**Participation in Early Childhood Education Programs Affected by Socioeconomic and Health Factors: Evidence from the Bangladesh MICS 2019 Survey**

A T M Shariful Alam1\*, Mohammad Nayeem Hasan1\*, Md. Nahidul Islam Emon1, Robiul Islam Akash1, Muhammad Abdul Baker Chowdhury2, Md Jamal Uddin1,3\*\*

1Department of Statistics, Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh

2Department of Neurosurgery, University of Florida College of Medicine, Gainesville, FL, USA

3Faculty of Graduate Studies, Daffodil International University, Dhaka, Bangladesh

**\*Equal contribution**

**\*\*Correspondence:**

Md. Jamal Uddin, Ph.D.,

Professor, Department of Statistics,

Shahjalal University of Science and Technology,

Sylhet 3114, Bangladesh.

Email: [jamal-sta@sust.edu](mailto:jamal-sta@sust.edu)

**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 investigates how socioeconomic and health-related factors affect the rates of ECE participation.

**Methods:** In this study, 9,447 children between the ages of 36 and 59 months were studied using MICS 2019 data, which employed a two-stage stratified cluster sampling procedure covering 64,000 homes with a 99.4% response rate. The outcome variable, enrollment in the ECE program, was binary, meaning it could be either "yes" or "no." Using logistic regression models, the primary factors impacting ECE participation were identified.

**Results:** The overall ECE participation percentage, according to our data, was 18.86%. The percentage was 18.92% for female students and 19.86% for male students. Compared to children aged 36-47 months, those aged 48-59 months showed significantly greater probabilities of participating in ECE (adjusted odds ratio (AOR): 7.89, 95% confidence interval (CI): 6.69-9.31). The odds of participation were also greater for those who lived in Mymensingh (AOR: 1.63, 95% CI: 1.10-2.42), had a mother who was between the ages of 20 and 34 (AOR: 1.21, 95% CI: 1.01-1.45), or had a mother who had completed secondary or higher education (AOR: 2.29, 95% CI: 1.69-3.11). Books in the household (AOR: 1.74), being free from underweight (AOR: 1.33) and stunting (AOR: 1.64) increased ECE participation, while Bengali ethnicity (AOR: 0.47) decreased it.

**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 results highlight the necessity of targeted initiatives to address disparities in access to ECE.

**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 take part in early childhood education programs may find it difficult to develop critical academic abilities like language, literacy, and math that are necessary for success in primary school. 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 robust groundwork for their emotional, social, and cognitive maturation and these programs exerts 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]. In rural Pakistan, researchers carried out a long-term study to look into how children's health (nutritional aspects) affected their involvement in school [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 showed that higher maternal education significantly increases children's participation in ECE programs, where the increase in the mother's education level shows an increasing participation rate in ECE programs [17]. Family income had an impact on children's engagement in ECE programs, and their performance in the program was lower than that of other children, according to a study on the participation of 3 to 4-year-old children in ECE programs that used data from 1968 to 2013 [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 current knowledge is that existing studies primarily focus on socio-economic factors, like maternal education or wealth index, and their impact on ECE program participation [13,17,22,23]. Moreover, some studies have studied the 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]. Nevertheless, no research has looked at the effects of socioeconomic and health factors on ECE program attendance at the same time. 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**

The 2019 Multiple Indicator Cluster Survey (MICS), a nationwide household survey carried out by the Bangladesh Bureau of Statistics in partnership with UNICEF, provided the data for this study. The MICS is intended to collect standardized data and critical metrics for assessing the current status 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**

Using a two-stage stratified cluster sampling technique, the 2019 MICS surveyed 24,686 eligible children under five, obtaining a 93.6% response rate, and 64,000 households, obtaining a 99.4% response rate. MICS conducts a comprehensive assessment of children's health across the survey covered Bangladesh's seven administrative divisions and selected 3,220 sample clusters from 64 districts designated as strata [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, with participation indicated by a value of '1' (i.e., 'yes') and non-participation indicated by a value of '0' (i.e., 'no') [26].

