**Impact of Socio-Economic and Health Factors on Early Childhood Education Participation in Bangladesh: Evidence from the MICS 2019 Nationwide Survey**

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**Abstract:**

Background: Early Childhood Education (ECE) programs are integral to achieving UNESCO's development goals, significantly influencing both immediate childhood development and long-term outcomes. This study explores the influence of socio-economic and health-related factors on ECE participation rates.

**Methods:** We used Multiple Indicator Cluster Survey (MICS), 2019 data. The sample comprised 9,447 children aged 36 to 59 months. The outcome variable was ECE program participation, which is binary, indicating either participation ('yes') or non-participation ('no'). Univariate and multivariable logistic regression models were applied to identify the key factors of ECE participation.

**Results:** Our analysis showed that the overall ECE participation rate was 18.86%. Among male students, the rate was 19.86%, and among female students, it was 18.92%. Children aged 48-59 months had significantly higher odds (AOR: 7.89, 95% CI: 6.69-9.31) of ECE participation compared to those aged 36-47 months. Living in Mymensingh (AOR: 1.64, 95% CI: 1.11-2.43) and having a mother aged 20-34 years (AOR: 1.21, 95% CI: 1.01-1.45) or with secondary or higher education (AOR: 2.29, 95% CI: 1.69-3.11) also increased participation odds. Additionally, the presence of books in the household (AOR: 1.74, 95% CI: 1.49-2.04), being free from underweight (AOR: 1.33, 95% CI: 1.06-1.66) and stunting (AOR: 1.64, 95% CI: 1.34-1.99) were associated with higher ECE participation, while Bengali ethnicity was linked to lower odds (AOR: 0.47, 95% CI: 0.28-0.82).

**Conclusion:** ECE participation is higher among older children, those with more educated mothers, and in households with books. Good nutritional status also boosts participation, while Bengali ethnicity is linked to lower odds. These findings highlight the importance of targeted interventions to address disparities in ECE access.

**2 Introduction:**

Ensuring a globally guaranteed minimum of one year of Early Childhood Education (ECE) constitutes a crucial element of UNESCO's developmental objective in the post-2015 agenda [1]. Children who do not participate in ECE programs may fail to acquire essential academic competencies, including language, literacy, and mathematical skills, which are pivotal for their subsequent primary school performance. ECE programs refer to different types of educational activities or initiatives such as preschool programs, nursery or kindergarten, early intervention programs, childcare centers, and pre-primary education centers [2]. ECE programs assume a pivotal role in delineating the life trajectory of children, engendering a robust groundwork for their emotional, social, and cognitive maturation and these programs exert a constructive impact not only in the immediate context but also reverberate into the long term, substantively influencing the realm of academic accomplishments [2][3]. Participation in ECE programs for a year or more positively correlates with later primary school participation and fosters comprehensive physical and mental preparedness [4,5].

Due to socioeconomic and cultural differences, there is a significant inequality in the number of participants in ECE programs among different regions. Internationally, the participation rate in ECE programs among children aged 36 to 59 months stands at a mere 39%. Regionally, the Latin America and Caribbean area leads with a substantial participation rate of 64%, followed by a 46% participation rate in South Asia. Conversely, the lowest participation rate in ECE programs, amounting to 24%, is reported in West and Central Africa [6]. Some studies have found growth in the participation of ECE programs in Cambodia, India, and Ghana [7]. In Pakistan participation rate in ECE programs was 37.2% [8]. According to the MICS, reports in 2006 only 14.6% of children between 36-59 months of age attended ECE programs, whereas in 2012-13, the participation rate in ECE programs was 13.4%, but by 2019, it had increased to 18.9% in Bangladesh [9–11]. In 2023, Bangladesh has a very low participation rate of 19% in ECE programs, which is just 1% greater than the least developed countries combined [6].

Some studies have shown that positive results at school entry are strongly correlated with high-quality ECE programs [12], family socioeconomic status, mother’s education level, ethnic background, and wealth index has been seen positively influencing greatly in ECE programs participation in the UK [13]. A longitudinal study has been conducted in rural Pakistan to investigate the impact of the health of the children (nutritional factors) on school participation [14]. Another study from Lahore, Pakistan has demonstrated how family size, income groups (economic status), and household head's education impact school participation [15]. E. Gurmu and D. Etana demonstrated that children's participation in primary schools is significantly influenced by socioeconomic and demographic factors, including economic status, number of siblings, and place of residence [16].

Greenberg has shown that maternal education has a significant impact on the children's ECE programs participation, where the increase in the mother's education level shows an increasing participation rate in ECE programs [17]. A study was conducted using data from 1968 to 2013 on 3 to 4-year-old children's participation in ECE programs, they found that family income impacted children's ECE programs participation and their performance in the program was less well than other children [18]. Another study from Kenya has found that poor health condition of children has a significant effect on low participation rate in preschool [19]. A study has found that parent’s engagement in certain learning-stimulating activities and presence of child books at home both have a positive impact on participation in ECE programs [20]. A study conducted in the UK found that family income, the mother's level of education, and ethnic and language backgrounds significantly and positively influence the attainment of ECE programs [13]. In Bangladesh through different types of activities and programs organized by NGOs in rural areas accessibility of ECE programs has increased because of this participation rate has also increased in past years [21].

