

# Coverage and predictors of routine immunization among 12-23 months old children in disaster affected communities in Pakistan

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## ABSTRACT

**Objectives:** We aimed this study to determine the relationship of various factors related to poor immunization in children in an earthquake affected community.

**Materials and Methods:** We conducted this cross-sectional study during 2007-2008 in Muzaffarabad district of Pakistani side of Kashmir. We selected 43 villages as clusters and in the second, 860 children between 12 and 24 months were selected from households through systematic sampling. Mothers of the eligible children were interviewed with a questionnaire. Logistic regression analysis was run to measure the association of various factors with appropriate immunization status of the children.

**Results:** We found that 74% of children had completed their required doses of routine immunization. There were greater odds of a child being unvaccinated if the family lived at a distance that was to be covered in more than 10 min by any transport (odds ratio [OR]: 1.12, confidence interval [CI]: 1.08-1.17), mother of the child was not educated (OR: 2.4, 1.3-4.4), child belonged to a low socioeconomic status (OR: 3.5, CI: 2.1-6.3), family had any challenge or situation that where they could not take the child to a health facility for vaccination (OR: 2.3, CI: 1.4-3.7) and for a female child that belonged to minority ethnic group (OR: 1.7, CI: 1.0-2.5).

**Conclusion:** Improvement in access of communities, especially of minority and poor in disaster-stricken, to immunization services and female education and awareness about the need for immunization in children could play a role in improving immunization coverage in such settings.

**Keywords:** Children, coverage, immunization, predictors

## Background

Although the mortality in children under 5 years of age has declined to half from 1990 (mortality of about 12.7 million); about 6.3 million still die annually and a quarter of these deaths occur due to vaccine preventable diseases.<sup>1</sup> Specifically, these also include an estimated 1.5 million deaths from diseases for which vaccines are recommended by the World Health Organization (WHO). The mortality from measles alone was estimated to be 145,700 in 2013.<sup>2</sup> This is coupled with low immunization coverage, particularly in developing countries. In 2009, about 23.2 million children were unimmunized globally against the third dose of diphtheria, tetanus and pertussis combo vaccine (DTP<sub>3</sub>) alone.<sup>3</sup> Increasing vaccine coverage has potential to save lives, prevent disability, reduce health-care costs, and help eradicate the vaccine-preventable diseases. Not only this;

but improved vaccine coverage also benefits unimmunized children through herd immunity.<sup>4</sup>

South Asia had 55% of the global under-5 mortality in 2013 though the rate declined from 126 in 1990 to 55 deaths per 1000 live births in 2013.<sup>1</sup> Among these, deaths from measles accounted for a significant proportion as during 1999 and 2005 the region made the slowest progress toward reduction of measles mortality.<sup>5</sup> The region is also yet to eliminate polio. South Asia was home to 12.1 million children not vaccinated against DTP<sub>3</sub>.<sup>6,7</sup>

In Pakistan, the Expanded Program of Immunization (EPI) at the time of the study included bacillus Calmette-Guerin (BCG) against tuberculosis and oral polio vaccine (OPV<sub>0</sub>) at birth, OPV<sub>1</sub>, DTP<sub>1</sub> and hepatitis B (Hep-B) at 6 weeks, OPV<sub>2</sub>, DTP<sub>2</sub> and Hep-B at 10 weeks, OPV<sub>3</sub>, DTP<sub>3</sub> and Hep-B at 14 weeks

and measles vaccine at 9 months of life. Only 35% children completed their vaccine schedule in 1990 which improved to 54% in 2012.<sup>8</sup> Pakistan Demographic and Health Survey, in 2013, estimated vaccine coverage rates as 85%, 80%, 50%, 61%, and 85% for BCG, DTP<sub>1</sub>, Hep-B<sub>3</sub>, measles and OPV<sub>3</sub>, respectively. However, these are national averages and much lower rates are reported for rural and among the conflict-hit and displaced population.<sup>8</sup>

It is important that a child completes all doses of the immunization so that the child develops a sufficient immune response to the disease as partial immunization will not provide complete protection.<sup>9</sup> A number of factors are responsible for lower immunization coverage in children including; residence in rural versus urban area,<sup>8</sup> ethnic and social factors,<sup>10</sup> poverty,<sup>11</sup> lack of information about immunization services.<sup>12</sup> Studies have consistently identified mother's education and occupation and distance from a health facility as important predictors of immunization in children.<sup>13</sup> Furthermore, ethnic and religious minorities tend to have lower immunization coverage rates and have higher risks of epidemics.<sup>14</sup> Apart from these factors affecting immunization, disasters such as earthquakes cause displacement of populations from their homes and crowded living conditions in internally displaced persons' camps. Studies have shown that immunization coverage can be challenging in disaster-hit areas and also that children under 5 years of age are always at risk of epidemics.<sup>15-17</sup> We aimed this study to determine the immunization status and related factor in children in a disaster-affected population.

