**Early childhood developmental status and its associated factors in Bangladesh: a comparison of two consecutive nationally representative surveys**

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**Abstract**

Inadequate cognitive and socio development in children results in physical and mental illness. We aimed to examine the status of early childhood development (ECD) and its associated factors using two multiple indicator cluster surveys (MICS) in Bangladesh. We used data from the MICS 2012 and 2019 surveys, which were both nationally representative. This study included 17494 children aged 36–59 months [8148 in 2012 and 9346 in 2019]. The outcome variable was ECD status: either developmentally on-track or not. To assess the ECD status and its associated factors, we used bivariable analysis, crude, and adjusted multivariable logistic models. Comparing both MICS surveys, the overall and individual domains of ECD status improved from 2012 (65.46%) to 2019 (74.86%), and the indicators of child literacy-numeracy improved from 21.2% to 28.8%, physical improved from 92.2% to 98.4%, and social-emotional improved from 68.4% to 72.7%. There was an upward trend in the learning approach from 87.5% to 91.4%. According to adjusted logistic model in both surveys (2012 and 2019), the age of 4 years had an AOR of 1.61 and 1.78 times higher developmentally on track than the age of 3. Female children (AOR) were 1.42 and 1.44 times more likely to be developmentally on track than males. Children growing up with secondary or higher-educated mothers (AOR) were 1.77 and 1.50 times more likely to be on track. Children from rich families (AOR) were 1.32 and 1.26 times more likely to be on track. Families with books had a better chance of being developmentally on track than their counterparts (AOR) at 1.50 and 1.53 times higher. Our study shows that the overall ECD status improved from MICS 2012 to MICS 2019. Several important factors, such as early childhood education programs, families' having children's books, mothers' educational level, and wealth index, were having a substantial impact on ECD status. Our study findings will assist public health initiatives in Bangladesh to improve ECD.

**Keywords:** ECD, child literacy-numeracy, physical, social-emotional, approaches to learning, multiple indicator cluster surveys (MICS), Bangladesh.

**Introduction**

A child's cognitive development, social, and emotional characteristics are all influenced by their formative years [1]. ECD relates to a child's physical, cognitive, socio-emotional, and growth in motor skills during a child’s formative periods of life [2]. From the prenatal period through infancy and childhood, a child's quickly expanding brain is incredibly prolific and proactive [3]. This period is the golden period for them to make themselves highly thirsty for learning and physically fit to become a successful and productive person in later life [4]. Within five years of birth, children begin to learn about the world around them, and this evolution is linked to the development of physical, verbal, perceptual, and psychological changes [5]. This allows them to stay focused, understand and follow directions, communicate with others, and solve increasingly complex problems [1].

According to world bank press news in March 2021, more than 40% of children below primary-school age, need childcare but don’t have access. Between 2010 and 2016, 25.3% of children in 63 low and middle-income countries (LMICs) had a developmental deficit, with 10.1% in Europe and Central Asia, 32.6% in South Asia, 17.0% in East Asia and Pacific, and 41.4% in West and Central Africa experiencing developmental delays [6]. For Sub-Saharan Africa (SSA), the median prevalence of cognitive 16.1% was not on track and 28.6% of the social-emotional domain was not developmentally on track [7]. For Bangladesh based on multiple indicator cluster surveys (MICS) 2013, 70% of the children were developmentally on track [8], and for Bangladesh MICS 2019, 25.26% of the children were not developmentally on track with ECDI [9].

ECD has become increasingly popular around the world since the turn of the twenty-first century. Population-based measures, according to developed countries, may help measure ECD and predict later life wellness [1]. Yet, despite the practical importance of the ECD, population-based estimates have not been readily available in LMICs countries [10].

According to Rana et al., (2022), household air pollution from solid fuel use is linked to ECD [11]. Alam et al., (2021) investigate the current ECD status of Bangladeshi young children aged 3–4 years and how it relates to various sociodemographic and familial aspects [9]. Increased parental stimulation involvement is expected to benefit ECD in LMICs [12]. In 63 low-and middle-income countries, Gil et al., (2020)looked at the prevalence and inequality of putative delays in child development [6]. Kang et al., (2018) provided findings from a study that looked at the links among undernutrition and indices of learning/cognition and social–emotional development in South Asian children aged 36 to 59 months. In South Asia, stunted children become less developmentally on track in the learning and cognitive domains [13]. Islam et al., (2021) investigated the relationship between developmental status and a variety of socio-demographic and environmental factors that could influence children's development [14].

The Lancet 2016 child development series concluded, using data from UNICEF and the World Bank, that 43 percent of children under five fail to achieve their developmental potential each year, and children living in LMIC countries are at risk of suboptimal development due to poverty, stunting, microbial shortages, contagious diseases, environmental exposure, and psychological issues [15, 16]. In Bangladesh, government and non-government organizations are working with many developmental facilities for children, child parents, and child caretakers to ensure all kinds of rights they deserve [17]. Creating an innovative foundation for strong development during the early years of life is essential for thriving communities, economic productivity, and civil societies. But most parents in Bangladesh are unaware of this scientific fact, which forms the core of ECD. UNICEF continues to promote the idea of ECD, show how policies work, strengthen networks and partnerships, and offer technical support and assistance[18] to people who are not aware of it. However, empirical research on overall ECD status and the comparison of different survey data is lacking. As a result, we sought to determine whether the ECD status and its associated factors changed in two consecutive Multiple Indicator Cluster Surveys (MICS) in Bangladesh.

