Maternal Cognitive Function and Neurobehavioral Development of Underprivileged Children

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Psychology at the University of Dhaka

January 2020

Declaration

I hereby declare that this dissertation is an original report of my own research and it has not been accepted for the award of any degree or diploma in this university or in any other institution. I also confirm that this dissertation does not contain any material previously published or written by any other author, except where due reference is stated in the text.

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Certificate

We, the undersigned, hereby certify that the work incorporated in this dissertation titled "Maternal Cognitive Function and Neurobehavioral Development of Underprivileged Children" submitted by Abu Yusuf Mahmud was conducted under our supervisions. We have read the dissertation and state our full approval of this.

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Acknowledgements

I am grateful to everyone who supported and contributed to this research in various capacities.

I express my deepest gratitude to my supervisor Professor Dr. Md. Kamal Uddin for his mentorship, motivation, and continuous support. His outstanding knowledge in the world of research and unique way of responding immediately to any problem was a great learning for me. His insightful feedback helped me great to improve the quality of research.

My appreciation goes to my second supervisor Dr. Fahmida Tofail for her valuable support. Her vast knowledge over the field of child development helped me to step in the right direction. I am extremely grateful to her for providing me with the opportunity to work with the icddr,b.

I am indebted to the mothers and children to participate in the study. I am thankful to the members of Child Development Unit of icddr'b, especially Jena Hamadini, head of the unit. I acknowledge the contribution of Shamima Shiraji, Shirina Aktar, & Bharati Roy. I would also like to thank the testers, interviewers, and field organizers for their integrity and sincerity in collecting data. I am also indebted to the teachers and staffs of Department of Psychology of the University of Dhaka. My special thanks goes to Prof. Dr. AKM Rezaul Karim and Tanveer Rahman for their supports and encouragement to conduct my PhD.

I am also grateful to the University Grants Commission of Bangladesh for PhD Fellowship, and to the Ministry of Education and Directorate of Secondary and Higher Education for deputation.

Finally, I would like to thank my wife Laila Nasrin, son Zinnurine Bin Mahmud, daughters Nuzaifa Binte Mahmud and Zoairia Binte Mahmud.

Dedication

To my parents:

Late Abdur Razzaque

and

Anjuman Ara Begum

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ASQ	Ages and Stages Questionnaires
BAMSE	Bangla Adaptation of Mini-Mental State Examination
Bayley-III	Bayley Scales of Infant and Toddler Development-III
BMI	Body Mass Index
BSID-II	Bayley Scales of Infant and Toddler Development-II
df	degrees of freedom
FO	Field Organizer
HAZ	height-for-age *z* scores
HCZ	head circumference *z* scores
HIV	Human Immunodeficiency Virus
HOME	Home Observation for Measurement of Environment
icddr,b	International Centre for Diarrhoeal Disease Research, Bangladesh
ID	Iron Deficiency
IDA	Iron Deficiency Anemia
IQ	Intelligence Quotient
IUGR	intrauterine growth restriction
LAMI	Low and Middle Income Countries
LBW	Low Birth Weight
LBW-T	Low Birth Weight Term
LMIC	Low-Income and Middle-Income Countries
MMSE	Mini-Mental State Examination
MSE	Mean Square Error

MS	Mean of Squares
MUAC	mid-upper arm circumference
NBW	Normal Birth Weight
NIH	US National Institutes of Health
OFC	head circumference
SD	Standard Deviation
SDG	Sustainable Development Goals
SEM	Structural Equation Modeling
SES	socioeconomic status
SPSS	Statistical Package for Social Sciences
SS	Sum of Squares
UNICEF	United Nations International Children's Emergency Fund
VPT	Very Preterm
WAZ	weight for-age *z* scores
WB	World Bank
WHO	World Health Organization
WHZ	weight-for-height *z* scores
WLZ	weight-for-length *z* scores

Abstract

Trajectories of neurobehavioral development of children in disadvantageous situations in terms of psychological, physiological, and environmental are retarded during the first 5 years of their life. It is also known that the factors like psychological, physiological, and environmental are greatly influenced by cognitive functioning of the caregiver during that time. With the background in mind, we aimed to examine whether there is any association of maternal cognitive function with the neurobehavioral development of children living in two urban slums in Dhaka city of Bangladesh. We enrolled 207 mother-child (12 to 42 months) dyads. Rigorously trained testers assessed children's cognitive, language, and motor development using adapted version of Bayley-III and behavior using Wolke's behavior ratings. They also assessed cognitive function of mothers using modified version of Mini-Mental State Examination (MMSE), and forward and backward Digit Span scale. Other measures included assessment of home stimulation/home environment, parenting practices, self-esteem of mothers and anthropometry of children using WHO standards. All data were checked and transformed or categorized as required. Pearson bivariate correlation showed that maternal cognitive function is positively associated with cognitive, language, and motor performance of children (r = .22 to .26, $p < .01$) with or without controlling for age of the children. Additionally, parenting practice was positively associated with each of the three domain of neurodevelopment equally (r = .21, $p < .01$), and MMSE was positively associated with both height and weight z scores (r = .21, $p < .01$). Finally, multiple linear regression analysis divulged that MMSE is a significant predictor of both cognitive and language development after controlling for possible covariates, but not for the motor development. Standardized coefficient value indicated that one unit increase in MMSE results in around .35 unit improvements in both the cognitive and language development.

Moreover, better home stimulation predicted improved cognitive ability ($\beta = .21$, $p < .05$) and higher self-esteem of mothers predicted improved motor ability of children ($\beta = .41$, $p < .01$). The findings of the study can be taken to suggest that maternal cognitive function has really a significant influence on the improvements in neurobehavioral development of underprivileged children in Bangladesh. Therefore, intervention programs need to be emphasized on maternal cognition to improve neurobehavioral development of children who are especially be raised in psychosocial adversity.

Chapter One: Introduction

Introduction

This thesis concerns the neurobehavioral development of underprivileged children in Bangladesh. It is widely accepted that children growing up in disadvantaged conditions suffer from poor neurodevelopment from their early age, and this developmental deficit exists throughout the lifecycle in various forms. We need to point out how we can improve the trajectories of children's neurobehavioral development. This cross-sectional study was conducted in the two slum areas of the Dhaka city. We examined both maternal cognitive function and neurobehavioral development of underprivileged children. The following subheadings will be discussed in this chapter.

- Child neurobehavioral development and brain growth,
- Importance of early neurobehavioral development,
- Factors affecting early neurobehavioral development,
- Consequences of poor neurobehavioral development,
- Practical significance of the study,
- Hypothesis, and
- Objectives.

1.1 Child Neurobehavioral Development and Brain Growth

Child neurobehavioral development consists of several interdependent domains of sensory-motor, cognitive-language, and social-emotional function of a children. Child development is affected by a range of psychosocial and biological factors through changes in brain structure and function, and behavioral changes (Wachs, 2000). Experiences in the first few years of life are of particular importance because vital development occurs in all the domains during this period, and the interaction between early environments and genetics influences this development and human behavior (National Research Council and Institute of Medicine, 2000). The brain growth occurs rapidly through neurogenesis, axonal and dendritic proliferation, synaptogenesis, cell death, synaptic pruning, myelination, and gliogenesis (Grantham-McGregor, Cheung, Cueto, Glewwe, Richter, & Strupp, 2007).

