immunization coverage among children aged 12-23 months in urban and rural areas of Sindh

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Abstract

Objectives: Child mortality is still high in developing countries due to low vaccination coverage and outbreaks of vaccine preventable diseases. Therefore, this study is conducted to determine the status of vaccination coverage and associated factors among children aged 12-23 months in urban and rural parts of Sindh, Pakistan. **Methods:** A cross-sectional study was conducted in the rural and urban settings of Sindh, Pakistan. Following the WHO guidelines, a 30 cluster household survey was conducted and 300 children were recruited for each study setting from Lyari, Karachi and Umerkot areas of Sindh province from Feb – Mar 2017. Information was obtained from consenting parents by trained interviewers through a pre-tested questionnaire. Multivariable logistic regression model was used to identify the factors associated with the vaccination. **Findings:** Overall 600 children from both settings were included in the analysis. A total of 62.8% children were vaccinated. About 80.3% children were fully vaccinated in Lyari in comparison to 45.3% in Umerkot. The logistic regression analysis factors associated with vaccination were: parent`s awareness of vaccination (AOR: 9.77; 95%CI: 1.76 – 54.28), knowledge about vaccination place (AOR: 2.51; 95% CI: 1.19 – 5.26) and mother's tetanus vaccination status (one dose AOR: 4.27; 95% CI: 1.84 – 9.93 and two doses AOR: 12.43; 95% CI: 7.71 – 20.04). **Conclusion:** In the urban setting, vaccination coverage was better than compared to rural settings. Parent's knowledge about vaccination and vaccination centers were identified as the statistically significant determinants of vaccination among children aged 12-23 months.

Keywords: Children; Vaccination Coverage; Urban; Rural; Pakistan

1 Introduction

Pakistan is among 10 countries in the world which shares the burden of 60% of 2.3 millions of unvaccinated children, every year [1]. Immunization is one of the most cost-effective interventions which has saved the lives of millions of children in past few decades. It is estimated that more than 1.5 million children can be protected annually from these diseases through vaccination if they are not missed from routine immunization (RI) coverage [2].

In [3,4] Pakistan, expanded program on immunization (EPI) was launched in 1976 on a pilot scale and was further expanded nationwide by 1978, aiming to reduce the morbidity and mortality associated with vaccine preventable diseases (VPDs) in children like childhood tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus and measles, and pregnant women and their newborns from tetanus. Later on, hepatitis B, *Haemophillus influenza* type B (Hib), Pneumococcal-10 vaccine (PCV-10) and inactivated Polio vaccine (IPV) were included in national EPI schedule. In Pakistan, around four out of ten children do not get full course of vaccination by their first year of life [5–7]. This is one of the main reasons that Pakistan is still lagging behind in the eradication of polio and is one of the three endemic countries in the world, one of the sixth leading countries with the burden of tuberculosis, and also having on and off outbreaks of measles and diphtheria [6,7]. To avoid outbreaks from vaccine preventable diseases; a high-level coverage estimated at 95% is essential [1].

Pakistan's routine immunization indicators are yet far behind the global standards. Awareness of VPDs and vaccines included in RI schedule are lower, not only among parents but also in some segments of health professionals in Pakistan [8,9]. Parents remain doubtful on repeated anti-polio mass campaigns in the country, vaccines effectiveness and its worth [8,10]. Despite the fact that government, donors and partners are spending huge amount on RI, only 30% of children were found fully vaccinated and most of them belong to urban parts of the province [5,10]. In the past, multiple studies have been conducted to find out the determinants and the coverage of RI but most of the studies were either conducted from general perspective at country/state levels, or on individual vaccines – like polio, measles etc., or hospital based studies or by analyzing available reports and records [6–8]. Whereas, reasons for partial immunization and factors responsible for missed opportunities were poorly understood [5,7].

Limited evidence is available in Pakistan to explain the phenomenon of incomplete or missed vaccination especially in the rural urban context. This study aimed to determine the status of vaccination coverage among children from 12-23 months of age in urban and rural areas of Sindh, Pakistan.