## Materials and Methods

### Study design

We conducted this community-based cross-sectional study in district of Muzaffarabad, Pakistan during 2007-2008. The area was struck by a catastrophic earthquake in October 2005.<sup>18</sup> It caused about 73,000 deaths, 80,000 injuries and rendered 2.8 million people without shelter.<sup>19,20</sup>

### Study setting

Study participants included mothers of the children between 12 and 23 months in district Muzaffarabad. District Muzaffarabad is located in Pakistan administered Kashmir or Azad Jammu and Kashmir (AJK). AJK has a total area of 13,297 km<sup>2</sup> and district Muzaffarabad has an area of about 2496 km<sup>2</sup>. The district had population of about 770,000, which was growing at an annual growth rate of 2.80% and had average family size of 7.1 persons per household according to the government estimates in 2006.<sup>21</sup>

### Sample size

EPI-Info version 6.1 was used to estimate the sample size for measuring immunization coverage and to account for factors associated with the immunization coverage. To determine the

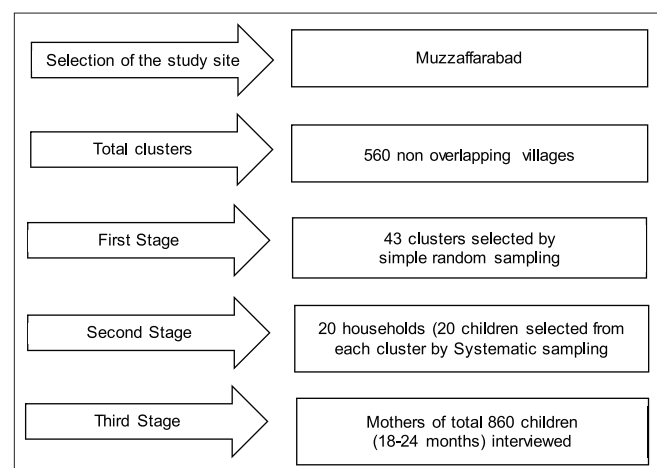
relationship of mother's education with immunization of the child, using a 95% level of confidence, 80% power, 2:1 ratio of exposed (illiterate mothers) to unexposed group (mothers with >5 years of education), estimated frequency of completed immunization of 65% in children of mothers without education, a design effect of 2 and an expected non-response rate of 10%, we required a sample of 860 children between the age of 12 and 23 months to be include in our study.

### Sampling technique

We used multistage cluster technique as sampling strategy to select the participants. A list was of 560 nonoverlapping villages, considered as clusters and was obtained from the offices of bureau of statistics AJK. Out of this frame, 43 clusters were selected through simple random sampling. In the next stage, 20 households were selected from each of the selected cluster by systematic sampling. The sampling interval "k" was determined by dividing the total number of households in the cluster with the number of households to be sampled therefore the k<sup>th</sup> number varied for each of the cluster. The first household was selected randomly and then "every k<sup>th</sup>" household was selected through systematic sampling. Mothers with at least a child between the age 12 and 23 months and permanent resident of the district Muzaffarabad were eligible to be included in the study. Information about only one child of 12-23 months was obtained from a household (Figure 1).

### Data collection

Data were collected through interviews with mothers of the children based on a structured questionnaire designed by the researchers. The vaccine coverage part of the tool was adapted from the WHO's EPI field manual. The data collection tool was translated into Urdu from English and translated back into English to ensure consistency. The tool comprised sections on sociodemographics, immunization coverage, and associated factors of immunization in children of 12-23 months of age.