Brain development can be modified by the quality of the environment (Grantham-McGregor et al., 2007). Independent animal research suggested that early undernutrition, iron-deficiency, environmental toxins, stress, and poor stimulation and social interaction can affect brain structure and function (Black, Jones, Nelson, & Greenough, 1998; Liu, Diorio, Day, Francis, & Meaney, 2000; Meaney, 2001; Rodier, 2004; Webb, Monk, & Nelson, 2001). In both humans and animals, variations in the quality of maternal care, a part of home environment, can yield changes in stress reactivity, anxiety (Gunnar, in press), and memory function in the offspring (Grantham-McGregor et al., 2007). In later childhood the affected children subsequently have lower levels of cognition and education. It is mentionable that remarkable recovery is often possible with early intervention through more nurturing environment with adequate stimulation, despite the vulnerability of the brain to early insults (Black et al., 1998; Bredy, Humpartzoomian, Cain, & Meaney, 2003).

1.2 Importance of Early Neurobehavioral Development

Thomson and Nelson (2001) assumed, after analyzing available data in the primates and in the human, that early experiences in the first few years of life are essential for the overproduction of synapses or neural connections which pour a great influence for the later life brain functioning. This is a highly sensitive period of brain when it remains in maximum receptive mode. Neural links or synapses are overabundant in the period of early neurodevelopment in monkeys and human. As a consequence, a full-term newborn’s brain is enchanted with the more abundance of synapses, known as synaptogenesis, compared to the brain of adult one. On the other hand the period of having a great number of synaptic production slows down with the inception of another period of synaptic retraction or curtailment, which influences quality on brain functioning. The period for synaptic "blooming and pruning" differs immensely by the area of human brain (see Figure 1). The estimation made by Huttenlocher (1979) that the highest synaptic production in the visual cortex happens at around the fourth month of postnatal period and consequently a slow reduction of synapses continues until the preschool time when the measurement of synapses has almost touched adult levels. In the medial prefrontal cortex, which controls a type of upper level cognitive activity and self-regulation, the highest rate of synapses takes place at the age of about one year, and it takes middle to late adolescent period to become dense like adult type synapses (Thomson & Nelson, 2001), the period of 2nd brain growth spurt.

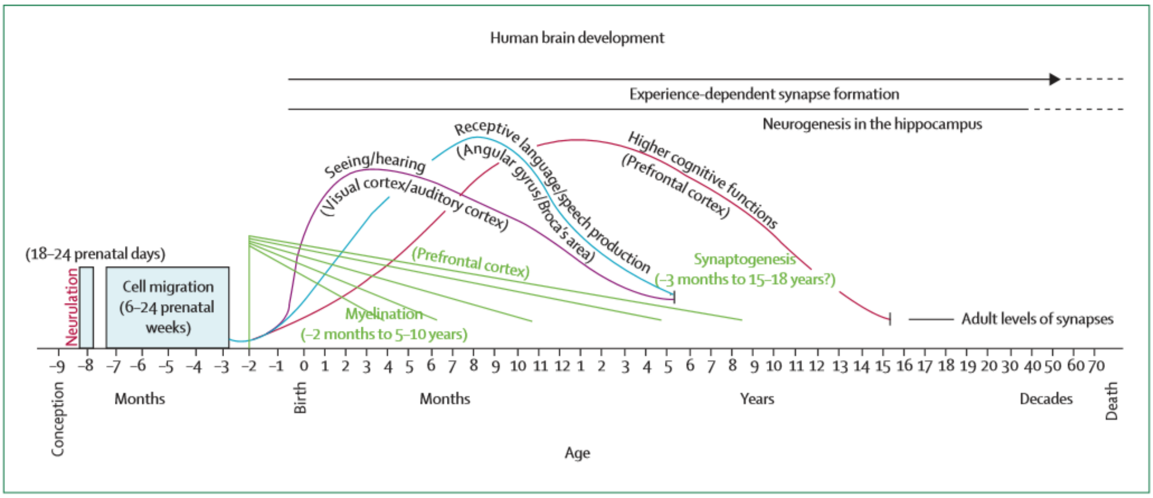


Figure 1. The process of human brain development (Thomson & Nelson, 2001).

Both genetic form and experience have an influence over the timing and happening of the synaptic production abundantly. Experiments with rodents suggested that the reason of more synaptic creation is to catch and integrate experience into the growing synaptic construction of the brain (Black et al., 1998; Greenough & Alcantara, 1993). It is opined that human brain mechanism certainly follows the process existed in primates, but there are confusions over how enormously and for which portions of brain it happens and the time of development. Further, it can be assumed that early experiences in variety bestow on the growth of distinct areas of the human brain, for example, the regions that control sensory and motor functions, communication, emotion, thinking, and reasoning; but there is little information about the type of experiences they are exposed to (Thomson & Nelson, 2001).

1.3 Factors Affecting Early Neurobehavioral Development

1.3.1 Poverty. Poor neurobehavioral development/ neurodevelopment is a big problem in the developing countries or in the areas where children are exposed to underlying poor social-economic conditions resulting in poor psychosocial care, food insecurity, hunger, no access to education, micronutrient deficiency, repeated illnesses, lacking of stimulation, and playing materials etc. Poverty is a factor that affects the neurodevelopment in various ways. Before preparing any effective intervention program to catch-up the developmental delay we need to assess the poor neurodevelopment as well as the indicators for poor neurodevelopment.

Assessing poverty is very difficult as there are lots of dimensions of poverty we need to take into consideration, especially when we attempt to unite them into a single platform (Deaton, 2001). In order to measure absolute poverty, in one approach, it is defined by severe deprivation of fundamental human needs (food, safe drinking water, education, sanitation, health etc.), lack of access to social services, and availability of household infrastructure (Gordon, Nandy, Pantazis, Pemberton, & Townsend, 2003). Granthan-McGregor et al. (2007) utilized the rate of percentage of people having income of less than US$1 per day as the indicator of poverty due to its availability of information for the maximum number of countries.

It is estimated that over 200 million children under 5 years of age in low-income and middle-income countries are not attaining their developmental potential. The primary causes of the developmental deficit include poverty and associated health, nutritional deficiencies, and unstimulating home environment or inadequate cognitive stimulation, and most of these children live in south Asia and sub-Saharan Africa (Grantham-McGregor et al., 2007; Walker, Wachs, Gardner, Lozoff, Wasserman et al., 2007). The need for intervention/stimulation is urgent to fulfill the developmental deficiency of millions of young children (Walker et al., 2007; Walker, Wachs, Grantham-McGregor, Black, Nelson et al., 2011).

The enrollment and grade attainment profile of the poor varies on the basis of regional patterns. In South America, the poor succeeded in beginning their enrollment in first grade, but they could not continue their education resulting in drop out in mammoth numbers. On the other hand, the poor children in western and central Africa and south Asia could not even register themselves in any educational institution, which creates enormous differences in grade attainment between the rich and the poor children. In some countries, the gap of the years of school completed between the rich and the poor is one or two years, while in other countries including India the difference grasps at 9 or 10 years (Filmer & Pritchett, 1999).