2 Methods

2.1. Study design, settings and population

This cross-sectional study was conducted in Lyari town of Karachi and Umerkot district from Sindh, Pakistan. Karachi is the largest city of the country and is located in the south-west part of Sindh province, whereas Umerkot district is located on the south-east part. Population of Lyari town is approximately eight hundred thousand people but the RI has been carried out with an annual target of about 27,000 children of less than one year of age. Majority of the population belongs to low and middle socio-economic class. On the other side, Umerkot is one of the remotest districts of Sindh province with poor infrastructure and majority of the population belonging to poor and low socio-economic class. This district consists mostly of villages and smaller cities with a population of approximately 1 million, with an annual target of around 34,000 children under one year for routine immunization.

2.2. Sampling strategy

Following the WHO guidelines for cluster surveys, a 30-cluster household survey was conducted in Lyari as well as in Umerkot separately from February to March 2017 [2]. A team comprising two members was hired by the researcher in Lyari and Umerkot separately to collect the data in the field. Teams were assigned to take clusters from selected areas by the principal investigator. Data collectors were bachelor graduates and belonged to same town/district. They were given a full day training including field mock exercise prior to collection of the data. For quality control, principal investigator re-checked 10% of the clusters from each team member with same children/parents entered in the data sheet. Sample size of 300 children in each unit was strictly applied to follow the WHO standards and protocols. Two stage probability methods were used to select the clusters using probability proportional to size (PPS) methodology. Firstly, at the time of selecting the areas for clusters where population of each area was listed and added up to make cumulative total of district/town. Population was summed up at the end and sample interval was obtained by dividing the total population with 30 (number of clusters to be taken). Excel sheets were used for random selection of samples.

We used second stage of PPS in the field when sample was started from randomly selected area/village (which was selected

in first stage of PPS). First house to start the sample was also selected randomly by using a note of Rupees 10, 50, 100 (whichever available with data enumerators) after reaching the middle of the area. Whereas pen was used to select the direction for sampling. Ten children in each cluster were included in the study from randomly selected area, having at least one child between the ages of 12-23 months in each household. Thirty clusters were taken in that way from already identified random clusters. In each study area i.e. Lyari town and Umerkot district, total of 300 children and mothers of same children were selected in 30 clusters (a total of 600 children and their mothers were included in a total of 60 clusters).

2.3. Data collection and analysis

Data was collected from February to March 2017. Parents in both areas of the study were asked about the vaccination history of their child between the ages of 12-23 months for the vaccination status, knowledge about RI and of mother's vaccination history against TT when she was pregnant. Questionnaire was pre-tested and then finalized before data collection. Vaccination cards were checked (where available) for the confirmation of receiving different vaccine doses, and BCG scars were checked to confirm the BCG vaccination. For the children, who either did not start their immunization schedule or had not received full course of vaccination after starting it; the reason of incomplete vaccination of child was sought from their caregivers. Information about the status of getting different antigens as per schedule (BCG, OPV 0,1,2,3, Penta 1, 2, 3, PCV-10- 1, 2, 3, measles 1, 2 and TT 1, 2 for mothers) was also obtained. Routine immunization coverage was classified into fully, partially and unvaccinated. Fully vaccinated child; who received all the recommended doses in EPI before reaching the first birthday i.e. BCG, three doses of OPV, Penta and PCV-10 and one dose of measles (as mentioned above). Partially vaccinated child; a child who started to receive vaccine through routine immunization program but could not complete the course with recommended vaccines under EPI and unvaccinated child; a child who did not receive a single dose of vaccines through routine immunization program.

The frequencies with percentages were calculated for categorical variables such as different vaccines coverage status, vaccination card retention, presence of BCG scar, vaccination status of children and mothers, place of vaccination, reasons for not vaccinating children etc. Mean along with standard deviation and range were calculated for quantitative continuous variable i.e. age of the child in months. Application of multiple logistic regression was done by step wise backward selection of variables with biological plausibility and a significance level of 0.10 for entry into the model. All statistical tests were considered significant with a p-value, 0.05. Data were analyzed with IBM SPSS Statistics for Windows version 21. Approval was obtained from Institutional Ethics Review Board (IRB) of Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology (SZABIST), Karachi Campus prior to the study.