**Material and methods**

We followed the STROBE guideline for better observational cross-sectional study reporting in epidemiology.

**Data source**

We used two consecutive data from the Multiple Indicator Cluster Survey (MICS) conducted in 2012, and 2019. UNICEF administers MICS, a large, multidimensional, nationally representative household survey. This survey uses standardized questionnaires to provide the information and key indicators about children. This survey is primarily focused on the health of reproductive women, maternity and child health interventions, child nutrition’s, and early childhood development. MICS also collects an identical set of socioeconomic characteristics of individuals and households [19, 20]. Datasets were open access for the public domain [21].

**Sampling design and sample size**

MICS survey is a double-stage cluster sampling procedure, randomly selecting households with children under five years. The 2012 MICS survey contained a sample of 51,895 households with a 98.5 percent response rate, while the 2019 MICS is based on a sample of 61,246 households with a 99.4 percent response rate. MICS provides a comprehensive picture of children’s and women’s health for the seven administrative divisions (Dhaka, Chittagong, Sylhet, Rajshahi, Rangpur, Barisal, and Khulna) of Bangladesh. Districts were identified as the primary sample strata for sample selection at stages two [19, 20]. In this study, the child age ranged from 36 through 59 months were selected. Therefore, this study included 17494 children, where 8148 were in 2012 MICS and 9346 children in 2019 MICS having the information about the ECD and used in the analysis (see Fig. 1).

**Outcome variables**

The Early Childhood Development Index (ECDI), developed by UNICEF, made a significant contribution. UNICEF's ECDI was launched for the first time in 2009 during the fourth round of MICS (2012 MICS) and is now available in the following survey. The ECDI took shape when UNICEF, in collaboration with countries and partners, created measures to assess child's home environment and access to early childhood care and education (ECCE). It contains ten dichotomous (yes/no) items in the categories of literacy-numeracy (3 items), physical (2 items), social-emotional (3 items), and learning techniques (2 items) were four early developmental domains. The MICS includes questions from the ECD module for children under the age of five and is aimed at mothers (or caregivers) of children aged three and four [10].

For creating our outcome variable (ECD status), we gave each child a score of 1 depending on the number of items to which the mother said yes, and a score of 0 otherwise. The ECDI variable was then constructed and used as the outcome variable based on the sum of these scores. This had a possible range of 0 to 4, with at least three of these four domains or scores greater than or equal to three indicating that the child was developmentally ‘on track.' The rest scores were treated as if they were developmentally ‘on delay’ [19, 20].

**Possible factors**

For identifying the possible factors associated with ECD status, a set of independent factors such as child’s age, sex, place of residence (urban vs rural), geographical location (division), educational level of mothers (secondary complete or higher, secondary incomplete, primary complete, and primary incomplete), wealth index (richest, middle, and poorest) [22], religion (Islam and others), household head’s sex, household head’s ethnicity (Bengali and others), mother’s age, early childhood diseases, nutritional status (underweight, stunting, wasting, and overweight), early childhood educational program, mother stimulation, father stimulation, other stimulation, salt iodization, books, toys, sanitation facility (unimproved and improved) [23], access of media (television, newspaper or radio), and child punishment was used.

Some additional explanations for some variables are as follows: the WHO recommends using three anthropometric indices to assess a child's nutritional status: height-for-age z-score (HAZ), weight-for-age z-score (WAZ), and weight-for-height z-score (WHZ) [2]. If the WHZ, HAZ, or WAZ was less than -2, the child was classified as wasted, stunted, or underweight. A child was considered overweight if his or her WHZ was greater than +2 [24]. Early childhood diseases were categorized into “yes” if the mother’s (or caretaker’s) of the child reported that the child had such symptoms (diarrhoea, symptoms of acute respiratory infection or fever), otherwise “no”. To measure stimulation in this study, the involvement of adults in the household with children in the following activities: reading books or looking at picture books with children, telling stories, singing songs, taking children outside the home, compound, or yard, playing with children, and spending time with children naming, counting, or drawing objects [19, 20]. We categorized “yes” if (fathers/mothers/others) have participated in any one activity with their children, otherwise “no”. Inadequate supervision is defined as a child under the age of five who has been left alone or under the supervision of another child under the age of ten for more than one hour at least once in the previous week [19, 20]. Salt iodization was categorised into “yes” if the iodine level was between 0 and 15 ppm or above 15 ppm and “no” if the iodine level was 0 ppm or no salt in the house [19, 20]. If a child aged 1 to 14 years had subjected to physical or psychological abuse by caregivers in the previous month, he or she was considered to subjected to child punishment [19, 20].

**Statistical Analysis**

To assess the relationship between ECD status and other factors, first, a bivariable analysis was used. The univariable multi-level [unadjusted] and multivariable multi-level [adjusted] logistic regression models were fitted separately for the 2012 and 2019 MICS survey data. In univariable analyses, one variable added at a time in the multi-level logistic regression model (Table S1) and for the adjusted model, all possible variables added together in the model (Table 3). To account for the complex survey design, we utilized the Svyset tool in Stata (StataCorp LP, College Station, Texas). We employed survey weight in all analysis by design features like the primary sampling unit (PSU), stratum, cluster, and sample weight with the Svyset command [25].