Cognitive test scores revealed that children from disadvantaged/underprivileged backgrounds have lower intellectual ability than children reared in more affluent families (Najman, Hayatbakhsh, Heron, Bor, O'callaghan, & Williams, 2009). The above statement has been made for the children from 2 years to adolescence. Najman et al. (2009) also mentioned that the associations could not alter if parental education, mother's cognition and shape of family are statistically controlled. In cognitive tests children raised in high-income families gain a range of 15% to 40% of a SD over children from lower income backgrounds. It is summarized that previous researches have also ensured the independent association of parental and grandparental socioeconomic status with lower child intellectual development at the age of 5 and 14 years (Najman et al., 2009).

Researchers have suggested that there is an impact of the timing and duration of poverty experienced by children upon the cognitive measurements. It was evidenced that poor family income in early childhood is the most important determinant of cognitive achievement of children than the family economic conditions in middle childhood as well as during adolescence (Duncan, Yeung, Brooks-Gunn, & Smith, 1998). Guo (1998) showed that experiencing poverty during childhood has a much more harmful effect on childhood cognitive ability than that of in early adolescence (cited from Najman et al., 2009). For the duration of poverty, Najman et al. (2009) summarized the result of some studies and found that long-term poverty has more deleterious effect on cognitive outcomes than transient poverty. Guo's study also reported that poverty exposed to four years before adolescence did not have any extra effect on child cognitive measurements apart from the state perceived for poverty during early childhood.

Multiple longitudinal studies suggested that children raised in low-income families have standard mental developmental scores in their early life, but the scores reduce significantly at the time of their preschool period (Black, Hess, & Berenson-Howard, 2000). Further, scores at the time of infancy are concentrated around the mean for national norms, whereas during toddlerhood scores are lower than the national standards and this difference in scores between infancy and toddlerhood has not appeared for children from middle-income families. Black et al. (2000) examined the results of Bayley Scales of Infant and Toddler Development-II (BSID-II) using 87 infants and toddlers reared in low-income families. They found that infants' performances were in line with the normative scores, but the toddlers' scores on mental, motor, and behavioral domain were below the normative data.

Some studies suggested that there is an association between wealth and development in preschool children. In an Indian study, rural children under 6 years of age attained poor developmental milestones, and paternal occupation was a significant factor for developmental milestones especially vision and fine motor, language and comprehension, and personal social (Vazir, Naidu, & Vidyasagar, 1998). A sample of over 3,000 predominantly underprivileged preschool children was tested in Ecuador for language ability using Peabody Picture Vocabulary Test where wealth and language test scores were associated (Paxson & Schady, 2005). Hoff (2003) measured productive vocabulary development of the children of 2 years of age and found that vocabulary performances differ on the basis of their socioeconomic status. Clearly, it means children from low socioeconomic background attain a poor performance in vocabulary tests.

Four different studies in different areas conducted at 6, 10, 12, and 18 months of age of children found that poverty and development are associated (Grantham-McGregor et al., 2007). A study was conducted in a periurban Egyptian village where child development was examined by the motor performance of Bayley test of 6 months of age, and the result revealed that poverty and child development are negatively related (Kirksey, Wachs, Yunis, Srinath, Rahmanifar et al., 1994). In a cohort of 245 children in northeast Brazil, mental and motor development was assessed at 12 months of age with the Bayley Scales of Infant Development, and multiple regression analysis divulged that poverty-related environmental factors have detrimental effect on mental and motor development (Lima, Eickmann, Lima, Guerra, Lira et al., 2004). Infant development at 6 months and 10 months was measured in a clinical setting with Bayley Scales of Infant Development-II in a randomized controlled trial in India where infants from lower socioeconomic status attained poor scores on mental development outcomes (Black, Sazawal, Black, Khosla, Kumar, & Menon, 2004). In Bangladesh, rural children's language comprehension was associated with parental income at their 18 months of age (Hamadini & Grantham-McGregor, 2004).

A number of longitudinal studies have shown that children from poor families have substantial developmental shortfall compared with children from more affluent backgrounds (Grantham-McGregor et al., 2007). One of the longest birth cohort studies in developing countries was conducted in Brazil where the result of the study divulged that there is a relation between parental income at birth and low outcomes on a developmental test at the age of 12 months in 1400 children, and school performances achieved at the age of 18 years in 2222 men on army recruitment list (Victora, Barros, Lima, Behague, Goncalves et al., 2003; cited from Grantham-McGregor et al., 2007). As many as 1469 adults were followed up in a nutrition supplementation trial in Guatemala (Stein et al., 2005). Parental socioeconomic status, as measured at the birth of respondents, was identified as a strong predictor of schooling achievement. Further, socioeconomic status of the participants was associated with cognitive functioning measured with Raven's Progressive Matrices.

The association between paternal wealth at birth and later educational and cognitive achievement was further supported by the data from three other longitudinal studies (Table 1) analyzed by Grantham-McGregor et al. (2007). Wealth quintiles at the time of children's birth were associated with IQ at 8 years of age in the Philippines, and with cognitive outcomes at the age of 7 years in South Africa, and 9 years in Indonesia. The effect size of the mentioned longitudinal studies was considerable. The range of scores between top and bottom quintiles was from 0.70 to 1.24 SD in children from various socioeconomic statuses in the three longitudinal studies. In the Guatemala study, the range was between 0.45 and 0.53 SD scores and the children who were participated in the study were from poor families. Wealth quintiles were used as the assessment of poverty in lieu of cutoff of US$1 per day due to the limitations in the data. In this way poverty works as an indicator of poor development (Grantham-McGregor et al., 2007).

Table 1

Summary of longitudinal studies depicting relation between wealth quintiles at birth and cognitive and educational outcomes (Grantham-McGregor et al., 2007)

	Philippines	Indonesia	South Africa	Brazil	Guatemala*	
	Cognitive Score (8 years of age at assessment, *n* = 2485)	Reasoning & arithmetic (9 years of age at assessment, *n* = 371)	Ravens Progressive Matrices† (7 years of age at assessment, *n* = 1143)	Attained grades (18 years of age at assessment, *n* = 2222)	Reading and vocabulary (26-41 years of age at assessment)	
					Boys (*n* = 683)	Girls (*n* = 786)
Fifth quintile	56.9	12.1	0.47	9.3	50.9	44.8
Fourth quintile	52.5 (-0.35)	11.0 (-0.31)	0.13 (-0.34)	8.2 (-0.48)		
Third quintile	51.6 (-0.42)	11.0 (-0.31)	-0.16 (0.63)	7.4 (-0.84)	43.3 (-0.45)	43.6 (-0.01)
Second quintile	49.4 (-0.60)	9.5 (-0.74)	-0.20 (-0.67)	6.8 (-1.11)		
First quintile	46.4 (-0.84)	8.4 (-1.06)	-0.23 (-0.70)	6.5 (-1.24)	41.0 (-0.53)	37.6 (-0.45)

Data are mean (effect size as unadjusted difference from the richest quintile in z scores). *Tertiles. †SD scores.

Several longitudinal studies showed substantial association between socioeconomic status and parental wealth at birth, and cognitive attainment (Sigman, McDonald, Neumann, & Bwibo, 1991; Stein, Behrman, DiGirolamo, Grajeda, Martorell et al., 2005). Poverty and sociocultural background increase children's exposure to psychosocial risks that influence development through behavioral changes (Walker et al., 2007).