3 Results and Discussion

3.1. Sample characteristics and vaccination status

In the total sample of 600 children; the minimum age of a child was 12 months and maximum of 23 months with mean $\pm$ standard deviation (SD) of 17.70 $\pm$ 3.46. In total; 50.2% of 600 children in the study were found male. Our study revealed that overall 377 (62.8%) children received full course of RI, 174 (29%) children were found partially vaccinated and 49(8.2%) children did not get any dose of RI. Our study revealed that collectively; 63% children from 12-23 months of age received full course of RI in both settings together, which is well below the standards of WHO which suggest 90% coverage for each individual antigen in routine immunization at two years' age. Also, 64% fully immunized children were reported in a survey of 1650 women with children aged 12–23 months in the districts of Gurùé and Milang, Mozambique [11]. Furthermore, Zimbabwe records show low immunization coverage of 69.2% in 2015 among children aged 12-23 months in Chadereka community, Centenary district [12].

We found 29% partially vaccinated children who received at least one dose of vaccine and 8% children did not get any dose of RI. In Pakistan previous studies conducted by government of Pakistan and international stakeholders like WHO, UNICEF and others have estimated full coverage of vaccination from 30 % to 88 % in different areas [1,9,10,13]. It has also been reported that 4 out of 10 children do not get full course of RI (60% FIC) in Pakistan [6]. Vaccination coverage in Pakistan has been observed quite low as per international accepted standards and especially in the context of specific parts of the country and among different social, ethnic and economic groups of people. Immunization coverage is better in contrast to African region where the proportion of fully immunized children was 24.3% reported in the national demographic and health survey in 2011 in Ethiopia [14].

However, in urban-rural context, a major difference was identified in the status of coverage of RI as study revealed that 241 (80.3%) children were fully vaccinated in Lyari and 136 (45.3%) in Umerkot, whereas, 53 (17.7%) children in Lyari and 121 (40.3%) children in Umerkot were found partially vaccinated. On other side; 6 (2%) children in Lyari and 43 (14.3%) children in Umerkot did not receive any dose of RI. Previously one study found coverage inequalities ranging from 58% to 85% in

rural to urban areas at sub district levels[5]. In our study, there was a major difference in the status of coverage of complete vaccination in rural and urban area of Sindh province in Pakistan. It was observed that 80% children were fully vaccinated in Lyari urban setting in comparison to 45% coverage in Umerkot rural setting. This rural urban difference can also be observed in other countries like China, Bangladesh, Nigeria and India. One study conducted in urban setting of Dhaka, Bangladesh found 83% children fully vaccinated like our study[15,16]. Demographic and health survey (DHS) of Bangladesh performed in a sample of 4925 parents having at least one child, concluded that there was massive gap in vaccination in rural-urban context of Bangladesh[17]. In this scenario, our study is closer to the findings of Pakistan demographic and health survey (PDHS) 2012-13 where 66% children of urban areas and 48% children of rural areas were found fully vaccinated[18]. As far as the routine vaccination is concerned, this study reveals that in urban areas more children were fully or partially vaccinated as compared to rural areas. Vaccination card retention in Lyari was 59.3% and in Umerkot 67.7% (Table 1).

Table 1. Characteristics of the study participants of Lyari and Umerkot areas of Sindh province.