The main gap in the current knowledge is that existing studies have predominantly focused on select socio-economic characteristics, such as the mother's education or wealth index, and their impact on ECE program participation [13,17,22,23]. Moreover, some studies have studied effect of different socio-economic characteristics such as economic status, number of siblings, and place of residence where other research studied the effect of family size, income groups (economic status), and household head's education on primary school participation [15,16,24]. However, no study has simultaneously examined the impact of both health and socioeconomic characteristics on participation in ECE programs participation. This research aims to investigate how various socio-economic factors, in combination with health factors, impact participation in ECE programs participation.

**3 Materials and Methods:**

**3.1 Data Sources**

This research used data from the 2019 Multiple Indicator Cluster Survey (MICS), a thorough national household survey conducted in partnership with UNICEF and administered by the Bangladesh Bureau of Statistics (BBS). The Multiple Indicator Cluster Survey (MICS) is designed to gather standardized data and essential metrics for evaluating the current conditions of children. It places particular emphasis on various factors, including child nutrition, maternal and newborn healthcare, and reproductive health, all of which directly impact child development. Furthermore, the survey systematically collects socioeconomic data pertaining to individuals and households throughout its data collection procedure [25].

**3.2 Sampling design and sample size**

The MICS survey uses a two-stage stratified cluster sampling method to collect data at the household level. The 2019 MICS is based on a sample of 64,000 households, achieving a response rate of 99.4%, while 24,686 eligible children under five years old were surveyed, with a response rate of 93.6%. MICS provides a comprehensive overview of children's health across Bangladesh's seven administrative divisions—Dhaka, Chittagong, Sylhet, Rajshahi, Rangpur, Barisal, and Khulna. In this survey, 64 districts were designated as strata, from which a total of 3,220 sample clusters were selected [26]. In this study, secondary data has been used. A total number of 9,447 observations of 36 to 59 months old was selected from a total number of 64400 observations on the basis of information which has been illustrated in **Figure 1**.

**3.3 Outcome Variable**

The outcome variable for ECE program participation is binary, where a value of '1' indicates participation (i.e., 'yes') and a value of '0' indicates non-participation (i.e., 'no') [26].

**3.4 Covariates**

This study utilized a range of covariates, including the child’s age, sex, place of residence, region of the country, mother’s educational level, wealth index, religion, sex of the household head, ethnicity of the household head, mother’s age, early childhood diseases, nutritional status (underweight, stunting, wasting, and overweight), toilet facilities, maternal stimulation, paternal stimulation, other forms of stimulation, salt iodization, presence of books, toys, media accessibility (such as television, newspapers, or radio), and child punishment. Details of these covariates and their levels are provided in **Table 1**.

WHO recommended four anthropometric indicators such as, weight-for-age and weight-for-height z-score, have been used to measure a children’s nutritional status [27]. In this study, we used z-scores to compare stunting, wasting, underweight, and overweight across genders and between two age groups: 36 to 47 months and 48 to 59 months. Children were classified as wasted or stunted if their weight-for-height z-score or height-for-age z-score was less than -2. Similarly, if the weight-for-age z-score of a child was less than -2 then the child has been considered underweight and if it was higher than +2 then the child has been considered overweight. Toilet facilities were categorized into two groups: improved and unimproved. Improved toilet facilities include pit latrines, flush toilets, and flush toilets connected to a piped sewer system or septic tank with a slab. Unimproved toilet facilities encompass hanging toilets, open pits, and bucket toilets [26].

The educational level of a mother was classified into four categories: incomplete primary education, complete primary education, incomplete secondary education, and secondary education or higher. The wealth index was divided into five categories: poorest, poor, middle, rich, and richest. Early childhood diseases were categorized as 'yes' or 'no'. A child was classified as 'yes' if they exhibited symptoms of diarrhea, fever, or acute respiratory infection (ARI), as confirmed by the mother or caretaker; otherwise, the classification was 'no'. The study assessed three types of stimulation: maternal stimulation, paternal stimulation, and other types of stimulation. Stimulation was defined by the involvement of individual adults (e.g., mother, father, or others) in activities such as reading books, telling stories, looking at picture books, playing, spending time naming, counting, or drawing with the child, or taking the child outside the home or yard. If a child participated in any of these activities with the adults, the response was recorded as 'yes'; otherwise, it was recorded as 'no' [26]. Inadequate supervision was defined as a situation where children under the age of 5 were either left in the care of another child younger than 10 years old or left alone for more than one hour at least once in the past week [26]. Salt iodization was classified into two categories as ‘yes’ and ‘no’. If the resident uses salt more than 0 ppm, then it was considered as ‘yes’ and if in the household there was no salt or the iodine level was 0 ppm then it was considered as ‘no’ [26].

**3.5 Statistical Analysis**

In this study, we used bivariate analysis with a chi-square test to evaluate the association between ECE program participation and other covariates. Univariate (unadjusted) and multivariable (adjusted) logistic regression models were fitted separately. Initially, all covariates with a p-value less than 0.2 were included in the adjusted model [28]. In the univariate analysis, we included one predictor variable at a time in the regression model. For the adjusted analysis, all potential predictor variables were combined into a single model. Results were presented as crude odds ratios (COR) and adjusted odds ratios (AOR), along with their corresponding 95% confidence intervals, and assessed at a 5% significance level.

