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Research Article

# The Role of Maternal Education in Advancing Childhood Immunization: An In-depth Analysis of MICS Data

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## Abstract

### *Objective*

*This study will analyze data from MICS 2022–2023 to explore the association between maternal and caregiver education levels and immunization coverage among children aged 12–23 months. Furthermore, it will also estimate immunization coverage at the national and provincial levels. While further identifying factors associated with incomplete immunization, it will ultimately offer recommendations to enhance immunization service quality in Afghanistan.*

### *Study design*

*Cross-sectional study*

### *Methods*

*This study utilized the most recent data from the 2022-2023 Afghanistan Multiple Indicator Cluster Survey (MICS). The analysis focused on immunization data for 6,177 children aged 12-23 months, comprising 3,125 boys and 3,052 girls. Variables included participants' level attributes such as age, sex, and antigen-specific immunization status, as well as household-level factors, including place of residence, region, wealth status, and maternal education. Univariate logistic regression models were used to estimate unadjusted odds ratios (ORs) for the association between each predictor variable and immunization status. Multivariable logistic regression and likelihood ratio tests were conducted to compare different univariate and multivariate logistic models. A p-value <0.05 at the 95% confidence interval was considered to indicate statistical significance (Kirkwood & Sterne, 2010).*

### *Results*

*At the national level, 36.6% of the children aged 12-23 months who participated in the study received basic immunization. Coverage varied across provinces, ranging from 86.1% in Bamyan to 2.6% in Urozgan (2.6%). Crude coverage rates for specific antigens at 23 months were as follows: BCG (64.7%), Penta1 (63.9%), Penta2 (57.7%), Penta3 (51.3%), Polio3 (58.9%), and measles1(51.2%). Immunization coverage among children of mothers who were uneducated was only 31.2%, compared to 55.1% among those whose mothers had higher education. Spoken language had a statistically significant relationship with basic immunization (p = 0.000). After adjusting for extraneous factors such as household wealth and urban–rural residence, maternal education remained a strong predictor. Adjusted ORs for mothers with a higher education (2.74, 95% CI 2.01-3.73, p = 0.000) were significantly greater than those for mothers with no education Conclusions: Our findings underscore the urgent need to invest in women's education, particularly in rural and marginalized communities where female education is scarce, as a crucial pathway to enhancing child health outcomes.*

**Keywords:** Maternal Education, Childhood Immunization, Afghanistan, Predictors of Child Immunization, Immunization Program, Vaccination, Vaccination Coverage, Vaccine-Preventable Diseases, Vaccines