Variables	Lyari	Umerkot	Total
	Number (%)	Number (%)	Number (%)
Age in months (Mean ± SD)	18.29 (3.17)	17.12 (3.64)	17.70 (3.46)
Gender			
Female	148 (49.5)	151 (50.5)	299
Male	152 (50.5)	149 (49.5)	301
Socioeconomic status			
Low	210 (45.1)	256 (54.9)	466
Lower middle	90 (67.2)	44 (32.8)	134
Aware of vaccination			
No	3 (12.5)	21 (87.5)	24
Yes	297 (51.6)	279 (48.4)	576
Know about place of vaccination			
No	3 (5.0)	57 (95.0)	60
Yes	297 (55.0)	243 (45.0)	540
Mother's TT vaccination status			
Zero dose	54 (17.4)	256 (82.6)	310
One dose	24 (75.0)	8 (25.0)	32
Two doses	222 (86.0)	36 (14.0)	258
Vaccination status of child			
Unvaccinated	6 (12.2)	43 (87.8)	49
Partially vaccinated	53 (30.5)	121 (69.5)	174
Fully vaccinated	241 (63.9)	136 (36.1)	377
BCG Scar			
No	57 (39.6)	87 (60.4)	144
Yes	243 (53.3)	213 (46.7)	456
Vaccination card			
No	122 (55.7)	97 (44.3)	219
Yes	178 (46.7)	203 (53.3)	381
Place of vaccination			
Vaccinated from Fixed EPI Centre	207 (77.8)	59 (22.2)	266
Vaccinated from Outreach Session	87 (30.5)	198 (69.5)	285

SD ;standard deviation, TT; tetanus toxoid, BCG; Bacillus Calmette–Guérin vaccine, EPI; expanded program on immunization.

Comparing the antigen wise coverage status of different antigens among children from 12-23 months of Lyari and Umerkot, overall coverage trend in Lyari seems to be steady and higher whereas it is on lower side and declining in Umerkot with subsequent doses from Penta 1 onwards. In Lyari, 97% children received BCG, whereas 73% children were reported to have received BCG in Umerkot. This may be due to the fact that people in Lyari avail hospital based delivery services more than the people of Umerkot where BCG is usually given at the time of birth of child. It also shows that the people in urban areas are inclining

more towards vaccination right from the birth of their babies. Pentavalent vaccine doses are recognized as the most effective form of vaccination (acceptability, availability & affordability), worldwide. The coverage status of first dose of Penta, PCV-10 and OPV in Lyari was 95% for all three antigens, whereas it was found as 80%, 82% and 81% coverage respectively in Umerkot. Pantavalent 3 is proxy for utilization. Whereas it is also stressed a lot on counting measles 1 as well (as still a lot of deaths are being reported due to measles, worldwide). This is again confirming that the access to vaccination services among communities are higher in urban areas in comparison to rural areas. Also, difference in the figures of three antigens in Umerkot is indicating towards the possibility of shortage of some vaccines or logistics at some point of time as well. There was shortage of BCG syringes for 8-10 months in the whole country, which might had affected BCG coverage in Umerkot. Stock in Karachi was used, also, Insulin syringes were used in absence of BCG syringes in some districts locally by vaccinators. Coverage of measles 1, the indicator of reaching the milestone of complete vaccination status under EPI, was found 81% in Lyari and 52% in Umerkot which is given to a child at completion of 9th month of life (Figure 1).