To assess the accuracy of the best model, we used the Area Under the Receiver Operating Characteristic (AUROC) curve, specificity, sensitivity indicators, the calibration belt plot, and the Hosmer-Lemeshow goodness-of-fit test. The AUROC curve measures the model's performance, with a higher AUROC indicating better accuracy. A lower p-value on the AUROC curve suggests that the model effectively discriminates between two groups, and an area under the curve greater than 0.50 indicates that the model performs better than random chance [29],[30]. The calibration belt plot and the Hosmer-Lemeshow goodness-of-fit test assess how well the model-estimated probabilities align with the observed outcomes. A p-value greater than 0.05 in both tests indicates that the model accurately classifies observations into outcome categories [31,32].

The 'svyset' command in Stata (StataCorp LP, College Station, Texas) was used to account for the complex survey design. This command incorporates design elements such as primary sampling units, strata, clusters, and sample weights into the analysis [33].

**3.6 Check for multicollinearity**

Multicollinearity in the final model was assessed using the Variance Inflation Factor (VIF), with a cut-off value set at 4.00 [34],[35]. This study has conducted all the variables with a VIF value less than 4.00.

**3.7 Ethical consideration**

This secondary data analysis, which used freely available data, was exempt from ethics assessment as no research involving human subjects was conducted for this project.

**4 Results:**

**Table 1** illustrates the association between ECE program participation and various covariates. The study found that factors such as the child’s age (in months), place of residence, geographic division, maternal education, wealth index, maternal stimulation, inadequate supervision, presence of books in the household, and conditions related to underweight and stunting significantly impact ECE participation. These associations were confirmed by chi-square test results, with p-values less than 0.05.

Among children aged 36 to 47 months, only 5.98% participate in ECE programs, while participation increases to 33.34% for those aged 48 to 59 months. Geographically, urban children show higher ECE participation rates, at 23.64%, compared to 18.27% for their rural counterparts. In Bangladesh, ECE participation varies by geographic division, with Mymensingh having the highest rate at 22.64%, followed by Dhaka at 21.63%, Khulna at 19.96%, Chattogram at 19.62%, Barisal at 18.10%, Rangpur at 17.76%, and Rajshahi at 17.05%. Sylhet has the lowest participation rate at 15.29%. Maternal education significantly influences ECE participation, with a 27.25% participation rate for children of mothers with secondary complete or higher education, compared to 12.95% for children of mothers with incomplete primary education. The family's wealth index also affects participation rates, with children from richest households showing a participation rate of 26.76%, while those from poorest households have a much lower rate of 15.40%. Maternal stimulation is another important factor, with children receiving it having a higher participation rate of 20.44%, compared to 14.55% for those who do not receive such stimulation. ECE participation is lowest among children raised with inadequate supervision (16.24%) and highest among those not raised with inadequate supervision (19.68%) **(Table 1)**.

Among children who have experienced early childhood illnesses such as diarrhea, fever, or ARI, participation in ECE programs is slightly higher at 19.68%, compared to 19.28% for those who have not had these illnesses. However, this difference is not statistically significant. The data also reveals that only 14.03% of underweight children are enrolled in ECE programs, while a higher percentage, 21.17%, of non-underweight children participate. Additionally, only 11.69% of children showing signs of stunting are involved in ECE programs, compared to 22.63% of their non-stunted peers **(Table 1)**.

**Table 2** illustrates the relationship between ECE program participation and its associated factors, with most predictor variables showing a significant association at the 5% significance level. The multivariable logistic regression analysis reveals that children aged 48–59 months have 7.89 times higher odds of participating in ECE programs compared to those aged 36–47 months (adjusted odds ratio [AOR]: 7.89, 95% confidence interval [CI]: 6.69–9.31). Urban children have 1.12 times higher odds of ECE programs participation than their rural counterparts (AOR: 1.12, 95% CI: 0.91–1.38). Children from the Mymensingh division have 1.64 times higher odds of participating in ECE programs compared to those from Barisal (AOR: 1.64, 95% CI: 1.11–2.43). Children of mothers aged 15–19 years and 20–34 years have higher odds of ECE participation, with odds ratios of 1.24 times (AOR: 1.24, 95% CI: 0.99–1.56) and 1.21 times (AOR: 1.21, 95% CI: 1.01–1.45) respectively, compared to children of mothers aged 35 years or older. Children of mothers with secondary education complete or higher are significantly more likely to participate in ECE programs, with 2.29 times higher odds compared to those with incomplete primary education (AOR: 2.29, 95% CI: 1.69–3.11). Additionally, children of mothers with secondary incomplete and primary complete education also have higher odds of participating in ECE programs compared to those with mothers who have incomplete primary education.