## 1. Introduction

Researchers widely acknowledge that childhood immunization is one of the most impactful public health interventions, as it significantly improves child health indicators, including a reduction in under-five mortality [1]. Immunization prevents an estimated 2.5 million deaths globally each year and is among the most cost-effective strategies for disease prevention, with at least 37 million deaths estimated between 2000 and 2019 Immunization programs have also indirectly strengthened primary healthcare systems in low- and middle-income countries globally [2]. This results in women's empowerment through improved family health management, which yields substantial social and economic benefits [3]. Despite vaccine availability, immunization coverage remains incomplete in many countries. In 2020, only 17.1 million children missed their first dose of the DPT vaccine, with 60% of these children residing in just ten developing nations, including Afghanistan [4]. Although significant progress has been made in global efforts to eradicate polio, the disease remains endemic in Afghanistan and Pakistan [3]. MICS surveys reveal that 60% of global deaths in children under five years of age are due to vaccine-preventable diseases [2]. The World Health Organization launched the Expanded Program on Immunization (EPI) in 1974 to control six key vaccine-preventable diseases: diphtheria, pertussis, tetanus, measles, poliomyelitis, and tuberculosis [5]. Since then, the EPI has played a critical role in improving child survival and reducing the global burden of disease [6]. In Afghanistan, the EPI began in 1978 under the name "Mass Immunization Program." Initially, the goal of the EPI program was to achieve universal coverage. However, decades of conflict, particularly during the Taliban regime in the 1990s, severely disrupted immunization services [7]. In 2004, DPT3 coverage in Afghanistan reached as low as8% [8]. COVID-19 pandemic further impacted immunization globally, with coverage decreasing by 10–50% due to widespread social restrictions [2]. A systematic review conducted in 2021 identified both modifiable (e.g., maternal knowledge, attitudes, and self-efficacy) and non-modifiable (e.g., parental demographics and logistical factors) determinants of immunization in Africa [9]. Other studies have shown that girls are more likely to receive partial immunization than boys are and that larger families are at greater risk for under-immunization. Since the Taliban gained control in 2021, the de facto government has imposed significant restrictions on women's and girls' rights, including access to education, employment, and freedom of movement [10]. These restrictions have led to an increase in mental health issues among women and girls [11]. These restrictions may have far-reaching consequences for public health interventions, including childhood immunization. This study will analyze MICS 2022–2023 data to explore the association between maternal and caregiver education levels and immunization coverage among children aged 12–23 months. This study will also estimate immunization coverage at the national and provincial levels while further identifying factors associated with incomplete immunization and ultimately offer recommendations to enhance immunization service quality in Afghanistan. Though prior studies identified maternal education as a strong determinant of immunization uptake [12,13]. The mechanism and strength of this relationship vary according to the settings. A great number of existing studies were country-specific, based on outdated data, or did not control for other socio-economic determinants such as household wealth or urban-rural residence [12]. We addressed the gap in this study by analyzing nationally representative, recent data from UNICEF's MICS to examine the association between maternal education and childhood immunization coverage in Afghanistan. By doing so, this paper will contribute new evidence on how maternal education can be utilized effectively to improve outcomes, especially in settings where coverage remains suboptimal.

## 2. Methodology

### 2.1. Study Design, Setting, and Sampling Procedure

This paper utilizes data from the Multiple Indicator Cluster Survey (MICS) for the period 2022-2023, conducted by the Afghanistan National Statistics and Information Authority (NSIA). Developed by the United Nations Children's Fund (UNICEF), the MICS is now a global survey program that provides high-quality, reliable, and internationally comparable statistical data on the status of women and children. It helps monitor progress toward national goals and the Sustainable Development Goals [14]. The Afghanistan MICS 2022-23 survey is a cross-sectional, population-based study of Afghan households. UNICEF employs a multistage, stratified cluster sampling design to generate estimates for various indicators related to the situation of women and children at both the national and subnational levels. Urban and rural areas within each province served as the main sampling strata, with census enumeration areas systematically selected within each stratum based on their size. A total of 23,338 households were sampled, for a response rate of 99.8%. Caretakers of all children under the age of five answered questions [14]. Data were collected from 33,398 children aged 0-59 months in 34 provinces across Afghanistan. Districts and villages were randomly chosen. The MICS6 tools were adapted and translated into local languages, such as Dari and Pashto. All team members received a 31-day training session before fieldwork began, and UNICEF and NSIA staff [7].

| SN | Age | Vaccine |
|---|---|---|
| 1 | Birth (0–11 Months) | BCG |
| 2 | Birth (as soon as possible within 14 days of life | OPV0 |
| 3 | 6 Weeks | Pentavalent 1, OPV1 |
| 4 | 10 Weeks | Pentavalent 2, OPV2 |
| 5 | 14 Weeks | Pentavalent 3, OPV3 |
| 6 | 9 Months | Measles, OPV4 |
| 7 | 18 Months | Measles |

**Table 1: Childhood Vaccination Schedule in Afghanistan, Adapted from Afghanistan's Immunization Card Issued by the Ministry of Public Health of Afghanistan**

### 2.2. Study Population

The data collection teams collected data from 23,338 households during the 2022-2023 period. A total of 33,398 children were eligible for interviews, and data collection teams successfully collected data from 32,989 children aged 0-59 months (98.8%) [14]. The focus of this paper is on data from the immunization of 6,177 children aged 12-23 months, comprising 3,115 males and 3,036 females.