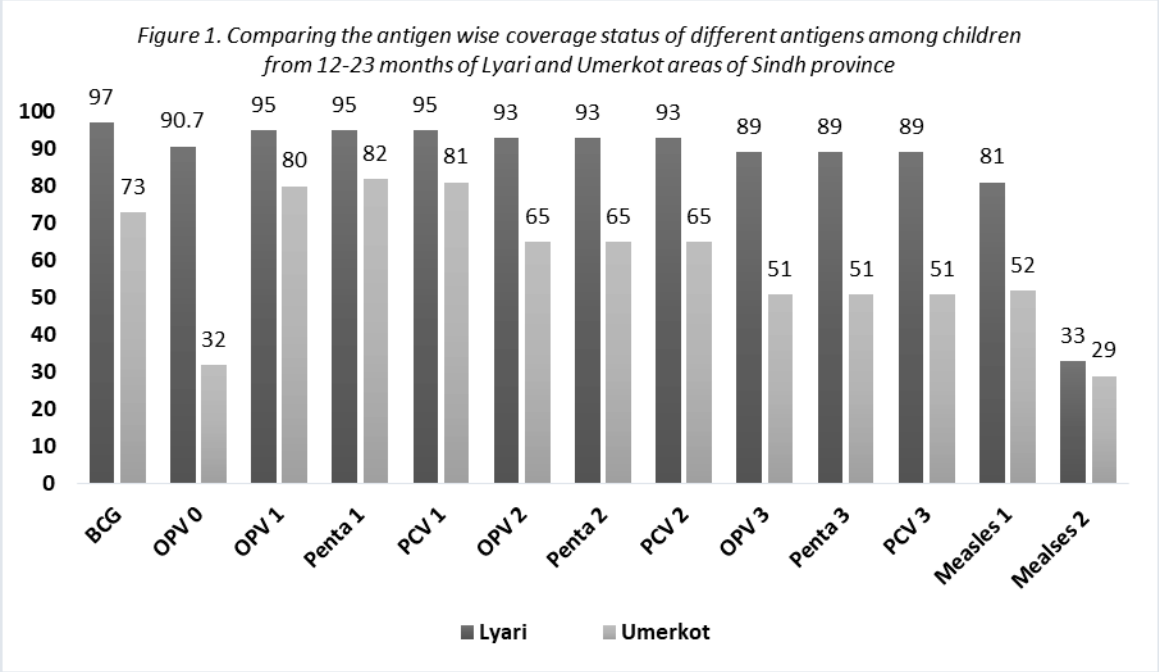

Fig 1. Comparing the antigen wise coverage status of different antigens among children from 12-23 months of Lyari and Umerkot areas of Sindh province.

It indicates that in urban areas, people tend to complete the course of vaccination of their children more than the people living in rural areas. However, one previous study conducted in 2007 peri-urban are of Gadap town, Karachi observed very low i.e. 45% age-appropriately vaccinated infants [19]. They have also used same WHO thirty-cluster sampling technique like our study but difference in coverage could be due to changes in population awareness level over time.

Measles 2 coverage was included in EPI schedule of Pakistan in 2014-15 in order to increase immunity against measles which is given when a child completes 15th month of his / her life [4]. In this study measles 2 coverage was found 33% in Lyari and 29% in Umerkot. The low coverage is may be due to recent introduction of this vaccination in the EPI schedule. One study conducted in East Delhi also found the lack of knowledge about vaccination doses as the main factor behind dropout of the vaccination course with the age of child [20]. In India, it has been estimated that 46% children received full course, 33% were partially vaccinated and 20% did not receive any dose of routine immunization [21,22]. In this study we found the dropout rates between BCG & measles 1; was 17% & 29 % in Lyari and Umerkot respectively. The dropout rate of Penta 1 to Penta 3 was 7 % in Lyari and 38% in Umerkot. The penta1 -measles1 dropout rate was 15% in Lyari and 37% in Umerkot. The acceptable range of drop-out rates between two antigens, as per WHO criteria is <10%, worldwide, including Pakistan [4].

Some of the reasons in other studies states the parents' apathy towards immunization can be summarized as; Unaware of the need of immunization, unaware of place and timings of immunization, misconceptions, rumors & trust issues, fear of AEFI or had some experience of AEFI in the past with other children in family/area (even fever, pain at site of injection etc.), place of immunization too far or timing of immunization inconvenient, child illness, or visited EPI centers but did not get child

immunized due to unavailability of vaccinator, any vaccine, or some schedule issues, like BCG or measles due to fix dates, mother too busy or family problems.