**Variable Selection**

Variables were selected in two stages. In the first stage, bivariable analysis (chi-square test) was conducted separately for each of the 26 variables. In total, 18 (MICS 2012) and 14 (MICS 2019) variables were selected by using 5% level of significance for adjusted logistic regression model (Table 3). With the selected predictor variables in second stage, a comprehensive multivariable model was created. With a cut-off value of 4.00, we also used the variance inflation factor (VIF) value to analyse multicollinearity in the final model [26]. All variables were included in the model in this stage because the VIF values of each variable were less than 4.00.

**Model Performance**

The Area under the Receiver Operating Characteristic (AUROC), the indicators of sensitivity, specificity to evaluate the accuracy of best model. The higher ROC areas indicated a better performance of the models. In ROC curve, lower P-value conclude that the model actually does discriminate between two categories and area under curve is higher than the 0.50 [27]. The intraclass correlation coefficient (ICC), cluster level variance with standard error, Akaike information criterion (AIC), Bayesian information criterion (BIC), and Log-likelihood were used to report the variation of ECD status at the community level and to test the models.

**Ethics Statements**

This freely available secondary data analysis was exempt from ethics assessment because no study on human subjects was done as part of this project.

**Results**

**Socio-demographic Characteristics**

The prevalence of developmentally on track children increased from 65.46% in 2012 to 74.86% in 2019, and the change is significant in proportional test (p<0.001) (see Fig. 2). For both surveys, the represented sample of age 3 was 4041 (49.59%) in MICS 2012 and 4750 (50.82%) in MICS 2019 and age 4 were 4107 (50.41%) in MICS 2012 and 4596 (49.18%) in MICS 2019. 4234 (51.96%) in MICS 2012 and 4823 (51.60%) in MICS 2019 of the respondent children were male and 3914 (48.04%) in MICS 2012 and 4523 (48.40%) in MICS 2019 of the respondent children were female. Based on residence status, 6855 (84.13%) in MICS 2012 and 7611 (81.44%) in MICS 2019 of the respondents were from rural and 1293 (15.87%) in MICS 2012 and 1735 (18.56%) in MICS 2019 of the respondent children were from urban. The distribution of developmentally on track status of 3 years old children was 59.46% according to 2012 MICS whereas it is increased to 68.72% in 2019 MICS and children of 4 years old were 71.40% on track in 2012 MICS whereas that increased to 81.26% in 2019 MICS. By the sex of the child, the female child was always more developmentally on track than the male child. In 2012 MICS, male child developmentally on track status was 63.41% and 67.65% for female. Similarly, in 2019 MICS, developmentally on track status for male and female children was 71.51% and 78.46%. The children from rural were 72.17% in 2012 MICS and 78.15% in 2019 MICS, who were more developmentally on track than the urban 63.72% in 2012 MICS and 73.99% in 2019 MICS childrenTable.2.

The comparison of ECD on-track status for indicated domains between the years 2012 and 2019 was assessed (see Table 1). The prevalence of this status has increased for each of the domains. The highest increase rate in ECD on track status (21.2% to 28.8%) was found in the literacy-numeracy domain. The lowest rate of increase in ECD on track status (68.4% to 72.7%) was found in the social-emotional domain.

The Overall ECD status by their socio-demographic and child characteristics for 2012 MICS and 2019 MICS surveys were shown in Table 2. The distribution of developmentally on track status of child bought in the family of the highly educated mother (Secondary complete or Higher) was 79.46% according to 2012 MICS. In contrast, it increased to 81.27% in 2019 MICS. A child bought by primary incomplete mother was lowest (58.80%) on track status in 2012 MICS whereas that increased to 68.53% in 2019 MICS still lower than other education group. By the wealth index of the child family, the richest family’s child was always more developmentally on track than middle or poorest family’s child. In 2012 MICS, richest family’s child developmentally on track status was 77.55% and 60.36% for poorest.

Similarly, in 2019 MICS, 84.05% and 69.48% were the developmentally on track status for respectively richest and poorest. The children who were not underweight and not stunned are 68.11% and 70.83% in 2012 MICS were more developmentally on track than the children with underweight and stunned, respectively. The children who were not underweight and not stunned are 75.97% and 76.79% in 2019 MICS were more developmentally on track than the children with underweight and stunned. The distribution of developmentally on track status of a child who attends early childhood programs was 78.93% according to 2012 MICS. In contrast, it increased to 85.99% in 2019 MICS, and a child bought in the family where books for children were present had 72.13% on track status in 2012 MICS whereas that increased to 80.65% in 2019 MICS, and child bought in the family where they punishment was 49.01% on track status in 2012 MICS whereas that increased to 64.80% in 2019 MICS.

The bivariable and multivariable logistic regression model results refer to the degree of relationship between early childhood development status and children’s socio-demographic profiles in **Table 3.** To show associations between early childhood developmentally on track status and child age, child sex, geographic location, division, education of mother, household’s wealth index, religion, sex of household head, ethnicity, mother’s age early childhood diseases, underweight, stunned, wasted, overweight, sanitation, early childhood programs, mother stimulation, father stimulation, other stimulation, inadequate supervision, salt iodization, books, toys, mass media and child punishment. The univariate logistic model indicates the individual associated with the ECD status. Nine variables showed a significant association at the 5% level of significance among all predictor variables (child age, child sex, division, mothers education, early childhood program, other stimulation, books, toys and child punishment) in 2012 MICS and 11 variables showed significant association at 5% level of significance (child age, child sex, division, mothers education, wealth index, early childhood program, father stimulation, other stimulation, inadequate supervision, books and child punishment) in 2019 MICS data.