In low-income and middle-income countries (LMIC), 34% of children younger than 5 years have linear growth retardation or stunting (Walker et al., 2011) resulted from poor nutrition often accelerated by infectious diseases (Walker et al., 2007). It was reported that patterns of growth retardation are identical across countries (Shrimpton, Victoria, de Onis, Lima, Blossner, & Clugston, 2001). Although the vacillation in growth starts in utero or in the first 12-18 months, continue to around 40 months (Martorell, Schroeder, Rivera, & Kaplowitz, 1995), but most children having stunting remain stunted through to adulthood (Grantham-McGregor et al., 2007).

Poverty and stunting both are connected to produce poor development because they represent different types of biological and psychosocial risks. Poverty is related to inadequate food, and poor sanitation and hygiene that increase infections and stunting in children. Poverty is also connected to inadequate mother's education, maternal stress, and depression (Bradley & Corwyn, 2002; Hamadini & Grantham-McGregor, 2004; Baker-Henningham, Powell, Walker, & Grantham-McGregor, 2003), and deficient stimulation in the home (Paxson & Schady, 2005). All these elements deleteriously influence child development which, in turn, produces poor school achievement that is further worsened by low family support (Grantham-McGregor et al., 2007). Degree of development in children becomes poor with the number of risk factors and risk factors associated with poverty commonly happened together (Rutter, 1989). Deficits in child development are frequently occurred in infancy (Feinstein, 2003; Espy, Molfese, & DilLaila, 2001), and become high with age (Richter, Griesel, & de Wet, 1998; Walker & Grantham-McGregor, 1990). In this way poverty affects the early neurodevelopment of children.

1.3.2 Malnutrition. Malnutrition affects neurodevelopment of children in different ways. It includes undernutrition and stunting, intrauterine growth restriction (IUGR), iodine deficiency, iron deficiency, other nutritional elements like zinc, breast milk, vitamin A etc.

1.3.2.1 Undernutrition and stunting. Childhood undernutrition has profound effects on neurodevelopment of children raised in poor socio-economic society. It is consistently documented that undernutrition early in life strikes in the neurodevelopmental process resulting intellectual deficits and poor school performance, and remains existed up to adolescence (Chang, Walker, Grantham-McGregor, & Powell, 2002; Grantham-McGregor, 1995; Walker, Chang, Powell, & Grantham-McGregor, 2005). Chronic undernutrition is measured by stunting which is originated from poor nutrition and sometimes co-exist with repeated infectious diseases. The effect of undernutrition could be understood by the studies of stunting and the researches concentrating on the effect of micronutrient insufficiency.

The linkage between undernutrition and intellectual deficits has been established in various studies. Several cohort studies consistently obtained findings in favor of significant relations between early childhood undernutrition and subsequent intellectual deficits. In Philippines, a cognitive performance test was administered upon >2000 underprivileged children at the ages of 8 and 11 years and the children's undernutrition status was obtained on the basis of anthropometric measurement accumulated between birth and 2 years of age (Mendez & Adair, 1999). The cognitive test scores of children having undernutrtion status were significantly lower than the score of non-stunted children. Further the shortage of test scores among stunted children was significantly associated with decreased schooling as a result of delayed school enrollment and high number of school absent. In another study in Jamaica, 103 stunted and 64 non-stunted children during 9-24 months of age were compared to see the effect of early intervention on cognition (Walker et al., 2005). The IQ test scores from 9-24 months to 18 years of age showed that early childhood undernutrition is related to intellectual development, and educational deficits in late adolescence (Figure 2) are lessened by early childhood home-visiting intervention.

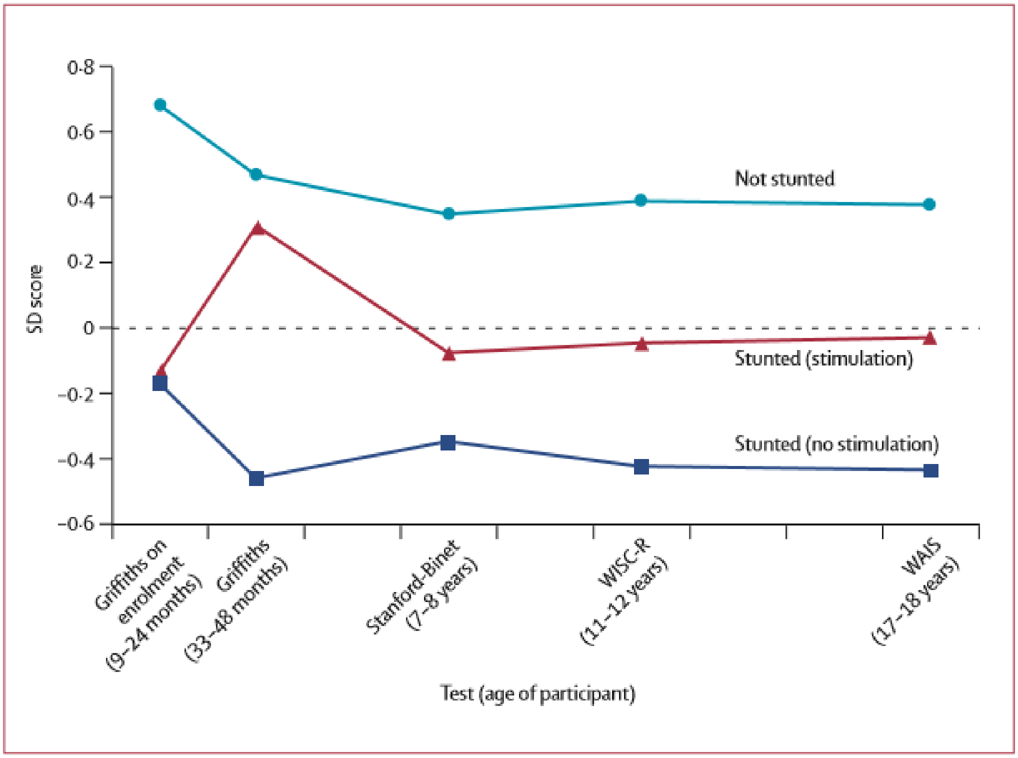


Figure 2. IQ scores of stunted and non-stunted children in Jamaica (Walker et al., 2005).

Cross-sectional studies involving school children also explored the association between nutrient status and cognitive performance as well as school achievement. To determine the influence of undernutrition on cognition, 566 school children at the age of 5-12 years from Kolkata, India were selected to administer Raven's colored progressive matrices and to measure weight-for-age *z* scores (WAZ) and height-for-age *z*-scores (HAZ) scores for nutritional statuses. The results indicated that cognitive test scores of the children are significantly correlated to HAZ and WAZ scores (Ghosh, Chowdhury, Chandra, & Ghosh, 2015). Another study in India, 598 school children having 6-10 years old from poor socio-economic background were assessed with Kaufman Assessment Battery for Children II for cognition, and HAZ and WAZ were computed using WHO guidelines. The data showed that 1 SD increase in HAZ and WAZ scores would cause to increase a 0.09 SD score in the cognitive test (Eilander, Muthayya, van der Knaap, Srinivasan, Thomas et al., 2010).

Randomized trials of food supplementation studies suggested that undernutrition in early childhood is connected to motor abilities in later childhood and school achievement. In Jamaica, a cohort of stunted children was received randomized trial of nutritional supplementation in early childhood and then they were compared with non-stunted children using Grooved Pegboard and two subtests of the Bruninks-Oseretsky test of motor proficiency at a mean age of 11 years 8 months. The under nutritious children obtained significantly poorer score in the rapid sequential continuous movements in later childhood, and the motor score, further, is associated with IQ and school achievement (Chang, Walker, Grantham-McGregor, & Powell, 2010).