3.2. Reasons for partial and missed vaccination

Our study revealed that 53 (17.7%) children of Lyari and 121 (40.3%) children of Umerkot could not complete their full course of vaccination despite having some shots of different vaccines. So, 174 (29%) children were partially vaccinated in both settings. In Lyari, the urban part of Sindh; 26 (49.1%) children could not complete full course of RI as their parents did not give importance to RI, whereas 15 (28.3%) children remained partially vaccinated as they were sick at the time of vaccination, 4 (7.5%) and 5 (9.4%) children were deprived of vaccination due to parent's fear of injection and fear of adverse effects following immunization (AEFI) respectively. On the other side, in rural context, 85 (70.2%) children after having some doses of vaccination, could not achieve full course of RI as their parents were unaware of the need for immunization, 16 (13.2%) children's parents did not give importance to RI for their children, 8 (6.6%) children could not complete course due to the reason that EPI center was too far from their home. Investigations were done about missing the vaccinations due to religious reasons and were found as not a valid reason and such cases were reported. Among unvaccinated children status; 6 (2%) children from Lyari and 43 (14.3%) children of Umerkot remained unvaccinated making 49 (8.2%) children in total who were found unvaccinated in the study. Reasons of unvaccinated children in Lyari included 5 (83.1%) children whose parents did not give importance to RI. Whereas in Umerkot; 34 (79.1%) children were such whose parents did not know about vaccination or unaware of the need of immunization and 6(14%) children were left unvaccinated as the EPI center was too far away from their home (Table 2).

Urban residence, socioeconomic status, mother's education level, mother's awareness about immunization and antenatal care during pregnancy are the variables found associated with increase in immunization coverage in countries like India, Ethiopia, Mozambique and Nigeria [23–27]. Previously in Pakistan about 7% children did not get vaccination due to different reasons. These reasons of no immunization of children include, demographic, distance to health facility, poverty status, literacy and education, and location of residence as identified in one study which analyzed the Pakistan integrated household survey 2001-2002 data [28].

3.3. Analysis of factors associated with vaccination status

In the final multivariable logistic regression analysis of factors associated with fully vaccinated status as compared to partially or unvaccinated were: parent's awareness of vaccination (AOR: 9.77; 95%CI: 1.76 - 54.28), knowledge about vaccination place (AOR: 2.51; 95% CI: 1.19 – 5.26) and mother's tetanus toxoid (TT) vaccination status (one dose AOR: 4.27; 95% CI: 1.84 – 9.93 and two doses AOR: 12.43; 95% CI: 7.71 – 20.04). No significant association was noted for age, sex and socioeconomic status (Table 3).

Statistically significant factors in the logistic regression model were: parent's awareness of vaccination (AOR: 76.43; 95% CI: 7.96 – 734.18), knowledge about vaccination place (AOR: 5.81; 95% CI: 2.18 – 15.52) and limited accessibility to vaccination center (AOR: 0.06; 95% CI: 0.01 – 0.26). Predominant factors being the utilization issue and be access to vaccination centers as well (like in case of rural areas like Umerkot or within city due to some reasons). No significant association was observed for age, sex, and fear of adverse events, sickness of child, socioeconomic status and mother TT vaccination status (Table 4).

Previous studies conducted in Pakistan also noted mother's TT vaccination status and parent's education and awareness about immunization as main factors associated with fully vaccinated children [19,29,30]. Factors associated with partial vaccination as compared to unvaccinated were parent's awareness of vaccination, knowledge about vaccination place and limited accessibility to vaccination center [19,29,30]. Previously one study conducted in the rural settings of Sindh province found to be the misconceptions of parents were among the main reasons for not getting the children vaccinated [11] It was also observed that Mothers' knowledge about vaccine preventable diseases and immunization and illiteracy was associated with delayed or non-immunization of children in Pakistan [31,32] .

Table 2. Reasons associated with unvaccinated and partially vaccinated children in the general population of Lyari and Umerkot areas of Sindh province