The multivariable result from 2012 and 2019 MICS data, child of age 4 had 62% (2012 MICS OR: 1.61, 95% CI: 1.39-1.87) and 78% (2019 MICS OR: 1.78, 95% CI: 1.58-2.00] higher chance of being developmentally on track than the age of 3. According to child sex, when all other variables were adjusted, the female child had 1.42 times higher chance (2012 MICS OR: 1.42, 95% CI: 1.23-1.64) and 1.44 times (2019 MICS OR: 1.44, 95% CI: 1.28-1.61) higher chance of being in developmentally on track status than the male child respectively in both datasets. By comparing both model the odds ratio of division gives different results in some categories, however, Rajshahi [(2012 MICS OR: 0.87, 95% CI: 0.64-1.17) and (2019 MICS OR: 0.98, 95% CI: 0.78-1.24)] and Sylhet [(2012 MICS OR: 0.62, 95% CI: 0.46-0.85) and (2019 MICS OR: 0.83, 95% CI: 0.65-1.07)] had lower chance of early childhood development than Barisal. In Both surveys, Rangpur had a higher chance [(2012 MICS OR: 1.87, 95% CI: 1.41-2.48) and (2019 MICS OR: 2.72, 95% CI: 2.17-3.42)] of developmentally on track than the Barisal. In both multivariable models, children bought by secondary complete or higher educated mothers had a 77% higher chance (2012 MICS OR: 1.77, 95% CI: 1.29-2.44) and 50% higher chance (2019 MICS OR: 1.50, 95% CI: 1.16-1.93) to be developmentally on track compared to primary incomplete or uneducated mothers. In both surveys, the child growing in rich families were found with higher chance [OR: 1.32, 95% CI: 0.98-1.78] in MICS 2012 and [OR: 1.26, 95% CI: 1.08-1.48] in MICS 2019 of being developmentally on track than the low-income family. Early childhood education programs play a positive role in early childhood development. In both surveys, the child who attended an early childhood education program were found to have higher chance [OR: 1.45, 95% CI: 1.14-1.83 in MICS 2012] and [OR: 1.58, 95% CI: 1.32-1.89 in MICS 2019] of being developmentally on track than the children who did not attend in early childhood education program..

Similarly, children who receive father and other stimulation have significantly different ECD status. Children with father and additional stimulation had a higher chance of being developmentally on track.

Supervision also plays a crucial role in ECD; compared with inadequate supervision, children raised with adequate supervision were found to have a higher chance of being developmentally on track in both surveys, but the 2012 MICS survey result was not significant. For example, children raised with adequate supervision had a 29% higher chance of developmentally on track. There was a substantial increase in ECD on track status among the children with books and toys. Similarly, access to mass media by a child's mother or caretaker has a major impact on early childhood development.

The intraclass correlation coefficient (ICC) revealed that 10.05% and 7.70% in 2012 and 2019, respectively of the variation of child ECD status could be attributed to the difference in the composition of the communities. This also implies that by adding the regional characteristics enhanced the model's capacity to explain differences in childhood ECD status between regions in MICS-2012 than MICS-2019. The table further show the model fit statistics. The lower AIC, BIC, and Log-likelihood values indicate a better fit model. In MICS-2012, the AIC estimates showed lower value (6828.166) than the MICS-2019 (9432.097). Similar result also found in BIC (7014.218 Vs 9616.643) in both surveys (Table 4). In our study, the value of AUROC curve was greater in the MICS-2019, which is 0.6818 (95% CI: 0.6695 - .6941). In MICS-2012, the value of AUROC curve 0.6710 (95% CI: 0.6564 - 0.6857). So, without any doubt, the Multilevel model is the better fitted for both surveys (Table S2).

**Discussion**

We investigated the prevalence of ECD and its associated factors in Bangladeshi children. We discovered that a large proportion of children (74.86%) were developing normally. This percentage was lower in Pakistan (Balochistan) and higher in Vietnam [28]. Furthermore, this ratio fluctuates between low- and middle-income nations, with the mean rate of children aged 36–59 months on track for development ranging from 426% in Sierra Leone to 859% in Belize [28]. We also observed substantial impact of child age, child sex, residence, division, mother’s education, and wealth index on the ECD status.

In this study, the boy’s ECD on track status was low compared to girls and correspondingly had a higher chance of developmental delay. These findings were consistent with other cohort studies in Western Cape, South Africa, where they explored developmental performance by cognitive, language, and fine motor in very young children [29]. Using two indicators, statistically significant gender differences among children with developmental delays in two or more nations were discovered. Gender inequality in "learning support" was inconsistent (higher disadvantage among boys in Vietnam and girls in Nepal). In Bangladesh, Pakistan, and Vietnam, boys with developmental delays had a significantly higher prevalence of "aggression" against others [30].

When compared to their poorer counterparts, children from the wealthiest families had a better probability of overall development. Because early childhood programs may increase existing developmental inequities if participation in promoted activities was higher in upper socioeconomic groups, which already have comparably better growth and development [31]. Evidence suggests that deprivation and adversity had a graded effect throughout the socioeconomic spectrum. Even children from the second-highest social class had inferior health and development than children from the highest socioeconomic status homes [32]. In five of the six countries, children with developmental delays were more likely than their peers to live in poverty. In three countries, the differences were statistically significant (Bangladesh, Laos, and Vietnam). Vietnam had the highest relative disadvantage rates, with children with developmental delays being 2.2 times more likely to be poor [30]. Poverty and traumatic childhood experiences affect brain development and cognition in long-term physiological and epigenetic ways [33].