Effect of supplementary feeding on motor development was investigated on 113 infants aged 6-20 months in twenty tea plantation centers in Indonesia. Measurement of motor development divulged that changes in caloric intake through dietary supplement are independently associated with motor test scores (Husaini, Karyadi, Husaini, Sandjaja, Karyadi, & Pollitt, 1991). A meta-analysis of two studies involving 178 participants from socio-economically disadvantaged children showed moderate positive effects of supplementary feeding on psychomotor ability (Kristjansson, Francis, Liberato, Jandu, Welch et al., 2015).

A community based cross-sectional study compared all the developmental domains to the undernutrition and psychosocial factors of extremely poor children less than 5 years old in southwestern Ethiopia. The developmental measurements encompassed personal-social, language, fine and gross motor, and social-emotional domains. The findings revealed that undernutrition and psychosocial factors are, independently, negatively associated with all neurodevelopmental outcomes of children (Worku, Abessa, Wondafrash, Vanvuchelen, Bruckers et al., 2018). In addition, gross motor and language skills are negatively associated with mother-child interactions and play activities of children in extreme poverty (Figure 3).

Nutritional status and developmental milestone were investigated on 512 mother-infant dyads of 6-8 months old infants in southwestern Uganda where the prevalence of undernutrition is high among the children. Developmental milestone was assessed with Bayley Scales of Infant and Toddler Development-III (Bayley-III) and Ages and Stages Questionnaires (ASQ), and WAZ, length-for-age *z* scores (LAZ), weight-for-length *z* scores (WLZ), head circumference *z* scores (HCZ), and mid-upper arm circumference (MUAC) were among the anthropometric measurements. Regression analysis divulged that each developmental domain is positively and significantly related to all parameters of nutrition except HCZ, and the main predictor of every developmental area is WAZ (Muhoozi, Atukunda, Mwadime, Iversen, & Westerberg, 2016). Thus, it is concluded that all neurodevelopmental domains of underprivileged children are strongly connected to childhood undernutrition.

Stunting is a short body state defined in terms of impaired growth and neurodevelopment in children exposed to chronic undernutrition, repeated infectious diseases, and deficient psychosocial intervention. It is estimated that 155 million children (i.e., 22.9% of children) under five years of age globally is affected by stunting in 2016 (UNICEF, WHO, WB, 2017). Stunting, as per World Health Organization (WHO) child growth standards, goes height of a child fallen into more than 2 SD below the median height-for-age *z*-scores among children of a specific sex (Perkins, Kim, Krishna, McGovern, Aguayo, & Subramanian, 2017).

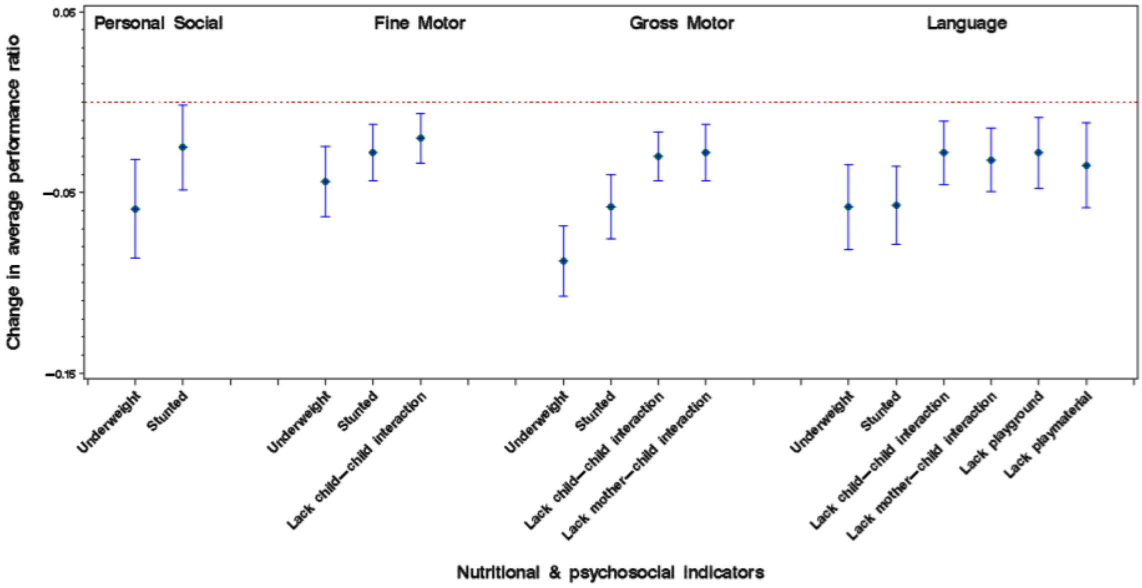


Figure 3. Nutritional and psychosocial parameters in relation to developmental domain (Worku et al., 2018).

Early childhood stunting or growth retardation is one of the factors that contribute to produce neurodevelopmental deficits in children in low- and middle-income countries (LAMI). In *The Lancet* series (child development in developing countries 1), the prevalence of stunting is identified as an indicator of poor development in underprivileged children (Grantham-McGregor et al., 2007). A large literature has reported a strong connection between stunting and neurodevelopment of children from the LMICs.

Cross-sectional observational studies. Relation between early childhood stunting and delayed school enrollment or poor school progress has been established by numerous cross-sectional studies. Buxton (2011) revealed that there is an association between stunted children and delayed enrollment in primary school in Ghana. In Tanzania, 227 children enrolled at primary school were compared with 214 non-enrolled children living in rural area (Beasley, Hall, Tomkins, Donnelly, Ntimbwa et al., 2000). Results showed that stunted children are less prone to be enrolled in school compared with non-stunted children.

In Terai, Nepal, data on 350 primary school age children were analyzed to assess the relationship between nutritional status and school participation (Moock & Leslie, 1986).

The results showed that height-for-age is appeared to be an important contributor of enrollment in school for children in this study. Age of children at enrollment in primary school was compared with 8-9 and 12-13 year old in Ghana (*n* = 1566), and Tanzania (1390) with a range of nutritional measures (Brooker, Hall, Bundy, Adjei, Allen et al., 1999). The results divulged that height-for-age *z* score (short stature) is significantly related to late school enrollment, and stunted children are prone to drop out earlier than non-stunted children.

Many studies have found an association between stunting and educational achievement in children from low-income families. Primary school children (*n* = 399) from low-income households in Malaysia were observed to investigate the relationship between nutritional status and educational attainment (Shariff, Jenny, Bond, & Johnson, 2000). The findings showed that stunting is strongly linked to educational achievement of children even after controlling for household socioeconomic status. Similarly, Wisniewski (2010) estimated the impact of nutrition on school test scores of grade four students in Sri Lanka from a rich dataset on different variables and found that stunting has direct impact on educational performances.

Observational evidence also suggested that early childhood stunting is connected to motor development among children in LMICs were of similar magnitude to those observed in cognition. A systematic literature review of 22 studies reporting motor domain associations revealed that linear growth in first 2 years of age is positively associated with motor development in LMICs (Sudfeld, McCoy, Danaei, Fink, Ezzati et al., 2015).