**3.4 Covariates**

A wide range of covariates were used in this study, such as the child's age and sex, residence, regional country classification, maternal educational attainment, wealth index, religious affiliation, gender and ethnicity of the household head, maternal age, prevalence of childhood diseases, and nutritional status as determined by the World Health Organization. four anthropometric measurements, such as weight-for-height and weight-for-age z-scores, were proposed, sanitation facilities, stimulation, salt iodization, availability of books, toys, media access (such as television, newspapers, or radio), and methods of child discipline. Table 1 presents data regarding these parameters and their respective levels.

This study employed z-scores to analyze stunting, wasting, underweight, and overweight across genders and between two age cohorts: 36 to 47 months and 48 to 59 months. Children were categorized as underweight if their weight-for-age z-score was less than -2, overweight if it was greater than +2, and wasted or stunted if their weight-for-height or height-for-age z-score was less than -2. Upgraded restrooms (such as pit latrines and flush toilets that are connected to a septic or sewer system) and unimproved restrooms (such as bucket toilets, open pits, and hanging toilets) were distinguished [26].

Four levels of maternal education were distinguished: incomplete primary, complete primary, incomplete secondary, and secondary or above. Five groups were created using the wealth index: poorest, poorest, middle, affluent, 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 evaluated three types of stimulation: maternal, paternal, and other. Stimulation was defined as adult involvement in activities like reading, storytelling, playing, counting, drawing, or taking the child outdoors. Participation in these activities was recorded as 'yes' if the child engaged, or 'no' if not. [26]. Toilets were divided into two categories: unimproved (bucket toilets, hanging toilets, and open pits) and improved (pit latrines, flush toilets, flush toilets connected to a sewage system, and flush toilets with a slab) [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**

To evaluate the relationship between variables and ECE program participation, we employed bivariate analysis with a chi-square test. Unadjusted and multivariable logistic regression models were fitted, including all covariates with a p-value < 0.2 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. Statistical significance was established at the 5% level, and the results were presented as adjusted odds ratios (AOR) and crude odds ratios (COR) with 95% CIs.

We evaluated the model’s accuracy using the calibration belt plot, Hosmer-Lemeshow test, sensitivity, specificity, and AUROC. An AUROC above 0.50 indicates better-than-random accuracy, while a lower p-value suggests effective group distinction [29],[30]. Calibration and fit were assessed with the calibration belt and Hosmer-Lemeshow tests, where p > 0.05 indicates proper classification [31,32]. Stata’s "svyset" command accounted for survey design factors [33]. Multicollinearity was checked with Variance Inflation Factor (VIF), ensuring all variables had a VIF below 4.00 [34],[35].

**3.6 Ethical consideration**

As this secondary data analysis utilized publicly available data and did not involve research with human subjects, it was exempt from ethical review.

**4 Results:**

**Table 1** illustrates the association between ECE program participation and various covariates. The study found that factors such as the age of child (in months), 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. Chi-square test results confirmed these associations, with p-values found to be 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%. Participation in ECE is significantly influenced by maternal education; children whose mothers have completed secondary education or higher are more likely to participate (27.25%) than children whose mothers have only completed primary education (12.95%). 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** delineates the correlation between ECE program attendance and its related components, with the majority of predictor variables demonstrating a significant association at the 5% significance threshold. Children between the ages of 48 and 59 months have a 7.89-fold higher likelihood of participating in early childhood education programs than children between the ages of 36 and 47 months, according to the results of the multivariable logistic regression analysis (adjusted odds ratio [AOR]: 7.89, 95% confidence interval [CI]: 6.69–9.31). Furthermore, compared to their rural counterparts, urban children are 1.12 times more likely to enroll in early childhood education programs (AOR: 1.12, 95% CI: 0.91–1.38). Children of mothers aged 15–19 and 20–34 years have increased odds of participating in ECE, with odds ratios of 1.24 and 1.21, respectively, compared to children of mothers aged 35 years or older. Compared to children whose mothers have only completed elementary school, children of mothers with secondary education or higher are 2.29 times more likely to participate in early childhood education programs (AOR: 2.29, 95% CI: 1.69–3.11). Moreover, a greater likelihood of engaging in ECE programs is exhibited by children of mothers with incomplete secondary and complete primary education compared to those with mothers possessing partial primary education.