**Figure 1:** Schema of sampling strategy in, predictor of vaccination coverage for children ( $N = 860$ ) of age 12-23 months in Muzaffarabad, 2007-2008

## Definitions

For each child, the immunization status was determined for each vaccine and “up-to-date immunization.” The up-to-date immunization coverage was defined as “the proportion of studied children aged 12-23 months who had completed their immunization schedule.” Children were considered fully immunized if they had completed their schedule of vaccines. Dropout meant incomplete doses of DTP, Hep-B and measles vaccines.

## Statistical analysis

The socioeconomic status (SES) variable was calculated from the number of household items which were assigned scores. We then checked the items for normality of distribution and calculated the means and standard deviations for the variable which was then categorized as low, middle and high SES of the household.

## Ethical approval

The study was approved by the AKU Ethical Review Committee. Permission for the study was also obtained from the District Health Department of AJK, also; informed written and verbal consent was taken from the participants before the interviews.

## Results

Statistical analysis system software version 9.1 was used to analyze data which were available for 860 cases. The primary outcome variable was immunization status. The mean age of children was 16.8 (standard deviation [SD]  $\pm$  0.25 months). The majority of the children belonged to Pahari ethnicity (83%), while the others were grouped together as “minority” which included Gilgitis, Magris, Pashto, and Kashmiris. About 10.8% of the families had undergone migration during earthquake and had returned back to their homes. Most of the families belonged either to lower (34.6%) or middle (38.8%) SES group.

The average distance to reach the nearest basic health facility was 62.6 (SD  $\pm$  6.3 min) and 60% of parents reported taking their children by foot to the nearby health facility for immunization. Only 27.3% parents possessed a vaccination card. Mothers of the children were more illiterate than their fathers (60.4% vs. 25.0%). Of children who were “unimmunized,” 80% of parents were “unaware for the need for immunization,” 11% parents “were not aware of the need to come for 2<sup>nd</sup> and 3<sup>rd</sup> doses of the vaccine,” 4% gave both the preceding reasons whereas 5% had “fears of side effects of vaccine” (Table 1).

Overall 74% children of 12-23 months were fully immunized and of the 26% of unimmunized children 23% had received at least one dose of a vaccine but had failed to complete the full immunization schedule (partially immunized) and 3.2%

children were those who had not received a single dose of vaccine. The dropout rate in children for DTP, Hep-B and measles was 9.1%, 8.8% and 11.2%, respectively (Table 2).

We used logistic regression analysis to assess the association of the different predictors with the up-to-date immunization coverage and adjusted for the confounders. We found that with every 10 min increase in the distance from the nearest health facility, the odds of being unvaccinated were 1.12 times (95% confidence interval [CI]: 1.08-1.17). Mother’s education significantly affected the immunization status as we found that children of illiterate mothers had 2.4 odds of being unvaccinated as compared to the children whose mothers had more than 8 years of education. Children with low SES had higher odds (odds ratio: 3.5, 95% CI: 2.1-6.3), to be unvaccinated as compared to higher SES families. Family related challenge also played some role in immunization status of the children and such children had 2.3 (95% CI: 1.4-3.7) times less odds of being unvaccinated. Male and minority ethnic children had 1.5 more odds of being unvaccinated as compared to a male and Pahari ethnic child. Similarly, a female and minority ethnic children had 1.7 (95% CI: 1.0-2.5) less odds of completed immunization as compared to a “Male and Pahari ethnic child. We also found a significant interaction between ethnicity and the gender of the child in multivariable analysis (Table 3).

## Discussion

The up-to-date coverage in children of 12-23 months of age was 74.1% and was higher in our sample than previously reported from Pakistan. The coverage for OPV vaccine was 90%, and the coverage of HBV and DTP was 80%. Our results are consistent with studies conducted in similar settings; such as a study from two other earthquake hit districts of Pakistan found the up-to-date coverage of 45.9% and 39.4%,<sup>22,23</sup> or a study which reported immunization coverage of between 60% and 70%.<sup>9,13</sup>

Living farther away from clinics affects immunization in children.<sup>24</sup> Living at a travel time of more than ten minutes in district Muzaffarabad from the health facility affected negatively the immunization of child probably because of mountainous terrain of district Muzaffarabad. Time and financial costs for attending a health facility tend to increase as the distance increases. In fact, 65% of families with unimmunized children said that place of immunization is too far. Most of these families had to walk to these health facilities possibly because of lack of transportation.