Children from the richest households had 1.23 times higher odds of participating in ECE programs compared to those from the poorest households (AOR: 1.23, 95% CI: 0.93–1.62). Similarly, children from rich, middle, and poor households had higher odds of ECE participation compared to those from the poorest households, though the wealth index did not show a significant association with ECE programs participation in the adjusted model. Children of Bengali ethnicity had 53% lower odds of participating in ECE programs compared to children from other ethnic groups (AOR: 0.47, 95% CI: 0.28–0.82). Children who received maternal stimulation had 1.12 times higher odds of participating in ECE programs compared to those who did not receive such stimulation (AOR: 1.12, 95% CI: 0.91–1.38), but this association was not significant in the adjusted model. Children whose supervision was not inadequate had 1.21 times higher odds of participating in ECE programs compared to those with inadequate supervision (AOR: 1.21, 95% CI: 0.94–1.56). However, this association was also not significant in the adjusted model. Households that kept books for children had 1.74 times higher odds of ECE participation compared to households without books (AOR: 1.74, 95% CI: 1.49–2.04) **(Table 2)**.

Children who did not experience diarrheal disease or ARI had 1.12 times higher odds of participating in ECE programs compared to those who did experience diarrheal disease (AOR: 1.12, 95% CI: 0.77–1.64) and 1.49 times higher odds compared to those who experienced ARI (AOR: 1.49, 95% CI: 0.86–2.55). However, no significant association was found between early childhood diseases and ECE program participation in the adjusted model. Conversely, children who were not underweight, stunted, or wasted had higher odds of participating in ECE programs compared to those who were underweight, stunted, or wasted. Specifically, the odds were 1.33 times higher for non-underweight children (AOR: 1.33, 95% CI: 1.06–1.66), 1.64 times higher for non-stunted children (AOR: 1.64, 95% CI: 1.34–1.99), and 1.27 times higher for non-wasted children (AOR: 1.27, 95% CI: 0.98–1.64). Most nutritional factors were significantly associated with ECE program participation in the adjusted model **(Table 2)**.

The Hosmer-Lemeshow chi-square test and associated p-value indicate that the model fits the data well **(Table 3)**. **Figure 2(a)** shows a classification plot, which highlights the point where sensitivity and specificity intersect at a probability cutoff value, reflecting the model's classification accuracy. The multivariable model achieved a classification accuracy of 81.28%. The area under the ROC curve for the model was 77.49% (95% CI: 76.30%–78.67%, Asymptotic p-value: <0.001), demonstrating its robustness **(Table 3 and Figure 2(b))**. The Calibration belt plot and test result showed a p-value of 0.102, indicating that the model’s calibration is good and the hypothesis of a well-calibrated model is not rejected **(Table 3 and Figure 2(c))**.

**5 Discussions:**

This study explores the impact of various socio-economic and health factors on early childhood education (ECE) participation, revealing an overall participation rate of 19.39%. In sub-Saharan Africa, approximately 17.9% of children aged 3 and 4 have access to early childhood education, while 61.7% of children in Latin America and the Caribbean benefit from it. In Ghana, a study showed that 68.67% of children surveyed were currently enrolled in Early Childhood Education [36,37]. However, a World Bank report indicates that around 55% of children in Bangladesh fail to achieve the minimum levels proficiency level by the end of elementary school [38].

The analysis shows that older children, those living in Mymensingh, and those with mothers who are younger or have higher education levels are more likely to participate in ECE. Additionally, having books in the household and good nutritional status is associated with higher participation rates, while Bengali ethnicity is linked to lower odds of ECE participation. This study found that children aged 48 to 59 months are more likely to participate in ECE programs than those aged 36 to 47 months. Our findings align with those of researchers who identified a sensitive period in the development of children between the ages of 3 and 4, during which they begin to form stable adult behavior patterns [35,39]. The Barcelona Objectives aimed to transform Europe's economy into a competitive, knowledge-based one, recognizing ECEC as a means to enhance human capacities. They set targets for childcare attendance: 33% for children under three and 90% for those over three, with the goal of near-universal coverage [40].

Participation rates also vary between rural and urban areas, with children in urban areas being more likely to attend ECE programs compared to their rural counterparts. This disparity is attributed to factors such as limited access to educational resources, a shortage of teachers, and other challenges in rural areas [41]. In Ghana, rural-urban disparities revealed that ECE enrollment was higher in urban areas than in rural ones [36]. This finding highlights the need to improve Early Childhood Education in rural areas, similar to our own findings. In our study, we observed that participation in ECE programs was higher in the Dhaka, Mymensingh, Rangpur, and Sylhet divisions compared to the Barisal division. Similar findings have been reported in other studies; for example, a study in Bangladesh found that children from the Mymensingh division have a greater likelihood of attending ECE programs compared to those from other divisions [35,42]. A unique combination of childrearing practices and societal values contributes to the high expectations many parents have for their children in ECE [43].

In our study, children of younger mothers are more likely to attend ECE programs compared to those with older mothers. This study also revealed a substantial influence of maternal education on children's participation in children’s ECE programs. Mothers with elevated levels of educational attainment exhibit a heightened acumen in parenting, leading to a heightened understanding and awareness of nutritional factors compared to mothers with lower educational backgrounds [44]. A study was conducted among the slums of Nairobi where they found a strong association between a mother’s age and education on a child’s nutrition level [45]. Another study was conducted using the data of Brazilian Demographic and Health Survey where they said mother’s education affects child height [46]. The more educated the mother is, she is more likely to send their child to an ECE program.