According to our study, lack of nutrition for children had a high risk of developmental delays. Children who were malnourished or who were regularly ill were more likely to suffer developmental issues, highlighting the importance of implementing coordinated early childhood development programs in partnership with the health and nutrition sectors [34].

Early childhood programs were an important source of support for young children's mental and physical development [35]. Children who attended an early childhood education program were much more developmentally on track than their peers, according to our research.

Adequate supervision, stimulation, having books and toys in household showed positive result on ECD on track status. Nurturing care had been linked to children's health, growth, and development around the world, and neuroscientific data suggests that nurturing care during early childhood mitigates the negative impacts of poor socioeconomic position on brain development [36].

In our study, mass media access of the household or caregivers could increase the chance of early childhood developmentally on track status. Early childhood development programming for both children and parents could be accessed more easily at home via television and other media [34]. Sesame Street was a children's educational television program that was broadcast in over 150 countries [37]. Nearly half of Bangladesh's 3–5-year-old children watched television on a daily basis, among them Sesame Street being seen by 83 percent of urban and 58 percent of rural pre-schoolers [38]. Sesame Street viewing provides significant improvements in reading and numeracy, health and safety, social reasoning, and attitudes toward others, according to a meta-analysis including over 10,000 youngsters from 15 countries [39].

It was found that child punishment causes a child developmental delay. Physical abuse, family instability, risky neighbourhoods, and poverty can cause children to had poor coping skills, have problems regulating emotions, and had lower social functioning than their peers [39].

**Strengths and limitations**

To our knowledge, this is the first study with Bangladeshi children based on the most recent MICS data in the context of developmental status utilizing ECDI scores. We used a sufficiently big nationally representative dataset that reflects Bangladesh's whole population. We also considered a variety of factors that influence developmental status.

Despite these advantages, our research had several flaws. We had no control over the variables we chose, the data quality, or the measurement indicators because we used secondary data. Only data on child development is available for children aged three and four. It's unknown how developmental ratings among younger children compare to those seen in 3- and 4-year-olds. To better understand children's development at the country level, more data encompassing the entire 0- to 5-year age range is required. Furthermore, the poll was done in 2012 and 2019, thus the developmental status may have changed since then.

**Recommendations**

The findings of this study should be taken into consideration by governments, international agencies, non-governmental organizations, and public health specialists who are working to improve early childhood development. Future study is needed, according to ECD, to develop more detailed and age-specific measurements that can better capture children's abilities across a variety of cultures and local situations. Beyond usual development standards, further effort is needed to understand the unique needs of children who may have more severe problems that necessitate more rigorous therapy and care. In reaction to the loss of human potential associated with early adversity, leaders from worldwide organizations have issued urgent calls for solutions to ensure that young children reach their developmental potential. Storytelling, singing, and playing with household objects are all low-cost activities that provide early development experiences for young children.

**Conclusion**

The study focused on the level and influencing factors of early childhood developmental status among children aged 3 and 4 years from rural and urban areas of Bangladesh. In Bangladesh, many children had developmentally on track came from highly educated mothers, initiatives should be taken to enlarge the mothers in higher education. Children in the poorest wealth status group of the countries are the most in need of assistance to reach their full development potential, the poorest group of Bangladesh are mostly in developmental delays. Lack of nutrition of a child interrupts the development, mothers or caregivers should be aware about that. In this study, nutritional balanced children are more developmentally on track than the poor nutritional child. The early learning setting procedures or pre-school learning could be a valuable step towards reducing the developmental delay, it also helps a child to make good results in a primary education program. To guarantee that children in Bangladesh realize their full developmental potential, a better understanding of the relationship between risk factors and early development, as well as measures to promoting parents' involvement in their children's learning, development, and health, is required. To improve the knowledge basis for what can successfully impact childhood development and schooling on health outcomes and inequities, more research is needed. This additional evidence will help public health officials address early childhood development and education as socioeconomic determinants of health.

**Declarations**

**Author Contributions**

M.N. Hasan, M R Babu, M.A.B. Chowdhury, and MJ Udinn conceptualized the study, designed the analytic approach, managed and performed the analysis, interpreted the results, and drafted the manuscript. M Rahman, N hasan and R Kabir helped with the analysis, interpreted the results, drafted the manuscript, reviewed, edited, and updated the manuscript.

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**Prior Publication:** This data has not been published previously and is not under consideration elsewhere.

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**Ethics approval.**

Our study was exempt from the ethical review approval because we used publicly available de-identified data.

**Reporting Guideline:** The study followed the Strengthening the Reporting of Observational Studies in Epidemiology ([STROBE](http://www.equator-network.org/reporting-guidelines/strobe/)) reporting guideline.

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**Tables and figures**

Total number of interviewed households were

MICS 2012: 51895 and MICS 2019: 64400

The Children under 5 years of age were selected from MICS 2012 and 2019.