Compared to children from the most deprived homes, children from affluent households were 1.23 times more likely (AOR: 1.23, 95% CI: 0.93–1.62) to participate in early childhood education programs. While the wealth index showed no significant correlation with ECE participation in the adjusted model, children from affluent, middle-class, and impoverished households were more likely to engage in ECE compared to those from the poorest families. Bengali children were 53% less likely to participate in ECE (AOR: 0.47, 95% CI: 0.28–0.82). Families with children's books had 1.74 times higher likelihood of ECE engagement **(Table 2)**.

Children devoid of diarrheal disease or acute respiratory infections (ARI) exhibited a 1.12-fold increased likelihood of enrollment in ECE programs compared to those with diarrheal disease (AOR: 1.12, 95% CI: 0.77–1.64), and a 1.49-fold increased likelihood compared to children with ARI (AOR: 1.49, 95% CI: 0.86–2.55). Conversely, children who were neither wasted, stunted, nor underweight had a higher likelihood of enrollment in ECE programs compared to their counterparts. The probabilities were 1.27 times greater for children without wasting (AOR: 1.27, 95% CI: 0.98–1.64), 1.33 times more for children without underweight, and 1.64 times greater for children without stunting. In the revised model, most nutritional indicators exhibited a strong connection with participation in ECE programs (Table 2).

The model adequately fits the data, as indicated by the Hosmer-Lemeshow chi-square test and corresponding p-value (Table 3). Figure 2(a) illustrates the model's classification accuracy by highlighting the convergence of sensitivity and specificity at a specific probability cutoff value. The multivariable model achieved a classification accuracy of 81.28%. The model's robustness was evidenced by a 77.49% area under the ROC curve (95% CI: 76.30%–78.67%, Asymptotic p-value: <0.001) (Table 3 and Figure 2(b)). The model exhibits satisfactory calibration, and the hypothesis of a well-calibrated model is not rejected, as indicated by the calibration belt plot and test result, which yielded a p-value of 0.102 (Table 3 and Figure 2(c)).

**5 Discussions:**

According to this study, the worldwide ECE participation rate was 19.39%, with 61.7% of children in Latin America and the Caribbean taking part, while the sub-Saharan African participation rate was only 17.9%. According to a study conducted in Ghana, 68.67% of the children surveyed were currently enrolled in early childhood education [36, 37]. According to World Bank research, more than 55% of Bangladeshi students fail to reach the required competency level by the end of primary 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. According to this study, children between the ages of 48 and 59 months are more likely than those between the ages of 36 and 47 months to participate in early ECE programs. Our results corroborate previous research identifying a critical developmental phase between ages 3 and 4, during which children begin to establish enduring adult behavior patterns [35,39]. The Barcelona Objectives recognized early childhood education and care as a means of enhancing human skills and aimed to turn Europe's economy into a competitive, knowledge-driven organization. They established targets for childcare enrollment: 33% for children under three and 90% for those over three, aiming for near-universal coverage [40].

Participation rates are differentiated across rural and urban regions, with early childhood education programs being more likely to be enrolled in by children in urban areas than those in rural ones. This discrepancy is due to variables including restricted access to educational resources, a deficiency of teachers, and additional problems in rural regions [41]. Enrollment in ECE is greater in urban regions compared to rural ones, reflecting inequalities between rural and urban areas in Ghana [36]. This discovery underscores the necessity to enhance ECE in rural regions, akin to our own conclusions. Our study revealed that enrollment in ECE programs was greater in the Dhaka, Mymensingh, Rangpur, and Sylhet divisions than in the Barisal division. Other studies have demonstrated similar findings; for example, one in Bangladesh found that children from the Mymensingh division are more likely than those from other divisions to participate in early childhood education programs [35,42]. Higher expectations for children in early childhood education are created by a distinctive amalgamation of parenting styles and cultural values [43].

According to our study, children of younger mothers are more likely to participate in early childhood education programs, and maternal education significantly affects this engagement. 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 conducted in the slums of Nairobi revealed a significant correlation between a mother’s age and education and a child’s nutritional status [45]. A separate study utilizing data from the Brazilian Demographic and Health Survey indicated that maternal education influences child height [46]. As a mother's education level increases, the likelihood of her enrolling her child in an early childhood education program also increases.