Across cross-sectional studies, it was found that stunting is linked to cognitive ability of children raised in low- and middle-income families. A recent meta-analysis including 52 studies from LMICs on cognitive domain associations found a robust positive relation between HAZ for children ≤ 2 years old and cognitive development, and each unit increase in HAZ was associated with +0.24 SD improvements in cognition (Sudfeld et al., 2015). Similarly, cognitive performance of 5-year-old children was assessed with Kaufman Assessment Battery for Children-II in Southern Ethiopia (Bogale, Stoecker, Kennedy, Hubbs-Tait, Thomas et al., 2013). Mean cognitive test scores of stunting and non-stunting children were significantly different from each other, and memory and visual processing outcomes of children were significantly lower in children with growth deficits. Furthermore, Perkins et al. (2017) reviewed other cross-sectional studies that overall demonstrate a positive association between child growth and child development. One time point nature of cross-sectional studies has limitation that it cannot confirm the relationship over changes in stunting.

Longitudinal observational studies. Several longitudinal studies have supports the link between early stunting and neurodevelopment of children from LMICs. Longitudinal data from 1674 Peruvian children included anthropometric measurement collected for children at 6-18 months (early stunting) and 4.5-6 years (concurrent stunting) of age along with their cognitive assessment (Crookston, Dearden, Alder, Porucznik, Stanford et al., 2011). Data analysis demonstrated that concurrent stunting is more strongly related to cognitive outcomes of children entering school than the early stunting. A study in a poor rural area in Bangladesh found that growth in the first 24 months is associated with the IQ at 64 months of children (Hamadini, Tofail, Huda, Alam, Ridout et al., 2014). A study using the South African Birth to Twenty cohort data revealed that stunting at 2 years is strongly associated with impaired fine motor skills and cognitive functioning in children at 5 years of age (Casale, Desmond, & Richter, 2014).

Numerous longitudinal studies documented that stunting in early childhood predicts later cognition and/or educational progress at school. Grantham-McGregor et al. (2007) analyzed the data from Philippines, Jamaica, Peru, Indonesia, Brazil, and South Africa to observe the effect of stunting. In these studies, later cognitive outcomes or school achievement were associated with stunting from 12 to 36 months. Further, compared with not-stunted (HAZ > -1 SD), moderate to severe stunted was related to the outcomes for cognitive tests in each study, and the effect size was between 0.4 to 1.05 SD. In addition, a recent review of longitudinal studies found that stunting at the age of 9-24 months is related to child neurodevelopment (Perkins et al., 2017). Most of the studies described above are indicated that there is a consistent relation between early childhood stunting or child height and poor neurodevelopment across each of the developmental domains.

1.3.2.2 Intrauterine growth restriction. The term IUGR is defined as poor growth of fetus during pregnancy resulting in birth weight below the 10^{th} percentile for the gestational age. Generally IUGR happens for the factors related to maternal nutrition or stress, inadequate oxygen supply to fetus, placental insufficiency etc. In LMICs, poor maternal nutrition and infections are the primary cause of IUGR (Walker et al., 2007). The effects of IUGR continue after the neonatal period is over and it disrupts the process of neurodevelopment in children. Several follow-up studies bestowed that IUGR increases the risk of neurodevelopmental deficits across different domains in children at the age of early childhood.

A number of studies reported that children born with IUGR have poor level of neurodevelopmental outcomes in developing countries. A case control study was conducted on 154 infants (77 IUGR and 77 controls) in Mexico and the results divulged that low neurodevelopment has a close relation to IUGR (Fernandez-Carrocera, Chavez-Torres, Casanueva, Barrera-Reyes, Ibarra-Reyes et al., 2003). Walker et al. (2007) summarized some studies orchestrated in developing countries on children with IUGR. In Guatemala, it was found that infants with low-birth-weight (LBW) achieved lower level cognitive outcomes at 2 and 3 years old and in Jamaica, infants at 7 months performed lower problem solving ability and poorer level of developmental outcomes at the age of 15 and 24 months compared with infants with normal birth weight (≥ 2500 g). In another study, developmental outcomes for LBW infants with IUGR were lower than infants having birth weight 3000-3499 g in Brazil. In addition, some behavioral features like less cooperative, happy, vocal or active were detected for infants with LBW in Brazil and Jamaica. Effect sizes of Guatemala, Jamaica, and Brazil studies are presented in Figure 4.

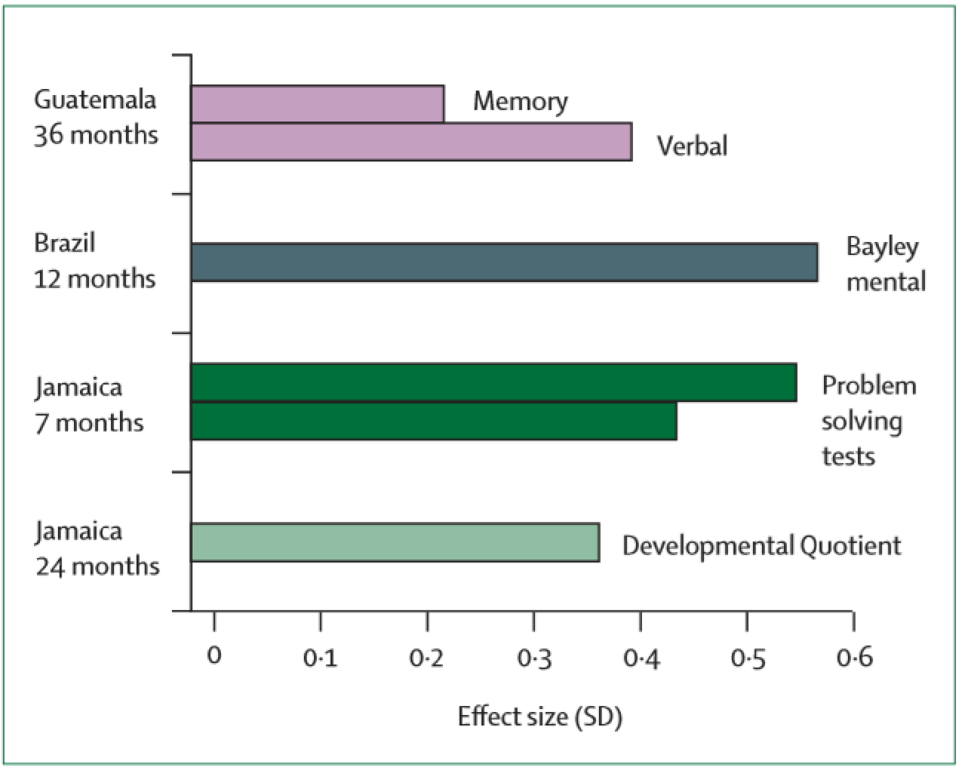


Figure 4. Effect size (SD) of children born with or without IUGR at term (Walker et al., 2007).

The effects of IUGR on neurodevelopmental impairment tend to persist even after childhood period is supported by studies in developed countries and it also disturbs the process of academic achievement. In a follow-up study in Spain, 59 IUGR children were recruited to compare cognitive functioning and academic achievement with 61 appropriate-for-gestational-age children at their 6-8 years of age (Bellido-González, Díaz-López, López-Criado, & Maldonado-Lozano, 2016). The study demonstrated that the IUGR children performed poorer cognitive tasks than the children of control group as well as the IUGR did lower in academic achievement test after adjusting for potential confounders. In Croatia, it was found that children born with intrauterine growth restriction has a negative effect on neuropsychological development at the age of 6 years and 4 months (Klaric, Galic, Kolundzic, & Bosnjak, 2012). In another study, LBW were significantly related to delayed developmental milestones in adolescence, and infants with LBW were at a higher risk of behavioral problems than infants with normal-birth-weight (NBW) (Liu, Sun, Neiderhiser, Uchiyama, & Okawa, 2001).