N1 = 20903 and N2 = 23101

Children under 3 years of age were omitted from both the survey data.

n1 = 15282 and n2 = 15340

The children with age 36 months to 59 months were selected from both the survey

n1 = 8148 and n2 = 9346

MICS 2012 data contains with

Rural = 1293 and Urban = 6855

Male 4234 and Female 3914

MICS 2019 data contains with

Rural = 1735 and Urban = 7611

Male 4823 and Female 4523

**Fig. 1. Schematic diagram of the analytic study sample**

|  |
| --- |
|  |
| **Fig. 2.** Distribution of developmental status of children by different survey years. |

|  |  |
| --- | --- |
|  |  |
| MICS 2012 | MICS 2019 |
| Fig. 3. Area Under ROC curve of adjusted model | |



**Table 1** Comparison of the developmentally on-track status for indicated domains between two consecutive MICS survey.

|  |  |  |
| --- | --- | --- |
| Domains | 2012 MICS (%) | 2019 MICS (%) |
| Literacy-numeracy | 21.2 | 28.8 |
| Physical | 92.2 | 98.4 |
| Social-Emotional | 68.4 | 72.7 |
| Approaches to learning | 87.5 | 91.4 |

**Table 2** Comparison of the early childhood developmental status, MICS 2012 and 2019**.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Characteristics** | **MICS 2012** | |  | **MICS 2019** | |  |
| **Developmentally on track** | | **P-value** | **Developmentally on track** | | **P-value** |
| **Yes** | **No** | **Yes** | **No** |
| **N (%)** | **N (%)** | **N (%)** | **N (%)** |
| **Age of child (in years)** | | | | | | |
| 3 | 2392 (59.46) | 1649(40.54) | <0.001 | 3166 (68.72) | 1584 (31.28) | <0.001 |
| 4 | 2909 (71.40) | 1198 (28.60) | 3680 (81.26) | 916 (18.74) |
| **Child’s sex** | | | | | | |
| Male | 2669 (63.41) | 1565 (36.59) | 0.002 | 3383 (71.51) | 1440 (28.49) | <0.001 |
| Female | 2632 (67.65) | 1282 (32.35) | 3463 (78.46) | 1060 (21.54) |
| **Place of residence** | | | | | | |
| Urban | 4388(63.72) | 2467 (36.28) | <0.001 | 5541 (73.99) | 2070 (26.01) | <0.001 |
| Rural | 913 (72.17) | 380 (27.83) | 1305 (78.15) | 430 (21.85) |
| **Division** | | | | | | |
| Barishal | 526 (67.86) | 262 (32.14) | <0.001 | 552 (67.8) | 269 (32.20) | <0.001 |
| Chattogram | 940 (55.04) | 682 (44.96) | 1479 (78.26) | 470 (21.74) |
| Dhaka | 1286 (67.45) | 674 (32.55) | 1453 (81.85) | 343 (18.15) |
| Khulna | 740 (71.70) | 326 (28.30) | 895 (73.07) | 409 (26.93) |
| Mymensingh | - | - | 347 (61.26) | 209 (38.74) |
| Rajshahi | 527 (66.76) | 263 (33.24) | 720 (69.57) | 307 (30.43) |
| Rangpur | 866 (78.38) | 262 (21.62) | 896 (83.71) | 207 (16.29) |
| Sylhet | 416 (54.15) | 378 (45.85) | 504 (61.73) | 286 (38.27) |
| **Mother’s Education** | | | | | | |
| Primary incomplete | 2076 (58.80) | 1462 (41.20) | <0.001 | 847 (68.56) | 389 (31.44) | <0.001 |
| Primary complete | 772 (62.73) | 447 (37.27) | 1590 (69.38) | 727 (30.62) |
| Secondary incomplete | 1800 (70.01) | 760 (29.99) | 3363 (76.88) | 1143 (23.12) |
| Secondary complete or Higher | 653 (79.46) | 178 (20.54) | 1046 (83.11) | 241(16.89) |
| **Wealth Index** | | | | | | |
| Poorest | 2621 (60.36) | 1696 (39.64) | <0.001 | 3026 (69.84) | 1331 (30.16) | <0.001 |
| Middle | 1839 (66.06) | 886 (33.94) | 2574 (75.65) | 904 (24.35) |
| Richest | 841 (77.55) | 265 (22.45) | 1246 (84.05) | 264 (15.95) |
| **Religion** | | | | | | |
| Islam | 4486 (66.08) | 2384 (33.92) | 0.044 | 5518 (74.97) | 2025 (25.03) | 0.658 |
| Others | 534 (61.42) | 321 (38.58) | 908(74.26) | 325(25.74) |
| **Household Head’s Sex** | | | | | | |
| Male | 4411 (65.67) | 2348 (34.33) | 0.852 | 5500 (75.12) | 1996 (24.888) | 0.254 |