This study also found that the children from those households that had children’s books or picture books were more likely to participate in the ECE programs. A study also found the similar finding [47]. This study identified that the children’s weight plays a significant effect on ECE programs. We discovered that 24.82% of the children were underweight. In contrast, those who were not underweight were 1.33 times more likely to participate in the ECE programs. Underweight is one of the main indicators of malnutrition in children and can create long term effects that can cause low educational participations and achievements [48–50] . In 2019 a study was conducted in Debre Tabor Town, Amhara Region Ethiopia, where they found that the cause of being underweight is family education and family wealth which was aligned with our study [51]. In our study we found that those who were not stunned were 1.64 times more likely to participate in ECE programs. As stunned children are shorter than a normal child, it could be possible to have less interest in the parents to send their children in ECE programs as they may think their children is not enough grown to start attending school. In a study, they found that wealth index and parental education has an impact of being a child stunned [52]. This study found that the children who were wasted were more likely to take part in ECE programs. It can be because the children may seem taller though their weight is low [53]. Thus, their parents think that their child may be big enough to start attending school.

**6 Strengths and limitations**:

This is the first study using the most recent MICS data to assess the impact of socio-economic and health factors on ECE participation in Bangladeshi children. We utilized a large, nationwide dataset and applied appropriate data analysis methods accounting for complex survey designs. However, the study has several limitations. It relies on secondary data, which limits control over variables, data quality, and measurement indicators. The cross-sectional design of the study means the findings are correlational, not causal, and such studies cannot estimate risk or determine incidence. Additionally, secondary data may contain errors from the original data collection, potentially causing variations in the results. We could not examine factors like community support, cultural influences, migration status, or awareness, and self-reported data may introduce recall or social desirability bias. Despite these limitations, the study provides valuable insights for future policy and interventions in Bangladesh and similar contexts.

**7**

We recommend some measures for improving Early Childhood Education (ECE) participation in Bangladesh. First, targeted interventions should be designed to address the context of rural areas where the ECE participation rates are comparatively lower, along with addressing barriers like limited access to resources and lack of trained teachers. Maternal education should be enhanced in rural and poorer areas to raise awareness among women about the importance of ECE programs. Programs promoting the importance of books and early literacy at home should also be encouraged, as our study found that children in households with books were more likely to attend ECE. Underweight and stunted children were less likely to attend ECE, so health promotions focusing on nutrition are also important. Education regarding the link between child nutrition and attainment can further catalyze ECE participation in lower-income communities. Last but not least, continued research regarding the community-related, culturally mediated, and regionally varied factors can fully inform fine-tuning national policy towards more equitable access to quality early childhood education for all children.

**8 Conclusions:**

The analysis reveals that age, maternal education, household environment, and nutritional status are key factors influencing early childhood education (ECE) participation. Older children, those with more educated mothers, and those in households with books are more likely to participate in ECE. Additionally, children who are not underweight or stunted have higher participation rates. However, Bengali ethnicity appears to be associated with lower odds of ECE participation. These findings highlight the importance of targeted interventions to address disparities in ECE access.

**Abbreviations**

There are several kinds of abbreviations used in this study. They are given following:

1. ECE: Early Childhood Education
2. MICS: Multiple Indicator Cluster Survey
3. BBS: Bangladesh Bureau of Statistics
4. AUROC: Area under the receiver Operating Characteristic curve
5. OR: Odds Ratio
6. VIF: Variance inflation factor
7. AUC: Area Under the Curve

**Data sharing statement**

The MICS datasets used in the analysis are available to the public upon request. More information about the MICS program, as well as access to the survey datasets, may be obtained at https://mics.unicef.org/.

**Competing interests**

The authors declare that they have no competing interests.

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**Tables and Figures**

**Table 1: Descriptive statistics on Early Childhood Education program participation, categorized by socio-economic and health factors**