### 2.3 Study Variables

#### 2.3.1. Outcome variable

In this study, the outcome variable was basic coverage of immunization. According to UNICEF, a 12–23-month-old child who is immunized against tuberculosis, polio, diphtheria, tetanus, pertussis, and measles can be deemed immunized with basic immunization (BCG, OPV3, DTP3, and measles1). According to Afghanistan's Expanded Program on Immunization (EPI), every child should receive Bacilli Calmette-Guérin (BCG) and Oral Polio Virus (OPV0) within 14 days of life, OPV3 and Diphtheria, Pertussis and Tetanus (DPT3) at 14 weeks, and measles at 9 months.

Children missing any of the vaccines included in the UNICEF definition of basic immunization were classified as not having received basic immunization. A composite variable for immunization status was generated, where 1= fully basic immunized and 0 = not fully basic immunized (Table 2).

#### 2.3.2. Exposure variables

We analyzed the data using Stata 18.0. Variables included participants' level attributes such as age, sex, and antigen-specific immunization status, as well as household-level factors, including place of residence, region, wealth status, and maternal education. To account for the complex sampling design of the MICS survey, we applied sample weighting throughout the entire analysis. To address the issue of missing data, we employed a comprehensive case analysis approach. To test the association between the categorical variables, we used the Pearson chi-square test. The basic immunization variable was labeled zero if the basic immunization was not complete and one if it was full. To obtain the unadjusted odds ratio of the predictor variables on the outcome, we performed univariate logistic regression models. A likelihood ratio test was conducted to compare different univariate and multivariate logistic models, and a $p<0.05$ at the 95% confidence interval was considered to indicate statistical significance [15].

#### 2.3.3. Ethical consideration

The MICS datasets do not include participants' identities, and we have not attempted to access any related information. We obtained authorization to analyze MICS 2022-23 from UNICEF, and the Afghanistan National Statistics and Information Authority (NSIA) ensured ethical compliance during its implementation. The data are freely available on the UNICEF website.

| | |
|---|---|
| **Individual-level variables** | |
| **Age** | A numeric variable, 0-59 months<br>Dummy (1 = 0–11-months, 2 = 12–23 months, 3 = 24–35 months, 4 = 36–47 months, 5 = 48–59 months) |
| **Gender** | Binary (1 for Males, 0 for Females) |
| **Household-level variables** | |
| **Area** | Binary (Urban 1; Rural 0) |
| **Region** | Dummy (1 = North, 0 otherwise 1 = Central, 0 otherwise 1 = South, 0 otherwise) |
| **Mother's education** | Categorical (1 = Preprimary, 1 = Primary, 2 = Secondary, 3= Higher) |
| | |
| **Wealth quintile** | Categorical (1 = Poor, 2 = Middle, 3 = Rich) |
| **Basic immunization** | Binary variable (0= Not Fully Immunized 1=Fully Immunized |

**Table 2: Description of Variables**

## 3. Results

### 3.1. Background Characteristics of Participants and Children

The sampled population comprised 15.69% of the urban areas and 84.31% of the rural regions. Participants in the survey reported 33,398 children, with 6177 aged 12 to 23 months serving as the primary focus of this study. Notably, the dataset contained no missing data. The weighted sample of children aged 12-23 months included 6177 children, with a mean age of 17.6 months (standard deviation = 3.37). The gender distribution revealed a somewhat greater percentage of boys, accounting for 50.6% of the sample, compared to 49.4% for girls. The mean age of the female caregivers was 38.9 years (standard deviation =10.9). A significant proportion of female caregivers had no formal education, accounting for 80.7% of the participants. Only 8.3% of the female caregivers had a primary education. Among female caregivers, 8.2% had lower and upper secondary education, and 2.7% had higher education. Less than 16% of the study participants resided in urban areas. The wealth quantile ranged from the poorest to the richest. More than half of the caregivers, 52%, presented immunization cards for their children. Six percent of mothers provided both other documents and immunization cards, and 1.2% of caregivers provided only other documents.