| Female | 609 (65.26) | 357 (34.74) | 926 (73.42) | 354 (26.58) |
| **Ethnicity of the household head** | | | | | | |
| Bengali | 4865 (65.58) | 2620 (34.42) | 0.798 | 6684 (74.89) | 2438 (25.11) | 0.474 |
| Others | 155 (66.60) | 85 (33.40) | 162 (72.70) | 62 (27.30) |
| **Mother’s Age at the Survey Time** | | | | | | |
| 15 – 19 | 190 (68.00) | 86 (32.00) | 0.010 | 1276 (77.02) | 428 (22.98) | 0.027 |
| 20-34 | 2991 (68.18) | 1444 (31.82) | 3035 (73.85) | 1148 (26.15) |
| 35+ | 883 (62.75) | 536 (37.25) | 2009 (74.83) | 751 (25.17) |
| **Early Childhood Diseases** | | | | | | |
| Yes | 1262 (64.63) | 712 (35.37) | 0.494 | 1895 (73.84) | 738 (26.16) | 0.205 |
| No | 4035 (65.72) | 2132 (34.28) | 4940 (75.24) | 1761 (24.76) |
| **Underweight** | | | | | | |
| Yes | 1660 (61.12) | 1047 (38.88) | <0.001 | 1591 (71.86) | 667 (28.14) | <0.001 |
| No | 3308 (68.11) | 1618 (31.89) | 5038 (75.97) | 1732 (24.03) |
| **Stunned** | | | | | | |
| Yes | 2037 (59.86) | 1355 (40.14) | <0.001 | 1749 (70.34) | 802 (29.66) | <0.001 |
| No | 2860 (70.83) | 1240 (29.17) | 4824 (76.79) | 1572 (23.21) |
| **Wasted** | | | | | | |
| Yes | 444 (65.59) | 239 (34.41) | 0.989 | 647 (74.34) | 238 (25.66) | 0.721 |
| No | 4516 (65.63) | 2415 (34.37) | 5905 (74.96) | 2134 (25.04) |
| **Overweight** | | | | | | |
| Yes | 407 (64.98) | 219 (35.02) | 0.832 | 395 (76.0) | 158 (24.0) | 0.544 |
| No | 4894 (65.50) | 2628 (34.50) | 6451 (74.78) | 2342 (25.22) |
| **Sanitation** | | | | | | |
| Improved | 4819 (65.17) | 2575 (34.83) | 0.348 | 6218 (74.83) | 2279 (25.17) | 0.712 |
| Unimproved | 201 (61.09) | 128 (38.91) | 207 (76.0) | 71 (24.0) |
| **Early childhood education programs** | | | | | | |
| Yes | 936 (78.93) | 246 (21.07) | <0.001 | 1498 (85.99) | 269 (14.01) | <0.001 |
| No | 4364 (63.31) | 2599 (36.69) | 5348 (72.19) | 2231 (27.81) |
| **Mother Stimulation** | | | | | | |
| Yes | 4619 (66.26) | 2422 (33.74) | 0.002 | 5696 (75.86) | 1949 (24.14) | <0.001 |
| No | 682 (60.2) | 425 (39.8) | 1150 (70.2) | 551 (29.8) |
| **Father Stimulation** | | | | | | |
| Yes | 3035 (66.49) | 1613 (33.51) | 0.078 | 3024 (73.11) | 1151 (26.89) | <0.001 |
| No | 2266 (64.02) | 1234 (35.98) | 3822 (76.29) | 1349 (23.71) |
| **Other Stimulation** | | | | | | |
| Yes | 4356 (66.5) | 2282 (33.5) | 0.003 | 3646 (74.15) | 1344 (25.85) | 0.118 |
| No | 945 (61.19) | 565 (38.81) | 3200 (75.68) | 1156 (24.32) |
| **Inadequate Supervision** | | | | | | |
| Yes | 542 (62.96) | 306 (37.04) | 0.343 | 590 (68.92) | 279 (31.08) | <0.001 |
| No | 4754 (65.74) | 2538 (34.26) | 6256 (75.41) | 2221(24.59) |
| **Salt Iodization** | | | | | | |
| Yes | 3600 (64.441) | 2075 (35.59) | 0.004 | 5172 (74.65) | 1894 (25.35) | 0.400 |
| No | 1420 (69.03) | 629 (30.97) | 1251 (75.77) | 456 (24.23) |
| **Child education Book at home** | | | | | | |
| Yes | 3325 (72.13) | 1251 (27.87) | <0.001 | 3837 (80.65) | 1017 (19.35) | <0.001 |
| No | 1976 (55.8) | 1596 (44.2) | 3008 (68.58) | 1483 (31.42) |
| **Toys** | | | | | | |
| Yes | 4084 (68.18) | 2053 (31.82) | <0.001 | 5645 (74.69) | 2081 (25.31) | 0.465 |
| No | 1217 (57.41) | 794 (42.59) | 1201 (75.67) | 419 (24.33) |
| **Mass Media** | | | | | | |
| Yes | 2038 (71.38) | 838 (28.62) | <0.001 | 3830 (74.69) | 1411 (25.31) | 0.803 |
| No | 2024 (61.88) | 1228 (38.12) | 2490 (74.95) | 916 (25.05) |
| **Child Punishment** | | | | | | |
| Yes | 137 (49.01) | 145 (50.99) | <0.001 | 321 (64.8) | 165 (35.2) | <0.001 |
| No | 5164 (66.13) | 2702 (33.87) | 6525(75.42) | 2335 (24.58) |