Furthermore, children whose mother were uneducated or had <8 years of education were 2.1 times less likely to be immunized, and our data showed a dose-response relationship for mother’s education and immunization. The importance of mother’s education underscored our finding that 80% of parents of unimmunized children were not aware of the

**Table 1:** Sociodemographic characteristics of children (N=860) 12-23 months in Muzaffarabad, 2007-2008 by up-to-date immunization status

Characteristics	N (%)			P value
	Over all	Vaccinated	Partially/unvaccinated	
Age (Mean±SD months)	16.8 <sup>1</sup> ±0.2 <sup>1</sup>			
Distance from Health Facility (Mean±SD minutes)	62.6 <sup>1</sup> ±6.3 <sup>1</sup>			
Gender				0.25
Males	433 (50.4)	329 (75.9)	104 (24.1)	
Females	427 (49.6)	308 (72.1)	119 (27.9)	
Ethnicity				0.014
Pahari	717 (83.4)	550 (76.7)	167 (23.3)	
Minority <sup>1</sup>	143 (16.6)	87 (60.8)	56 (39.2)	
Father education				0.001
No education	215 (25.0)	132 (61.4)	83 (38.6)	
8 years and lesser education	300 (34.9)	225 (75.0)	75 (25.0)	
>8 years education	345 (40.1)	280 (81.2)	65 (18.8)	
Mother education				0.001
Un-educated	519 (60.4)	357 (68.8)	162 (31.2)	
8 years and lesser education	197 (22.9)	152 (77.2)	45 (22.8)	
>8 years education	144 (16.7)	128 (88.9)	16 (11.1)	
LHV in health facility				0.019
Yes	797 (92.7)	600 (75.3)	197 (24.7)	
No	63 (7.3)	37 (58.7)	26 (41.3)	
Migration status <sup>1</sup>				0.037
Yes	93 (10.8)	60 (75.2)	33 (24.8)	
No	767 (89.2)	577 (64.5)	190 (35.5)	
SES <sup>2</sup>				0.001
High	229 (26.63)	203 (88.65)	26 (11.35)	
Middle	334 (38.84)	244 (73.05)	90 (26.95)	
Low	297 (34.53)	190 (63.97)	107 (36.03)	
Nature of living				0.74
Extended	139 (16.16)	101 (72.66)	38 (27.34)	
Nuclear	721 (83.84)	536 (74.34)	185 (25.66)	
Mode of transport to health facility				0.88
By walking	515 (59.88)	383 (74.37)	132 (25.63)	
By bus/car	345 (40.12)	254 (73.62)	91 (26.38)	
Possession of vaccination card				
Yes	234 (27.21)	179 (76.50)	55 (23.50)	
No	625 (72.67)	458 (73.28)	167 (26.72)	

<sup>1</sup>The minority ethnicity comprised Kashmiri, Gojari, Gilgiti and Magri ethnicities. <sup>2</sup>A family who had migrated at least once due to earth quake was considered as migrated, <sup>3</sup>SES status was calculated from possession of household items (low SES=No household item; middle SES=Up to 2 household items; high SES=More than 2 household items). SES: Socioeconomic status, LHV: Lady health visitor, SD: Standard deviation

need for immunization. Research clearly points to the link between maternal education and child immunization status.<sup>25</sup> A study from Bangladesh reported that children of mothers with primary education were 1.7 times more likely to be fully immunized.<sup>24</sup> A study from Pakistan found that children with incomplete immunization were 71% more likely to have illiterate mothers.<sup>26</sup> A study conducted in squatter settlements of Karachi in 2002 found that health education messages to

families increased immunization status of children to about 16% from baseline.<sup>27</sup> Perinatal health education of mothers also increased immunization coverage of their children.<sup>28</sup>

SES of a family also significantly affected immunization of children in our sample. Children belonging to low SES had 3.6 times lower up-to-date immunization. Studies have consistently shown a significant link between poverty with