### 3.2. Coverage by Antigen

Initially, crude coverage of basic immunization, as defined by UNICEF, was calculated and included BCG, polio, diphtheria, tetanus, pertussis, and measles (BCG, OPV3, DTP3, and measles 1). At the national level, 36.6% of the children aged 12-23 months who participated in the study received basic immunization. The coverage varies between provinces, with the highest reported in Bamayan (86.1%) and the lowest reported in Urozgan (2.6%). The crude coverage rates for the various zones are as follows: 39.14% for the central zone, 31.40% for the eastern zone, 28.71% for the northern zone, 32.73% for the northern zone, 31.84 for the western zone, 9.89% for the southern zone, 18.21 for the southeastern zone, and 23.06 for the southwestern zone. Additionally, the crude coverage rates for specific antigens at 23 months were 64.7% for BCG, 63.9% for Penta1, 57.7% for Penta2, 51.3% for Penta3, 58.9% for Polio3 (OPV), and 51.2% for the measles1 vaccine (Table 3). Only 22.8% of the poorest group received basic immunization, while 55.4% of the richest group was covered by basic immunization; the difference was statistically significant ($p < 0.000$). The coverage of basic immunization in urban areas was significantly greater (49.6%) than that in rural areas (32.5%) ($p < 0.000$). Among the children whose parents spoke Dari, 39.6% (941 out of 1,435) were immunized, while only 4.4% (7 out of 157) of the children whose parents spoke Nuristani received basic immunization.

| Vaccine (Antigen) | Number Vaccinated (n) | Coverage (%) |
|---|---|---|
| **BCG** | 3996 | 64.7% |
| **Penta1** | 3947 | 63.9% |
| **Penta2** | 3564 | 57.7% |
| **Penta3** | 3168 | 51.3% |
| **Polio1** | 3063 | 74.7% |
| **Polio2** | 4138 | 67.0% |
| **Polio3** | 3638. | 58.9% |
| **Measles1 (MCV1)** | 3162 | 51.2% |

**Table 3: Antigen-Specific Immunization Coverage Among Children Aged 12–23 Months (CARD, n = 6177)**

### 3.3. Factors Associated with the Immunization Status of Children Aged 12-23 Months

We examined the associations between wealth index, residential area, mothers' level of education, and spoken language. Only 22.4% of the poorest group received basic immunization, while 55.4% of the richest group received basic immunization; the difference was statistically significant ($p < 0.000$). The coverage of basic immunization in urban areas was significantly greater (49.6%) than that in rural areas (32.5 %) ($p < 0.000$). A strong relationship was found between mothers' level of education and basic immunization coverage ($p = 0.000$). The coverage among children whose mothers were uneducated was only 31.2%, whereas it was 55.1% for children whose mothers had higher education . Additionally, spoken language had a statistically significant relationship with basic immunization ($p = 0.000$). Table 4 presents the associations between selected socioeconomic and demographic factors and basic immunization status in children aged 12 to 23 months. We found significant associations between basic immunization coverage and mothers' level of education, residence, children's sex, and parents' financial status. Children living in urban areas had a significantly greater odds ratio (OR) than did those living in rural areas (1.56, 95% CI 1.35-1.80; $p < 0.0001$). We found a significant relationship between basic immunization coverage and sex (OR = 1.15, 95% CI 1.02-1.28; $p = 0.018$). The unadjusted ORs for mothers with a primary education (2.37, 95% CI 1.97-2.86, $p = 0.000$), secondary education (2.74, 95% CI 2.27-3.30, $p = 0.000$), and higher education (2.74, 95% CI 2.01-3.73, $p = 0.000$) were significantly greater than those for mothers with no education. Furthermore, the adjusted odds ratios for the associations between basic immunization coverage and mothers' primary (2.23, 95% CI 1.85-2.69; $p = 0.000$), secondary (2.34, 95% CI 1.93-2.84; $p = 0.000$), and higher education levels (2.15, 95% CI 1.56-2.97; $p = 0.000$) were significantly lower than the unadjusted odds ratios. Additionally, the associations between caregiver financial status, categorized as poor, middle income, and rich, and basic immunization coverage remained statistically significant after adjusting for variables such as maternal education level, residence, and sex, indicating greater coverage than among the poor group. We calculated the Variance Inflation Factors (VIFs) to assess multicollinearity among independent variables following the multiple regression analysis. Primarily, we found high multicollinearity among categories of the household wealth index (VIFs>15). We combined the poorest and second quintiles into a single "poor" group, and the fourth and richest quintiles into a single "rich" group and recalculated the VIF values. All values were below 2 (mean VIF = 1.11), indicating that multicollinearity was no longer a concern [16]. Sample weights were applied; the detailed weighting procedure can be found in the MICS 2023 [17].