This study also found that the children from those households that had 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 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 children who were wasted were more likely to participate in ECE programs, possibly because these children may appear taller despite having a lower weight [53]. Thus, their parents think that their child may be big enough to start attending school.

**6 Strengths and limitations**:

This study is the inaugural analysis of the latest MICS data to evaluate the influence of socio-economic and health determinants on early childhood education participation among Bangladeshi children. We employed an extensive, national dataset and implemented suitable data analysis techniques that consider intricate survey designs. Nevertheless, the study possesses multiple drawbacks. It depends on secondary data, which constrains control over variables, data quality, and measurement metrics. The cross-sectional nature of the study indicates that the findings are correlational rather than causative, and such studies are incapable of estimating risk or determining incidence. Moreover, secondary data may encompass inaccuracies from the initial data collection, thus leading to discrepancies in the results. Self-reported data may be prone to social desirability bias or recall bias, and we were unable to evaluate attributes like awareness, cultural influences, migrant status, or community support. Notwithstanding these constraints, the study offers significant insights for forthcoming policies and actions in Bangladesh and analogous settings.

**7 Recommendations:**

We propose several strategies to enhance participation in ECE in Bangladesh. Initially, customized interventions must be formulated to tackle the specific context of rural regions, where early childhood education participation rates are relatively diminished, while also addressing obstacles such as restricted access to resources and a deficiency of qualified educators. Maternal education must be improved in rural and economically disadvantaged regions to increase women's knowledge of the significance of ECE programs. Initiatives that advocate the significance of books and early literacy in the home environment should be promoted, since our research indicated that children in book-rich households were more inclined to participate in ECE. Underweight and stunted children exhibited reduced attendance in early childhood education, thereby emphasizing the significance of health programs centered on nutrition. Educating about the connection between child nutrition and academic achievement might enhance early childhood education participation in low-income communities. Lastly, further research into geographically diverse, culturally impacted, and community-specific factors can successfully direct the development of national policy to ensure that all children have equitable access to high-quality early childhood education.

**8 Conclusions:**

The analysis indicates that age, mother education, family environment, and nutritional status are critical determinants affecting early ECE participation. Older children, those with more educated mothers, and those in book-laden households are more inclined to engage in early childhood education. Moreover, children that are neither underweight nor stunted exhibit elevated involvement rates. Nonetheless, Bengali ethnicity seems to correlate with reduced likelihood of ECE participation. These findings underscore the necessity of focused initiatives to rectify inequities in early childhood education 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 this analysis are publicly available upon request. More information about the MICS program and access to the survey datasets can be obtained at <https://mics.unicef.org/>.

**Competing interests**

The authors declare that they have no conflicts of interest.

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**References:**

[1] R. Strietholt, N. Hogrebe, H.D. Zachrisson, Do increases in national-level preschool enrollment increase student achievement? Evidence from international assessments, Int J Educ Dev 79 (2020) 102287. https://doi.org/10.1016/J.IJEDUDEV.2020.102287.

[2] A. Ansari, R.C. Pianta, J. V. Whittaker, V.E. Vitiello, E.A. Ruzek, Starting Early: The Benefits of Attending Early Childhood Education Programs at Age 3, Am Educ Res J 56 (2019) 1495–1523. https://doi.org/10.3102/0002831218817737.

[3] A.J. Reynolds, J.A. Temple, S.R. Ou, I.A. Arteaga, B.A.B. White, School-based early childhood education and age-28 well-being: Effects by timing, dosage, and subgroups, Science (1979) 333 (2011) 360–364. https://doi.org/10.1126/SCIENCE.1203618/SUPPL\_FILE/1203618.REYNOLDS.SOM.REVISION1.PDF.

[4] F.E. Aboud, Evaluation of an early childhood parenting programme in rural Bangladesh, J Health Popul Nutr 25 (2007) 3–13.

[5] MPME, Country Report On Early Childhood Care & Education in Bangladesh, (2013) 34.