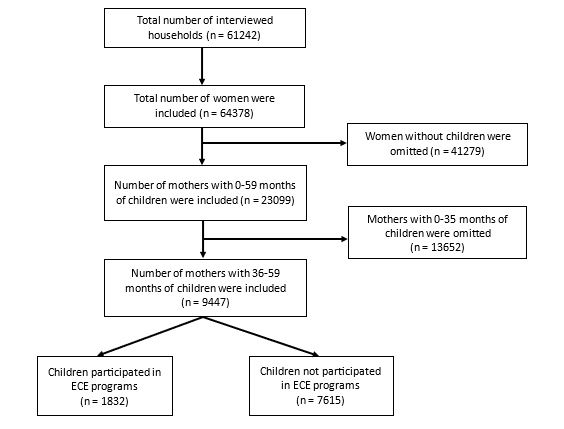
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Programs participation** | | | **p-value** |
| **Yes**  **n (%)** | **No**  **n (%)** | **Total**  **n (%)** |
| ***Socio-economic factors*** |  |  |  |  |
| **Age of child**  **(in months)** |  |  |  |  |
| 36-47 | 288 (5.98) | 4527 (94.02) | 4815 (50.99) | <0.001 |
| 48-59 | 1544 (33.34) | 3087 (66.66) | 4631 (49.01) |  |
| **Childs’ sex** |  |  |  |  |
| Male | 949 (19.86) | 3828 (80.14) | 4777 (50.57) | 0.296 |
| Female | 883 (18.92) | 3786 (81.08) | 4669 (49.43) |  |
| **Place of residence** |  |  |  |  |
| Urban | 466 (23.64) | 1507 (76.36) | 1973 (20.89) | <0.001 |
| Rural | 1366 (18.27) | 6108 (81.73) | 7474 (79.11) |  |
| **Division** |  |  |  |  |
| Barisal | 96 (18.10) | 439 (81.90) | 535 (5.67) | 0.011 |
| Chattogram | 407 (19.62) | 1666 (80.38) | 2073 (21.96) |  |
| Dhaka | 471 (21.63) | 1706 (78.37) | 2177 (23.03) |  |
| Khulna | 197 (19.96) | 789 (80.04) | 986 (10.43) |  |
| Mymensingh | 163 (22.64) | 557 (77.36) | 720 (7.62) |  |
| Rajshahi | 201 (17.05) | 980 (82.95) | 1181 (12.50) |  |
| Rangpur | 181 (17.76) | 840 (82.24) | 1021 (10.82) |  |
| Sylhet | 155 (15.29) | 638 (84.71) | 793 (7.96) |  |
| **Mothers’ age** |  |  |  |  |
| 15-19 | 363 (20.65) | 1395 (79.35) | 1758 (20.05) | 0.097 |
| 20-34 | 1075 (19.63) | 4402 (80.37) | 5477 (62.42) |  |
| 35+ | 266 (17.27) | 1273 (82.73) | 1539 (17.54) |  |
| **Mothers’ education** |  |  |  |  |
| Primary incomplete | 161 (12.95) | 1084 (87.05) | 1245 (13.18) | <0.001 |
| Primary complete | 374 (16.25) | 1930 (83.75) | 2304 (24.39) |  |
| Secondary incomplete | 926 (20.40) | 3612 (79.60) | 4538 (48.04) |  |
| Secondary complete or higher | 371 (27.25) | 990 (72.75) | 1361 (14.39) |  |
| **Wealth index** |  |  |  |  |
| Poorest | 325 (15.40) | 1786 (84.60) | 2111 (22.34) | <0.001 |
| Poor | 305 (16.19) | 1581 (83.81) | 1886 (19.97) |  |
| Middle | 336 (19.07) | 1428 (80.93) | 1764 (18.68) |  |
| Rich | 367 (20.13) | 1457 (79.87) | 1824 (19.33) |  |
| Richest | 498 (26.76) | 1363 (73.24) | 1861 (19.69) |  |
| **Religion** |  |  |  |  |
| Islam | 251 (19.38) | 995 (80.62) | 1246 (85.98) | 0.600 |
| Other | 1480 (19.49) | 6153 (80.51) | 7633 (14.02) |  |
| **Household head sex** |  |  |  |  |
| Male | 1479 (19.49) | 6110 (80.51) | 7589 (85.48) | 0.996 |
| Female | 2501 (19.50) | 1038 (80.50) | 3539 (14.52) |  |
| **Ethnicity** |  |  |  |  |
| Bengali | 1801 (19.30) | 7529 (80.70) | 9330 (98.76) | 0.099 |
| Others | 31 (26.64) | 85 (73.36) | 116 (1.24) |  |
| **Mother stimulation** |  |  |  |  |
| Yes | 1587 (20.44) | 6176 (79.56) | 7763 (82.18) | <0.001 |