Reasons	Partially vaccinated		Unvaccinated	
	Lyari (n=53)	Umerkot (n=121)	Lyari (n=6)	Umerkot (n=43)
	Number (%)	Number (%)	Number (%)	Number (%)
Parents didn't know about need of Immunization	0	85 (70.2)	0	34 (79.1)
Parents didn't give importance	26 (49.1)	16 (13.2)	5 (83.1)	2 (4.7)
Child was sick	15 (28.3)	1 (0.8)	0	0
Vaccine was not available at the time of visit	0	4 (3.3)	0	0
Fear of injection	4 (7.5)	0	0	0
Fear of AEFI	5 (9.4)	2 (1.7)	1 (16.7)	1 (2.3)
Vaccination center too far	0	8 (6.6)	0	6 (14)
Child was not at home on vaccination day	1 (1.9)	0	0	0
Expected vaccinator will come at home	0	5 (4.1)	0	0
Religious	0	0	0	0
Others	2 (3.8)	0	0	0

AEFI= Adverse events following immunization

Table 3. Univariable and multivariable logistic regression analyses of factors associated with fully vaccinated as compared to unvaccinated or partially vaccinated children of Lyari and Umerkot areas of Sindh province

Variables	OR (univariable) (95% CI)	p-value	OR (multivariable) (95% CI)	p-value
Age in months (Mean ± SD)	1.02 (0.97 – 1.07)	0.330		
Gender				
Female	1			
Male	0.99 (0.72 – 1.38)	0.983		
Socioeconomic status				
Low	1			
Lower middle	1.52 (1.04 – 2.29)	0.048		
Aware of vaccination				
No	1		1	
Yes	20.52 (4.77 – 88.16)	<0.001	9.77 (1.76 - 54.28)	0.009
Know about place of vaccination				
No	1		1	
Yes	6.74 (3.61 – 12.58)	<0.001	2.51 (1.19 – 5.26)	0.015
Mother's TT vaccination status				
Zero dose	1		1	
One dose	4.68 (2.04 – 10.77)		4.27 (1.84 – 9.93)	
Two doses	13.94 (8.75 – 22.19)	<0.001	12.43 (7.71 – 20.04)	<0.001

OR= odds ratio, CI = confidence interval, SD= standard deviation

Table 4. Univariable and multivariable logistic regression analyses of factors associated with partially vaccinated as compared to unvaccinated children of Lyari and Umerkot areas of Sindh province

Variables	OR (univar iable) (95% CI)	p-value	OR (multivariable) (95% CI)	p-value
Age in months (Mean ± SD)	0.99 (0.91 – 1.08)	0.882		
Gender				
Female	1			
Male	1.06 (0.56 – 2.01)	0.844		
Socioeconomic status				
Low	1			
Lower middle	2.22 (0.82 – 6.00)	0.118		
Mother's TT vaccination status				
Zero dose	1			
One dose	2.32 (0.28 – 19.32)	0.095		
Two doses	8.27 (1.09 – 62.74)			
Aware of vaccination				
No	1		1	<0.001
Yes	129.75 (16.78 – 1003.29)	<0.001	76.43 (7.96 – 734.18)	
Know about place of vaccination				
No	1		1	
Yes	15.59 (7.21 – 33.71)	<0.001	5.81 (2.18 – 15.52)	<0.001
Parents attitude				
Vaccine is important	1			
Vaccine is not important	1.91 (0.79 – 4.57)	0.146		
Fear of AEFI/ sickness of child				
No	1			
Yes	4.32 (0.99 – 18.84)	0.052		
Vaccination center too far	1		1	
No	0.35 (0.11 – 1.05)	0.061	0.06 (0.01 – 0.26)	<0.001
Yes				

OR= odds ratio, CI = confidence interval, SD= standard deviation

4 Conclusion

Routine vaccination within Sindh province of Pakistan displays significant variations in rural and urban settings. It was observed that there was better vaccination coverage in urban area as compared to rural area but still very low according to WHO standards. Parent's awareness of vaccination, knowledge about vaccination place and mother's tetanus toxoid vaccination status are those major factors related with the vaccination status of children. These findings suggest developing and implementing an evidence based effective strategy of raising awareness among communities regarding routine vaccination and clarifying their misconceptions, fears and attitude of ignoring the importance of immunization especially in rural areas. Routine immunization is a cost-effective public health intervention, so improvements in vaccination coverage and minimizing regional variations can be helpful in the reduction of childhood mortality in Pakistan.

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