Fish oil supplementation in a randomized controlled trial during pregnancy did not benefit infants' development at 10 months and LBW infants scored significantly poorer mental and psychomotor developments than those of NBW infants in a low-income Bangladeshi community (Tofail, Hamadani, Ahmed, Mehrin, Hakim, & Huda, 2012). In a double blind controlled intervention with dietary supplementation during pregnant women in Taiwan revealed that the food supplementation does not improve IQ or mental ability but progresses child motor outcomes (Adair & Pollitt, 1985).

A systematic review of 16 studies suggested that children born with IUGR are at the risk of neurodevelopmental impairment than those with NBW from 6 months to 3 years of age (Levine, Grunau, McAuliffe, Pinnamaneni, Foran, & Alderdice, 2015). Similarly, 38 studies on children born with IUGR were systematically reviewed and the review denoted that children with IUGR born at ≥ 35 and < 35 weeks of gestation attained a score of approximately 0.5 SD and 0.7 SD respectively lower than non-IUGR children in all neurodevelopmental outcomes (Murray, Fernandes, Fazel, Kennedy, Villar, & Stein, 2015). Thus IUGR affects the neurodevelopmental outcome during early childhood.

1.3.2.3 Iodine deficiency. Iodine deficiency is one of the major causes of weakened neurodevelopment. It is also connected to maturation of nervous system and functioning of physiological process stemming from thyroid hormone (Pharoah & Connolly, 1995). In low-income countries, iodine deficiency acts as a major concern for health and development of children at their early childhood and pregnant women. According to WHO publication report, the number of people having insufficient iodine intake is around 2 billion in the world (de Benoist, McLean, Andersson, & Rogers, 2008), and an estimated 246 million school-aged children (29.8%) in the world do not have sufficient iodine intake (Zimmermann & Andersson, 2012).

Insufficient iodine intake can lead to hypothyroidism (goiter) which can happen at any stage of life. The negative impact of iodine deficiency is severe during the period of fetal development and the stage of early childhood. As a result it causes mental impairment leading to reduced intellectual ability and poor school performance which is preventable (de Benoist et al., 2008). Previous researches have pointed out to determine the effect of maternal iodine deficiency on the neurobehavioral development of offspring. There is a consistent finding that maternal iodine deficiency is connected to poor neurodevelopment of children (Zimmermann, 2009).

A prospective mother and child cohort study was investigated the link between maternal iodine deficiency during pregnancy and early childhood cognitive and motor development (Murcia, Espada, Julvez, Llop, Lopez-Espinosa et al., 2018). In this study, cognitive and motor ability was measured applying McCarthy Scales of Children's Abilities in 1803 children at the age of 4-5 years, and maternal iodine status was detected through urinary iodine concentration in a spot test. Regression analysis found an association between lower urinary iodine during pregnancy and poorer cognitive function in children, but no relation was showed with motor development.

A meta-analysis in China, 37 studies of 12,291 children less than 16 years old compared IQ scores of children raised in iodine deficient areas with children from naturally iodine sufficient areas (Qian, Wang, Watkins, Gebski, Yan et al., 2005). Both groups were reported to be comparable on the basis of social, economical, and educational aspects. IQs of children reared in iodine deficient areas were 12.45 points lower in average than that of children growing up in iodine sufficient areas, and iodine supplementation before or during pregnancy helps the children recover 8.7 points of IQ. A recent meta-analysis yielded a slightly reduced IQ differences than the previous review showing a range of 6.9 to 10.2 points lower IQ in iodine shortage children relative to sufficient iodine enriched children (Bougma, Aboud, Harding, & Marquis, 2013). The results of these studies echo the negative consequences of iodine deficiency on intellectual development in the offspring.

Iodine supplementation studies also investigated the effects of maternal iodine deficiency on psychomotor development of children. In a follow-up study in Xinjiang province in western China, a severe iodine shortage area, 207 children ranging from 4 to 7.3 years were examined (O'Donnell, Rakeman, Zhi-Hong, Xiu-Yi, Mei et al., 2002). Among them, 80 children, who received iodine first time at their 2 years, served as control group and rest of the children's mothers received oral iodized oil as supplementation during pregnancy. Iodine intervention before the end of 2nd trimester predicted greater psychomotor scores for children compared with those who received iodine supplementation later in pregnancy or at 2 years. Effect of iodine deficiency in the first trimester of pregnancy on the psychomotor development was justified by another study conducted in an iodine deficient region in Portugal in which the major determinant of psychomotor development at 18 and 24 months was the thyroxine level before the second trimester (Costeira, Oliveira, Santos, Ares, Saenz-Rico et al., 2011).

In Bangladesh, the impact of iodine shortage on school achievement was examined in which two groups of children depending upon thyroxine hormone levels were compared (Huda, Grantham-McGregor, Rahman, & Tomkins, 1999). The hypothyroid group (low thyroxine group) did worse performance than the euthyroid children on reading and spelling tasks, and general cognitive ability test. A comparative cross-sectional study in southern Ethiopia echoes the similar findings which confirmed the detrimental effect of goiter, a disorder caused by iodine deficiency, upon the school performance (Wolka, Shiferaw, & Biadgilign, 2014). In this study, goiter was strongly related to poor academic achievement even after controlling for parental education and school absenteeism. Thus the results of these studies of varying quality yielded the congruent evidence relating to the connection between iodine deficiency and the neurodevelopment in early childhood as well as later school achievement.

1.3.2.4 Iron deficiency. Iron deficiency (ID) during pregnancy and in early childhood is a major public health concerns which produce negative consequences on neurodevelopment of children, particularly in LAMI. The requirement of iron during pregnancy is very high for its indispensable role to neurotransmission, metabolism, and myelination in the developing brain and infant cognition (Lozoff, Beard, Connor, Barbara, Georgieff, & Schallert, 2006; Mireku, Davidson, Boivin, Zoumenou, Massougbodji et al., 2016). There are numerous studies that evidenced poor cognitive and motor performance in young children with iron deficiency anemia (IDA) that existed in a low state even after the infants received iron therapy (Lozoff et al., 2006). However, a number of studies in children consistently showed the linkage between maternal prenatal iron levels and neurodevelopmental outcomes in the offspring (Christian, Murray-Kolb, Khatry, Katz, Schaefer et al., 2010; Shafir, Angulo-Barroso, Calatroni, Jimenez, & Lozoff, 2006).

In a cohort follow-up study, 676 children aged 7 to 9 years old, whose mothers had been received iron supplementation from early pregnancy through 3 months postpartum, were included to examine the intellectual and motor functioning in rural Nepal (Christian et al., 2010). Children of iron treatment group did better performance than control group in the all tests of intellectual ability including working memory and motor ability. In a randomized trial with home intervention study, infants with IDA and non-IDA at the age of 6 and 12 months were treated with iron therapy and divided into intervention who received an hour long counseling to foster development and surveillance randomly (Lozoff, Smith, Clark, Perales, Rivera, & Castillo, 2010).