| No | 245 (14.55) | 1439 (85.45) | 1684 (17.82) |  |
| **Father stimulation** |  |  |  |  |
| Yes | 807 (19.1) | 3424 (80.9) | 4231 (44.78) | 0.528 |
| No | 1025 (19.7) | 4191 (80.3) | 5216 (55.22) |  |
| **Other stimulation** |  |  |  |  |
| Yes | 993(19.66) | 4038(80.34) | 5031 (53.27) | 0.426 |
| No | 830(19.06) | 3577(80.94) | 4407 (46.73) |  |
| **Inadequate supervision** |  |  |  |  |
| Yes | 129 (16.24) | 667 (83.76) | 796 (8.43) | 0.026 |
| No | 1703 (19.68) | 6947 (80.32) | 8650 (91.57) |  |
| **Books in household** |  |  |  |  |
| Yes | 1261 (25.62) | 3661 (74.38) | 4922 (52.09) | <0.001 |
| No | 571 (12.61) | 3954 (87.39) | 4525 (47.91) |  |
| **Toys in household** |  |  |  |  |
| Yes | 1495 (19.19) | 6296 (80.81) | 7791 (82.48) | 0.353 |
| No | 337 (20.36) | 1318 (79.64) | 1655 (17.52) |  |
| **Mass media** |  |  |  |  |
| Yes | 996 (19.02) | 4242 (80.98) | 5238 (59.70) | 0.315 |
| No | 708 (20.02) | 2828 (79.98) | 3536 (40.30) |  |
| **Child punishment** |  |  |  |  |
| Yes | 106 (21.06) | 396 (78.94) | 502 (5.31) | 0.416 |
| No | 1726 (19.30) | 7219 (80.70) | 8945 (94.69) |  |
| ***Health factors*** |  |  |  |  |
| **Diarrheal disease** |  |  |  |  |
| Yes | 64 (15.90) | 338 (84.10) | 402 (4.25) | 0.111 |
| No | 1767 (19.50) | 7274 (80.50) | 9043 (95.75) |  |
| **Fever** |  |  |  |  |
| Yes | 106 (21.06) | 396 (78.94) | 1825 (19.31) | 0.471 |
| No | 1726 (19.30) | 7219 (80.70) | 7622 (80.69) |  |
| **ARI** |  |  |  |  |
| Yes | 366 (20.10) | 1457 (79.90) | 135 (1.43) | 0.063 |
| No | 1466 (19.20) | 6156 (80.80) | 9304 (98.57) |  |
| **Early childhood diseases (any one)** |  |  |  |  |
| Yes | 534 (19.68) | 2178 (80.32) | 2712 (28.76) | 0.700 |
| No | 1296 (19.28) | 5427 (80.72) | 6723 (71.24) |  |
| **Underweight** |  |  |  |  |
| Yes | 318 (14.03) | 1945 (85.97) | 2263 (24.82) | <0.001 |
| No | 1452 (21.17) | 5406 (78.83) | 6858 (75.18) |  |
| **Stunned** |  |  |  |  |
| Yes | 301 (11.69) | 2269 (88.31) | 2570 (28.44) | <0.001 |
| No | 1463 (22.63) | 5000 (77.37) | 6463 (71.56) |  |
| **Wasted** |  |  |  |  |
| Yes | 191 (21.55) | 696 (78.45) | 887 (9.86) | 0.162 |
| No | 1563 (19.26) | 6551 (80.74) | 8114 (90.14) |  |
| **Overweight** |  |  |  |  |
| Yes | 114 (18.93) | 489 (81.07) | 603 (6.38) | 0.795 |
| No | 1718 (19.4) | 7126 (80.6) | 8844 (93.62) |  |
| **Sanitation facility** |  |  |  |  |
| Improved | 1685 (19.57) | 6923 (80.43) | 8608 (96.96) | 0.353 |
| Unimproved | 45 (16.93) | 224 (83.07) | 269 (3.04) |  |
| **Salt iodization** |  |  |  |  |
| Yes | 1415 (19.6) | 5787 (80.4) | 7202 (81.16) | 0.527 |
| No | 316 (18.9) | 1357 (81.1) | 1673 (18.84) |  |
| **Total** | **1832 (19.39)** | **7615 (80.61)** | **9447 (100.00)** |  |