[6] UNICEF, Early childhood education - UNICEF DATA, (2023). https://data.unicef.org/topic/early-childhood-development/early-childhood-education/#data (accessed September 7, 2023).

[7] H. Yoshikawa, S.B. Kabay, The evidence base on early childhood care and education in global contexts. Background paper, UNESCO 2015 Global Monitoring Report on Education for All., Education (Chula Vista) (2015) 1–39.

[8] UNESCO, Pakistan ECCE Case Study, (2007).

[9] BBS-UNICEF, Bangladesh Multiple Indicator Cluster Survey 2006, Final Report, Bbs-Unicef 1 (2007).

[10] UNICEF, Progotir Pathey Bangladesh- Multiple Indicator Cluster Survey 2019, (2019).

[11] Progotir Pothey, Bangladesh: Multiple Indicator Cluster Survey 2012–2013: Final Report, 2015.

[12] NSW Department of Education, A Review of Research on the Effects of Early Childhood Education, (2018) 1–28.

[13] P. Sammons, K. Elliot, K. Sylva, E. Melhuish, I. Siraj-Blatchford, B. Taggart, The impact of pre-school on young children’s cognitive attainments at entry to reception, Br Educ Res J 30 (2004) 691–712. https://doi.org/10.1080/0141192042000234656.

[14] H. Alderman, J.R. Behraan, V. Lavy, R. Menon, Child health and school enrollment: A longitudinal analysis, Journal of Human Resources 36 (2001) 203–205. https://doi.org/10.2307/3069675.

[15] M. ul H. Baluch, S. Shahid, Determinants of enrollment in primary education: A case study of district Lahore, Pak Econ Soc Rev 46 (2008) 161–200.

[16] E. Gurmu, D. Etana, Socio-economic and Demographic Determinants of Children’s Primary School Enrolment in Ethiopia, East Afr Soc Sci Res Rev 29 (2013) 1–30. https://doi.org/10.1353/eas.2013.0004.

[17] J.P. Greenberg, The impact of maternal education on children’s enrollment in early childhood education and care, Child Youth Serv Rev 33 (2011) 1049–1057. https://doi.org/10.1016/j.childyouth.2011.01.016.

[18] K. Magnuson, J. Waldfogel, Trends in Income-Related Gaps in Enrollment in Early Childhood Education: 1968 to 2013, AERA Open 2 (2016) 1–13. https://doi.org/10.1177/2332858416648933.

[19] C. Gakii Murungi, Children Health Needs and It’S Influence on Pre-School Education Enrolments, 1 (2012).

[20] M.I. Alam, M. Mansur, P. Barman, Early childhood development in Bangladesh and its socio-demographic determinants of importance, Early Child Dev Care 192 (2022) 1901–1920. https://doi.org/10.1080/03004430.2021.1951260.

[21] UNESCO, Pre-primary Education and the School Learning Improvement Plan in Bangladesh. Case Study, 2015.

[22] R.L. Crosnoe, C.A. Johnston, S.E. Cavanagh, Maternal education and early childhood education across affluent English-speaking countries, Int J Behav Dev 45 (2021) 226–237. https://doi.org/10.1177/0165025421995915.

[23] A.S. Bustamante, E. Dearing, H.D. Zachrisson, D.L. Vandell, Adult outcomes of sustained high-quality early child care and education: Do they vary by family income?, Child Dev 93 (2022) 502–523. https://doi.org/10.1111/cdev.13696.

[24] M. Sultana, A.R. Sarker, N. Sheikh, R. Akram, N. Ali, R.A. Mahumud, N.H. Alam, Prevalence, determinants and health care-seeking behavior of childhood acute respiratory tract infections in Bangladesh, PLoS One 14 (2019) e0210433. https://doi.org/10.1371/JOURNAL.PONE.0210433.

[25] H.A. Begum, R. Perveen, E. Chakma, L. Dewan, R.S. Afroze, D. Tangen, The challenges of geographical inclusive education in rural Bangladesh, International Journal of Inclusive Education 23 (2019) 7–22. https://doi.org/10.1080/13603116.2018.1514729.

[26] Progotir Pathey, Bangladesh multiple indicator cluster survey 2019 Key findings, (2019).