| Variable | Category | Nu. Of participants, Fully Immunized (Yes) | % of participants in different groups | Nu. Of participants, Not Fully Immunized (No) | % of participants in different groups | P-value |
|---|---|---|---|---|---|---|
| | | Number | % | Number | % | |
| Age (months) | 12–23 | 2392 | 27.4% | 3785 | 72.6% | 0.000 |
| Gender | Male | 1277 | 14.5% | 2228 | 36.1% | 0.0136 |
| | Female | 1115 | 12.9% | 2258 | 36.6% | |
| Mother's Education | Pre-primary | 1500 | 18.9% | 3821 | 61.9% | 0.000 |
| | Primary | 358 | 3.5% | 298 | 4.8% | |
| | Secondary | 348 | 3.7% | 275 | 4.5% | |
| | Higher | 124 | 1.2% | 92 | 1.5% | |
| Parents' Spoken Language | Dari | 941 | 20.9 % | 1435 | 22.4% | 0.000 |
| | Pashto | 581 | 12.4% | 2366 | 33.4% | |
| | Uzbeki | 124 | 2.9% | 241 | 4.3% | |
| | Turkmani | 54 | 0.6 % | 54 | 4.3% | |
| | Nuristani | 7 | 0.02% | 150 | 0.33% | |
| | Balochi | 16 | 0.12% | 13 | 0.17% | |
| | Pashaie | 33 | 0.34% | 116 | 0. 76% | |
| Residence | Urban | 691 | 10.0% | 829 | 13.0% | 0.000 |
| | Rural | 1701 | 26.6% | 3162 | 49.5% | |
| Wealth Status | Poorest | 341 | 5.4% | 1017 | 15.9% | 0.000 |
| | Poor | 426 | 6.7% | 836 | 13.1% | |
| | Middle | 480 | 7.5% | 820 | 12.8% | |
| | Rich | 583 | 7.9% | 727 | 11.4% | |
| | Richest | 642 | 10.1% | 590 | 9.3% | |

Note: 1439 out of 4431 children classified as not fully immunized were partially immunized.

**Table 4: Factors Associated with Immunization Status, Aged 12-23 Months (n = 6177)**



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| Variable | number | % Fully Immunized | Crude OR (95% CI) | p-value | Adjusted OR (95% CI) | p-value |
|---|---|---|---|---|---|---|
| **Child's Age (months)** | | | | | | |
| **12–23** | 2392 | 36.4% | – | – | Reference | – |
| **Gender** | | | | | | |
| Male | 1277 | 39.6% | 1.15 (1.03–1.28) | 0.018 | 1.13 (1.00–1.26) | 0.042 |
| Female | 1115 | 35.3% | Reference | – | Reference | – |
| **Mother's Education** | | | | | | |
| Pre-primary | 1500 | 31.2% | Reference | – | Reference | – |
| Primary | 358 | 50.0% | 2.37 (1.97–2.86) | <0.001 | 2.23 (1.85–2.70) | <0.001 |
| Secondary | 348 | 53.0% | 2.74 (2.27–3.30) | <0.001 | 2.34 (1.90–2.84) | <0.001 |
| Higher | 124 | 55.1% | 2.74 (2.01–3.73) | <0.001 | 2.15 (1.56–2.97) | <0.001 |
| **Residence** | | | | | | |
| Urban | 691 | 49.6% | 1.56 (1.35–1.80) | <0.001 | 1.06 (0.90–1.26) | 0.497 |
| Rural | 1701 | 32.5% | Reference | – | Reference | – |
| **Wealth Status** | | | | | | |
| Poor | 767 | 29.3% | Reference | – | Reference | – |
| Middle | 984 | 39.0.5% | 1.36 (1.18–1.58) | <0.001 | 1.30 (1.12–1.51) | 0.001 |
| Rich | 641 | 52.1% | 2.10 (1.74–2.25) | <0.001 | 1.61 (1.39–1.86) | <0.001 |