**Table 2:** Vaccination coverage for children ( $N=860$ ) of age 12-23 months in Muzaffarabad, 2007-2008

Vaccine doses	Overall prevalence (95% CI)	Valid doses <sup>3</sup> (95% CI)
BCG	87.5 (82.4-92.8)	86.4 (81.1-91.7)
DTP <sub>1</sub>	87.4 (81.9-92.9)	25.0 (18.8-31.2)
DTP <sub>2</sub>	85.0 (79.3-90.7)	23.5 (17.7-29.3)
DTP <sub>3</sub>	80.1 (74.2-86.0)	22.3 (16.6-28.0)
HEP1	87.7 (82.2-93.2)	24.9 (18.6-31.2)
HEP2	84.9 (79.1-90.6)	23.7 (17.9-29.5)
HEP3	80.0 (74.1-85.9)	22.1 (16.5-27.7)
OPV0	97.1 (95.9-98.3)	25.4 (19.1-31.6)
OPV1	97.1 (95.9-98.3)	24.5 (18.4-30.6)
OPV2	95.9 (94.4-97.5)	23.6 (17.7-29.5)
OPV3	91.3 (88.6-93.9)	23.3 (17.4-29.2)
Measles	78.7 (74.3-83.1)	13.9 (9.7-17.9)
Immunization status of 12-23 months children (up-to-date) <sup>1</sup>		
Fully	74.1 (67.9-80.3)	
Partially	22.9 (17.1-28.7)	
Not	3.0 (1.7-4.4)	

<sup>1</sup>Up-to-date coverage indicates the proportion of children aged 12-23 months with complete immunization. Doses administered  $\leq 4$  days before the recommended age for a vaccine was considered as valid. A minimum interval of 28 days (4 weeks) was needed to be recorded as valid. BCG: Bacillus Calmette Guerin, OPV: Oral polio vaccine, DTP: Diphtheria, tetanus and pertussis, HEP: Hepatitis

**Table 3:** Multivariable analysis - Risk factors for up-to-date immunization in children aged 12-23 months in Muzaffarabad, 2007-2008 ( $N=860$ , immunized=637 (74.1%), not immunized=223, [25.9%])

Predictors	OR <sup>1</sup>	95% CI	P value
Distance <sup>2</sup>	1.12	(1.08-1.17)	0.001
Mother's education			
>8 years education	1.00		
8 years and lesser education	2.1	(1.1-4.1)	0.03
Un-educated	2.4	(1.3-4.4)	0.001
SES <sup>3</sup>			
High	1.00		
Middle	2.5	(1.5-4.1)	0.007
Low	3.6	(2.1-6.3)	0.001
Family related obstacle <sup>4</sup>			
No	1.0		
Yes	2.3	(1.4-3.7)	0.007
Gender*Ethnicity			0.05
Male and Pahari	1.0		
Female and Pahari	2.4	(0.3-4.6)	
Male and minority <sup>5</sup>	1.5	(1.1-1.9)	
Female and Minority	1.7	(1.0-2.5)	

<sup>1</sup>The adjusted ORs reported, show the association of the different variables with the outcome variable as "Not being vaccinated," <sup>2</sup>Distance was measured in minutes, the OR given is for a distance of 10 min, <sup>3</sup>SES status was calculated from possession of household items. (low SES=No household item; middle SES=Up to 2 household items; high SES=More than 2 household items), <sup>4</sup>Family related obstacles included mothers being "busy" or "ill" to bring child for immunization, <sup>5</sup>The minority ethnicity comprised of Kashmiri, Gojari, Gilgiti and Magri ethnicities. SES: Socioeconomic status, OR: Odds ratio, CI: Confidence interval

low immunization coverage in children.<sup>10,11,29</sup> Children from low SES families had 80% lower immunization as concluded by a study.<sup>24</sup>

We found that children in families, which faced some challenge where a mother or someone other who made the decision was ill, were less likely to have up to date immunization. Our results are consistent with results from other studies done in Pakistan which showed that family circumstances contributed to the decisions to access immunization for children.<sup>9</sup>

Our data also showed variable immunization coverage across different ethnic groups and gender. Compared to a male and Pahari ethnic child a female child and a child belonging to a minority ethnic group were 1.7 times less likely to have completed immunization. Wooten *et al.*<sup>30</sup> and Luman *et al.*<sup>31</sup> have reported similar ethnic disparities in immunization. A study from northern areas of Pakistan showed that children of ethnic minorities had lower immunization and higher risk of epidemic from measles.<sup>32</sup>

## Conclusion

Communities which are located away or have difficulty in accessing health services, especially in disaster-stricken areas arranging outreach or mobile immunization strategy can be useful. Female education needs to be prioritized in these communities and mothers be given awareness on immunization through health education sessions organized by rolling out existing system of community health workers. The poor, especially from ethnic minority and marginalized communities, need additional leverage to access immunization services for their children.

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