**Table 2: Factors associated with participation in Early Childhood Education programs, considering socio-economic and health variables**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **COR (95% CI)** | **p-value** | **AOR (95% CI)** | **p-value** |
| **Age of child**  **(in months)** |  |  |  |  |
| 48-59 | 7.86 (6.78-9.12) | <0.001 | 7.89 (6.69-9.31) | <0.001 |
| 36-47 | Reference |  | Reference |  |
| **Childs’ sex** |  |  |  |  |
| Male | 1.06 (0.95-1.19) | 0.296 | **-** | **-** |
| Female | Reference |  | **-** |  |
| **Place of residence** |  |  |  |  |
| Urban | 1.38 (1.19-1.61) | <0.001 | 1.12 (0.91-1.38) | 0.270 |
| Rural | Reference |  | Reference |  |
| **Division** |  |  |  |  |
| Chattogram | 1.10 (0.86-1.42) | 0.435 | 1.07 (0.77-1.49) | 0.678 |
| Dhaka | 1.25 (0.97-1.61) | 0.084 | 1.17 (0.84-1.62) | 0.352 |
| Khulna | 1.13 (0.86-1.48) | 0.377 | 1.00 (0.71-1.40) | 0.990 |
| Mymensingh | 1.32 (0.97-1.81) | 0.080 | 1.64 (1.11-2.43) | 0.012 |
| Rajshahi | 0.93 (0.70-1.24) | 0.623 | 0.83 (0.58-1.18) | 0.298 |
| Rangpur | 0.98 (0.74-1.29) | 0.874 | 1.05 (0.73-1.51) | 0.792 |
| Sylhet | 0.82 (0.59-1.13) | 0.223 | 1.07 (0.71-1.61) | 0.756 |
| Barisal | Reference |  | Reference |  |
| **Mothers’ age** |  |  |  |  |
| 15-19 | 1.25 (1.01-1.53) | 0.036 | 1.24 (0.99-1.56) | 0.065 |
| 20-34 | 1.17 (0.99-1.38) | 0.063 | 1.21 (1.01-1.45) | 0.045 |
| 35+ | Reference |  | Reference |  |
| **Mothers’ education** |  |  |  |  |
| Secondary complete or higher | 2.52 (1.99-3.18) | <0.001 | 2.29 (1.69-3.11) | <0.001 |
| Secondary incomplete | 1.72 (1.41-2.11) | <0.001 | 1.68 (1.30-2.18) | <0.001 |
| Primary complete | 1.30 (1.05-1.62) | 0.017 | 1.46 (1.13-1.90) | 0.004 |
| Primary incomplete | Reference |  | Reference |  |
| **Wealth index** |  |  |  |  |
| Richest | 2.01 (1.66-2.42) | <0.001 | 1.23 (0.93-1.62) | 0.148 |
| Rich | 1.38 (1.14-1.68) | 0.001 | 1.11 (0.78-1.26) | 0.949 |
| Middle | 1.29 (1.08-1.56) | 0.006 | 1.08 (0.85-1.36) | 0.534 |
| Poor | 1.06 (0.88-1.29) | 0.546 | 1.01 (0.77-1.21) | 0.740 |
| Poorest | Reference |  | Reference |  |
| **Religion** |  |  |  |  |
| Islam | 0.95 (0.80-1.14) | 0.600 | - | - |
| Other | Reference |  | - |  |
| **Household head sex** |  |  |  |  |
| Male | 0.99 (0.84-1.19) | 0.996 | - | - |
| Female | Reference |  | - |  |
| **Ethnicity** |  |  |  |  |
| Bengali | 0.66 (0.40-1.08) | 0.099 | 0.47 (0.28-0.82) | 0.007 |
| Others | Reference |  | Reference |  |
| **Mother stimulation** |  |  |  |  |
| Yes | 1.50 (1.27-1.79) | <0.001 | 1.12 (0.91-1.38) | 0.269 |
| No | Reference |  | Reference |  |
| **Father stimulation** |  |  |  |  |
| Yes | 0.96 (0.86-1.08) | 0.528 | - | - |
| No | Reference |  | - |  |
| **Other stimulation** |  |  |  |  |
| Yes | 1.05 (0.93-1.18) | 0.426 | - | - |
| No | Reference |  | - |  |
| **Inadequate supervision** |  |  |  |  |
| No | 1.26 (1.03-1.55) | 0.026 | 1.21 (0.94-1.56) | 0.133 |
| Yes | Reference |  | Reference |  |
| **Books in household** |  |  |  |  |
| Yes | 2.39 (2.10-2.72) | <0.001 | 1.74 (1.49-2.04) | <0.001 |
| No | Reference |  | Reference |  |
| **Toys in household** |  |  |  |  |
| Yes | 0.93 (0.79-1.09) | 0.353 | - | - |
| No | Reference |  | - |  |
| **Mass media** |  |  |  |  |
| Yes | 0.94 (0.83-1.06) | 0.315 | - | - |
| No | Reference |  | - |  |
| **Child punishment** |  |  |  |  |
| Yes | 1.12 (0.86-1.45) | 0.416 | - | - |
| No | Reference |  | - |  |
| **Diarrheal disease** |  |  |  |  |
| No | 1.29 (0.94-1.75) | 0.111 | 1.12 (0.77-1.64) | 0.544 |
| Yes | Reference |  | Reference |  |
| **Fever** |  |  |  |  |
| No | 1.05 (0.91-1.22) | 0.471 | - | - |
| Yes | Reference |  | - |  |
| **ARI** |  |  |  |  |
| No | 1.52 (0.98-2.35) | 0.063 | 1.49 (0.86-2.55) | 0.152 |
| Yes | Reference |  | Reference |  |
| **Early childhood diseases (any one)** |  |  |  |  |
| No | 1.03 (0.90-1.69) | 0.700 | - | - |
| Yes | Reference |  | - |  |
| **Underweight** |  |  |  |  |
| No | 1.65 (1.41-1.92) | <0.001 | 1.33 (1.06-1.66) | 0.012 |
| Yes | Reference |  | Reference |  |
| **Stunned** |  |  |  |  |
| No | 2.21 (1.89-2.58) | <0.001 | 1.64 (1.34-1.99) | <0.001 |
| Yes | Reference |  | Reference |  |
| **Wasted** |  |  |  |  |
| No | 1.15 (0.94-1.40) | 0.162 | 1.27 (0.98-1.64) | 0.068 |
| Yes | Reference |  | Reference |  |
| **Overweight** |  |  |  |  |
| Yes | 0.97 (0.76-1.23) | 0.795 | - | - |
| No | Reference |  | - |  |
| **Sanitation facility** |  |  |  |  |
| Improved | 1.19 (0.82-1.74) | 0.250 | - | - |
| Unimproved | Reference |  | - |  |
| **Sold iodization** |  |  |  |  |
| Yes | 1.05 (0.90-1.23) | 0.527 | - | - |
| No | Reference |  | - |  |

**Table 3: Hosmer-Lemeshow Test, Area under ROC Curve, and Calibration test and classification accuracy for final logistic regression model**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Hosmer-Lemeshow Test** | | **Area Under ROC Curve** | | **Calibration test** | | **Correctly classified** |
| Chi- square | P-value | AUC | P-value | Test-statistic | P-value | 81.28% |
| 4879.85 | 0.974 | 77.49 (76.30-78.67) | <0.001 | 2.67 | 0.102 |



**Figure 1: Schematic diagram of the analytic study sample**

|  |  |  |
| --- | --- | --- |
|  |  |  |
| **Figure 2(a): Sensitivity analysis** | **Figure 2(b): Area Under ROC curve** | **Figure 2(c): Calibration belt plot** |