**Table 5: Odds Ratio (OR) and 95% Confidence Interval (CI) of Socioeconomic and Demographic Determinants for Basic Immunization (n = 6177)**

## 4. Discussion

This study revealed a statistically significant correlation between maternal education level and childhood immunization coverage in Afghanistan. Children whose mothers had any level of formal education, primary, secondary, or higher, were materially more likely to receive basic immunization than were those whose mothers had no education. These findings are consistent with previous research in low- and middle-income countries, which showed that maternal education enhances health-seeking behaviors, increases awareness of disease prevention, and improves access to and utilization of healthcare services [5,9,18]. The adjusted odds ratio (AOR) for children whose mothers had a higher education level was more than twice that of children whose mothers had no education (AOR = 2.15), reinforcing the notion that educational attainment is a significant determinant of a child's immunization level. This correlation can be attributed to several factors, including better knowledge of vaccination schedules, improved communication skills with healthcare providers, and stronger agency in household decision-making among educated women. Furthermore, we observed significant disparities in immunization coverage across wealth quintiles and between urban and rural areas. The odds of being fully immunized among children of participants in the wealthiest quintile were twice as high as those in the poorest quintile (adjusted odds ratio, AOR = 2.031). This correlation aligns with earlier studies, which indicate that economic capability enhances access to transportation, information, and quality health services [3]. Although urban residence initially had a higher crude odds ratio for immunization, its effect diminished after we adjusted for education and wealth, suggesting that these factors mediate the urban–rural divide in immunization access. Moreover, the children of participants living in the southern zone and the children of Nuristani-speaking families had significantly lower immunization coverage. Disparities of this nature may reflect systemic inequities in healthcare access, geographic barriers, cultural norms, or historical neglect of marginalized communities. The current sociopolitical context, particularly the ongoing restriction of girls' education under the Taliban regime, poses a substantial threat to long-term immunization coverage [19,20]. Suppose fewer women are allowed to access even basic education. In that case, future generations may witness a further decline in childhood immunization rates, which could reverse the progress made under previous public health initiatives, such as the Expanded Program on Immunization (EPI).

### 4.1. Study limitations

While this study offers robust national and subnational insights using a large, representative dataset, several limitations may exist. A MICS survey is a cross-sectional study in nature, which limits the ability to draw causal inferences between maternal education and immunization outcomes [21]. A recall bias is a known limitation of cross-sectional studies, especially when immunization data are collected based on caregiver-reported information. However, in this study, the child's immunization status was initially verified through the immunization card to minimize inaccuracies and recall bias.

## 5. Conclusion

The findings of the present study revealed that mothers who have been educated at the primary school level or higher have children with significantly greater odds of receiving basic immunization after adjusting for confounding factors such as household wealth and urban–rural disparities. Our findings underscore the urgent need to invest in women's education, particularly in rural and marginalized communities where female education is scarce, as a crucial pathway to enhancing child health outcomes. In the current context of educational restrictions on girls and women, there is a real risk of reversing decades of progress in public health, strengthening outreach, expanding equitable access to immunization services, and safeguarding education opportunities for girls. This approach is a central component of any strategy aimed at improving immunization coverage and child survival in Afghanistan.

### Declarations

### Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could appear to influence the work reported in this paper.

### Data Availability

The data used in this study are publicly available from the UNICEF Multiple Indicator Cluster Surveys (MICS) website at https://mics.unicef.org/. Access to the datasets requires registration and approval from UNICEF.

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