Frequencies were weighted using sample weight

**Table 3** Factors associated with the developmental status of children, MICS 2012 and 2019.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Characteristics** | **MICS- 2012** | | **MICS- 2019** | |
| **Multivariable** | | **Multivariable** | |
| **Adjusted**  **OR (95% CI)** | **P-value** | **Adjusted**  **OR (95% CI)** | **P-value** |
| **Age of Child** |  | |  | |
| 4 | 1.61 (1.39-1.87) | <0.001 | 1.78 (1.58-2.00) | <0.001 |
| 3 | Reference | - | Reference | - |
| **Child’s Sex** |  | |  | |
| Female | 1.42 (1.23-1.64) | <0.001 | 1.44 (1.28-1.61) | <0.001 |
| Male | Reference | - | Reference | - |
| **Place of residence** |  | |  | |
| Rural | 1.10 (0.88-1.36) | 0.409 | 0.96 (0.82-1.12) | 0.626 |
| Urban | Reference | -- | Reference | - |
| **Division** |  | |  | |
| Chattogram | 0.59 (0.45-0.76) | <0.001 | 1.55 (1.25-1.91) | <0.001 |
| Dhaka | 0.99 (0.77-1.27) | 0.924 | 1.99 (1.61-2.47) | <0.001 |
| Khulna | 1.02 (0.78-1.33) | 0.838 | 1.07 (0.86-1.32) | 0.556 |
| Mymensingh | - | - | 0.85 (0.65-1.12) | 0.242 |
| Rajshahi | 0.87 (0.64-1.17) | 0.357 | 0.98 (0.78-1.24) | 0.901 |
| Rangpur | 1.87 (1.41-2.48) | <0.001 | 2.72 (2.17-3.42) | <0.001 |
| Sylhet | 0.62 (0.46-0.85) | 0.003 | 0.83 (0.65-1.07) | 0.147 |
| Barishal | Reference |  | Reference | - |
| **Mother’s Education** |
| Secondary complete or Higher | 1.77 (1.29-2.44) | <0.001 | 1.50 (1.16-1.93) | 0.002 |
| Secondary incomplete | 1.25 (1.03-1.51) | 0.022 | 1.21 (1.01-1.45) | 0.044 |
| Primary complete | 0.97 (0.78-1.22) | 0.810 | 0.96 (0.80-1.16) | 0.673 |
| Primary incomplete | Reference | - | Reference | - |
| **Wealth Index** |  |  |  |  |
| Richest | 1.32 (0.98-1.78) | 0.067 | 1.26 (1.08-1.48) | 0.003 |
| Middle | 1.02 (0.87-1.21) | 0.812 | 1.12 (0.96-1.31) | 0.137 |
| Poorest | Reference | - | Reference | - |
| **Mother’s Age** |  | |  | |
| 15 – 19 | 1.21 (0.82-1.78) | 0.342 | - | - |
| 20 – 34 | 1.15 (0.96-1.38) | 0.130 | - | - |
| 35+ | Reference | - | - | - |
| **Underweight** |  | |  | |
| No | 1.12 (0.93-1.35) | 0.234 | 1.02 (0.88-1.18) | 0.797 |
| Yes | Reference | - | Reference | - |
| **Stunned** |  | |  | |
| No | 1.17 (0.98-1.40) | 0.082 | 1.09 (0.95-1.25) | 0.215 |
| Yes | Reference | - | Reference | - |
| **Sanitation facility** |  | |  | |
| Unimproved | 1.09 (0.87-1.34) | 0.447 | - | - |
| Improved | Reference | - | - | - |
| **Early childhood education programs** |  | |  | |
| Yes | 1.45 (1.14-1.83) | 0.002 | 1.58 (1.32-1.89) | <0.001 |
| No | Reference | - | Reference | - |
| **Mother Stimulation** |  | |  | |
| Yes | 0.96 (0.76-1.22) | 0.745 | 1.01 (0.87-1.19) | 0.862 |
| No | Reference | - | Reference | - |
| **Father Stimulation** |  | |  | |
| Yes | - | - | 0.78 (0.69-0.87) | <0.001 |
| No | - | - | Reference | - |
| **Others Stimulation** |  | |  | |
| Yes | 1.33 (1.09-1.61) | 0.004 | - | - |
| No | Reference | - | - | - |
| **Inadequate Supervision** |  | |  | |
| No | - | - | 1.29 (1.07-1.56) | 0.009 |
| Yes | - | - | Reference | - |
| **Salt Iodization** |  | |  | |
| No | 0.99 (0.84-1.17) | 0.928 | - | - |
| Yes | Reference | - | - | - |
| **Child education Book at home** |  | |  | |
| Yes | 1.50 (1.27-1.77) | <0.001 | 1.54 (1.36-1.75) | < 0.001 |
| No | Reference | -- | Reference | - |
| **Toys** |  | |  | |
| Yes | 1.54 (1.29-1.85) | <0.001 | - | - |
| No | Reference | -- | - | -- |
| **Mass Media** |  | |  | |
| Yes | 1.13 (0.95-1.34) | 0.180 | - | - |
| No | Reference | -- | - | -- |
| **Child Punishment** |  | |  | |
| Yes | 0.70 (0.49-0.99) | 0.043 | 0.64 (0.50-0.82) | <0.001 |
| No | Reference | -- | Reference | -- |

**Table 4** Goodness of fit of multivariable logistic regression model, MICS 2012 and 2019.

|  |  |  |
| --- | --- | --- |
|  | **MICS-2012** | **MICS-2019** |
| **Cluster level variance (SE)** | 0.38 (0.09) | 0.27 (0.05) |
| **ICC (%)** | 10.05 | 7.70 |
| **AIC** | 6828.166 | 9432.097 |
| **BIC** | 7014.218 | 9616.643 |
| **Log-likelihood** | -3386.083 | -4690.0483 |
| **Observations** | 5,680 | 8,937 |