[27] WHO, Child growth standards, (2022). https://www.who.int/tools/child-growth-standards (accessed October 22, 2022).

[28] M. Nayeem Hasan, M.I. Abdul Baker Chowdhury, J. Jahan, S. Jahan, N.U. Ahmed ID, M. Jamal Uddin, Cesarean delivery and early childhood diseases in Bangladesh: An analysis of Demographic and Health Survey (BDHS) and Multiple Indicator Cluster Survey (MICS), (2020). https://doi.org/10.1371/journal.pone.0242864.

[29] J.A. Cook, A. Rajbhandari, Heckroccurve: ROC curves for selected samples, Stata Journal 18 (2018) 174–183. https://doi.org/10.1177/1536867X1801800110.

[30] M.N. Hasan, S. Tambuly, K.F. Trisha, M.A. Haque, M.A.B. Chowdhury, M.J. Uddin, Knowledge of HIV/AIDS among married women in Bangladesh: analysis of three consecutive multiple indicator cluster surveys (MICS), AIDS Res Ther 19 (2022) 1–10. https://doi.org/10.1186/S12981-022-00495-8/TABLES/3.

[31] M.W. Fagerland, D.W. Hosmer, A generalized Hosmer-Lemeshow goodness-of-fit test for multinomial logistic regression models, Stata Journal 12 (2012) 447–453. https://doi.org/10.1177/1536867X1201200307.

[32] G. Nattino, S. Lemeshow, G. Phillips, S. Finazzi, G. Bertolini, Assessing the calibration of dichotomous outcome models with the calibration belt, Stata J 17 (2017) 1003–1014.

[33] Stata, Survey Data Analysis in Stata, (2022). https://stats.oarc.ucla.edu/stata/seminars/svy-stata-8/ (accessed November 9, 2022).

[34] K. Parang, L.I. Wiebe, E.E. Knaus, Novel Approaches for Designing 5 ’ -O -Ester Prodrugs of 3 ’ -Azido- 2 ’, 3 ’ -dideoxythymidine ( AZT ), (2000) 995–1039.

[35] M.N. Hasan, M.R. Babu, M.A.B. Chowdhury, M.M. Rahman, N. Hasan, R. Kabir, M.J. Uddin, Early childhood developmental status and its associated factors in Bangladesh: a comparison of two consecutive nationally representative surveys, BMC Public Health 23 (2023) 1–13. https://doi.org/10.1186/S12889-023-15617-8/TABLES/4.

[36] M.W. Agyekum, S.B. Yeboah, C. Dzradosi, K. Ofosu-Ampong, M.O. Quaye, C. Donkoh, A. Acquah, C.K. Dzikunu, E. Pajibo, D. Yelkpieri, E.M.J. Tamanja, E.A. Nsoh, Rural-urban differentials in early childhood education and child development: Evidence from Multiple Indicator Cluster Survey (MICS) in Ghana, PLOS Global Public Health 3 (2023) e0002171. https://doi.org/10.1371/JOURNAL.PGPH.0002171.

[37] D.C. McCoy, C. Salhi, H. Yoshikawa, M. Black, P. Britto, G. Fink, Home- and center-based learning opportunities for preschoolers in low- and middle-income countries, Child Youth Serv Rev 88 (2018) 44–56. https://doi.org/10.1016/J.CHILDYOUTH.2018.02.021.

[38] World Bank, Bangladesh - Learning Poverty Brief, (2019).

[39] S. Chen, S. Wolf, Measuring the Quality of Early Childhood Education in Low- and Middle-Income Countries, Front Psychol 12 (2021) 774740. https://doi.org/10.3389/FPSYG.2021.774740/BIBTEX.

[40] P.O. of the E. Union, Barcelona objectives : the development of childcare facilities for young children in Europe with a view to sustainable and inclusive growth., (2013). https://doi.org/10.2838/43161.

[41] N. Kamal, S. Curtis, M.S. Hasan, K. Jamil, Trends in equity in use of maternal health services in urban and rural Bangladesh, Int J Equity Health 15 (2016) 1–11. https://doi.org/10.1186/s12939-016-0311-2.

[42] Md.T. Ahmed, S.A. Zubayer, What determines the accessibility of early childhood education in Bangladesh?, Discover Education 2024 3:1 3 (2024) 1–16. https://doi.org/10.1007/S44217-024-00278-5.

[43] M.J. Alam, Influence of Play-based Learning in Early Childhood Education (ECE) in Bangladesh: Lessons from Japan, Asia-Pacific Journal of Research in Early Childhood Education 16 (2022) 203–229. https://doi.org/10.17206/APJRECE.2022.16.2.203.

[44] Y. Chen, H. Li, Mother’s education and child health: Is there a nurturing effect?, J Health Econ 28 (2009) 413–426. https://doi.org/10.1016/j.jhealeco.2008.10.005.

[45] B.A. Abuya, J. Ciera, E. Kimani-Murage, Effect of mother’s education on child’s nutritional status in the slums of Nairobi, BMC Pediatr 12 (2012) 80. https://doi.org/10.1186/1471-2431-12-80.

[46] D. Thomas, J. Strauss, M. Henriques, J. Strauss, M. Henriques, Board of Regents of the University of Wisconsin System How Does Mother ’ s Education Affect Child Height ?, 26 (2016) 183–211.

[47] L. Weng, Z. Wu, W. Xiao, Research in the use of picture books in educational activities in five domains of early childhood education, in: ACM International Conference Proceeding Series, 2021. https://doi.org/10.1145/3456887.3456935.

[48] GDHS, Ghana demographic health survey, 2014.

[49] E. Acquah, E.K.M. Darteh, H. Amu, D.K.A. Adjei, Predictors of underweight in children under-five years in Ghana, 53 (2019) 71–78.

[50] T. Millennium, D. Goals, The Millennium Development Goals Report, (2010).

[51] N. Selomon Tibebu, T. Dessie Emiru, C. Marew Tiruneh, B. Dessie Getu, K. Amogne Azanaw, A Community-Based Cross-Sectional Study, Ped Health (2020). https://doi.org/10.2147/PHMT.S288071.

[52] T.R. Chowdhury, S. Chakrabarty, M. Rakib, S. Winn, J. Bennie, Risk factors for child stunting in Bangladesh: an analysis using MICS 2019 data, Archives of Public Health 80 (2022). https://doi.org/10.1186/S13690-022-00870-X.

[53] T.M. Toma, K.T. Andargie, R.A. Alula, B.M. Kebede, M.M. Gujo, Factors associated with wasting and stunting among children aged 06–59 months in South Ari District, Southern Ethiopia: a community-based cross-sectional study, BMC Nutr 9 (2023). https://doi.org/10.1186/S40795-023-00683-3.

[54] T.S. Mwamwenda, Early Childhood Education in Africa, 5 (2014) 1403–1412. https://doi.org/10.5901/mjss.2014.v5n20p1403.

**Tables and Figures**

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

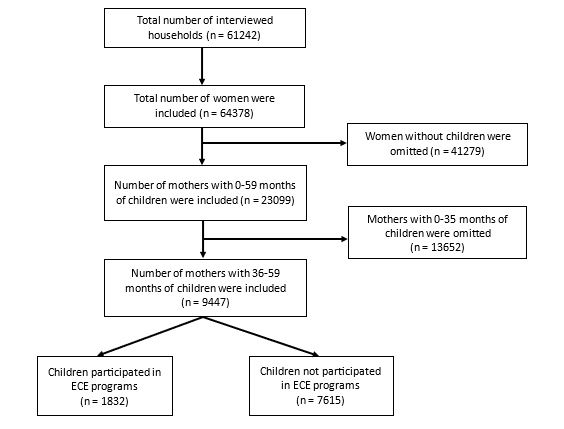
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Programs participation** | | | **p-value** |
| **Yes**  **n (%)** | **No**  **n (%)** | **Total**  **n (%)** |
| ***Socio-economic factors*** |  |  |  |  |
| **Age of child**  **(in months)** |  |  |  |  |
| 36-47 | 288 (5.98) | 4527 (94.02) | 4815 (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 | 1.63 (1.10-2.42) | 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** |