Bayley Scales of Infant Development was administered at the beginning and end points which showed less positive social-emotional behavior and poor cognitive performance exhibited by the infants with IDA before the supplementation, but the both scores were improved at the later point. Another follow-up study in China, social-emotional skills of children with IDA during infancy but corrected by food supplements later were compared with non-anemic children at the age of 4 years in which the children with chronic IDA displayed less positive social-emotional behavior than the non-anemic pre-school aged children (Chang, Wang, Wang, Brouwer, Kok et al., 2011). These findings suggest that ID and IDA are associated with the later early childhood intellectual, motor, and social-emotional development in low income countries.

A meta-analysis of 14 randomized controlled trials has assessed the effects of iron intake of infants and school aged children on the measures of cognitive function in which control groups were provided iron intake through natural food sources or supplements for at least 2 months duration (Hermoso, Vucic, Vollhardt, Arsic, Roman-Viñas et al., 2011). The review suggested that iron intervention has a modest positive effect upon the cognitive and psychomotor development of anemic infants and children. Grantham-McGregor and Ani (2001) reviewed the correlational and case-control studies and found relations between IDA and poor cognitive and psychomotor function, and behavioral problems. Review of longitudinal studies also revealed that children with ID in infancy persist the lower intellectual capability, academic achievement, and behavioral problems before middle childhood.

Thus these studies evidenced that ID and IDA affect neurodevelopment process of infants for the short term and it is also evidenced that the disturbance caused by anemia continues for long term by slowing their cognitive development as well as lowering the school achievement.

1.3.2.5 Other nutritional elements. Apart from iodine and iron, there are nutritional sources such as zinc, breastfeeding, vitamin A that are linked to child neurodevelopment. The evidence of the contribution of vitamin A and B_{12} to neurodevelopment is scarce.

Breast milk, a source of nutrients such as essential fatty acids, enters into the body of infants through breastfeeding which reduces the chance of morbidity, and closers mother-child relations, and contributes to the development (Grantham-McGregor, Fernald, & Sethuraman, 1999; cited from Walker et al., 2007). A meta-analysis of 20 studies which compared the cognitive scores of breast-fed children with that of formula-fed children delineated that higher cognitive development is significantly associated with breastfeeding from infancy to adolescence (Anderson, Johnstone, & Remley, 1999). A cohort study of 697 infants in Korea that tested mental development index at age 12, 24, & 36 months using Korean version of the BSID-II reported that breast-fed infants show significantly better cognitive development than formula-fed infants (Lee, Park, Ha, Hong, Ha et al., 2016). Two randomized trials in Honduras reported that exclusive breast-fed for 4 months improves the motor ability of infants than the infants given solid foods (Dewey, Cohen, Brown, & Rivera, 2001). The findings indicated that breastfeeding is associated with neurodevelopment of young children.

Around 25% of the world's population is affected by zinc deficiency and it is in the main risk factors for disease in developing countries (Brown, Rivera, Bhutta, Gibson, King et al., 2004). Krebs, Miller, and Hambidge (2014) opined that zinc deficiency is a primary cause of lower growth and neurodevelopment in children. In a supplementation study, zinc and iron together administered on 221 infants at 6 and 12 months of age from rural Bangladesh (Black, Baqui, Zaman, Persson, Arifeen et al., 2004). The result showed that zinc supplementation with iron has a beneficial effect on motor development and behavior. In a randomized controlled trial in Jamaica, zinc supplementation along with psychosocial stimulation benefited cognitive and psychomotor performance of undernourished children (Gardner, Powell, Baker-Henningham, Walker et al., 2005). The effect of zinc deficiency on the neurodevelopment still remains dubious as there are also contradictory findings relating to the lone impact of zinc (Walker et al., 2007).

1.3.3 Infectious diseases and environmental exposures. Child neurodevelopment is also affected by various infectious diseases and environmental exposures. Prevalence of infectious diseases is widespread in young children in low income countries. It includes intestinal helminth, human immunodeficiency virus (HIV)/ acquired immune deficiency syndrome (AIDS), diarrhoea, malaria etc. which affect child neurodevelopment in developing countries.

Any species of helminth cause intestinal infections to a third of the world's population, particularly the intensity of infections is highest among the school-aged children (Watkins & Pollitt, 1997). The study investigated the effect of helminthes on early childhood neurodevelopment is scarce. In a cross-sectional program in rural Nicaragua, 961 infants and children were screened for intestinal parasites and developmental delays (Oberhelman, Guerrero, Fernandez, Silio, Mercado et al., 1998). The study showed that language test is significantly associated with intestinal parasites. A recent longitudinal cohort study was conducted in Peru on 880 children who were recruited at one year of age and followed up at 18 months in which soil-transmitted helminth was measured (Blouin, Casapia, Joseph, & Gyorkos, 2018). A relationship was found between helminth infections in one or two years of age and poor cognitive and verbal development later in childhood.

Children infected with HIV/AIDS in early childhood lead to neurodevelopmental deficits. It is estimated that 2.1 million children under 15 years old are living with HIV/AIDS (UNICEF, 2017). Infants with HIV infections are at the risk of strong encephalopathy with catastrophic consequences. Despite without severe outcomes, children could entangle with the possibility of delayed development, particularly in the language domain (Brown, Lourie, & Pao, 2000). If the caregivers of children are infected with HIV, the impacts on child development are mediated by reduced resources and psychosocial factors (Walker et al., 2007).

Diarrhea, a waterborne disease, causes disturbance in the process of neurodevelopment of children, particularly in the first 2 years of life due to poor access to clean water and shortage of sanitation facilities in the low income countries. A cohort study in Brazil reported that children with diarrhea in the first 2 years of life show significantly lower intelligence scores even after controlling for possible confounders (Niehaus, Moore, Patrick, Derr, Lorntz et al., 2002). In another study in Brazil, early childhood diarrhea was associated with impaired school achievement suggesting that diarrhea in the early age hinders school performance (Lorntz, Soares, Moore, Pinkerton, Gansneder et al., 2006). In this way diarrhea has a profound effect on child neurodevelopment.

Malaria is another infectious disease that poses a great threat to the children aged less than 5 years in sub-Saharan Africa. A number of studies reported the neurocognitive and language impairments in children suffered from severe forms of malaria. Cerebral malaria was associated with poor performance in neurocognitive assessments of children, and the deficits are visible as long as nine years later in Kenya (Carter, Mung'ala-Odera, Neville, Murira, Mturi et al., 2005). Considerable language impairment was found in the children admitted to hospital with cerebral malaria in another study in Kenya (Carter, Lees, Gona, Murira, Rimba et al., 2006).

Environmental exposures (lead, arsenic, pesticides etc.) often play a vital role in the genesis of childhood neuropsychological impairments, particularly in the low income countries. Tong, von Schirnding, & Prapamontol (2000) summarized observing studies on lead poisoning that at a low level of human exposure to lead is responsible for the impaired psychological and neurobehavioral functions. Average blood lead concentration was negatively associated with full-scale IQ scores conducted on 1,333 children aged from infancy to 10 years in seven longitudinal cohort studies in both developing and developed countries (Lanphear, Hornung, Khoury, Yolton, Baghurst et al., 2005). In a cohort study, children living in a town adjacent to a lead smelter in Kosovo, Yugoslavia reported modest decrements in intelligence, motor scores and small higher behavior problems even controlling for social confounders (Factor-Litvak, Wasserman, Kline, & Graziano, 1999).

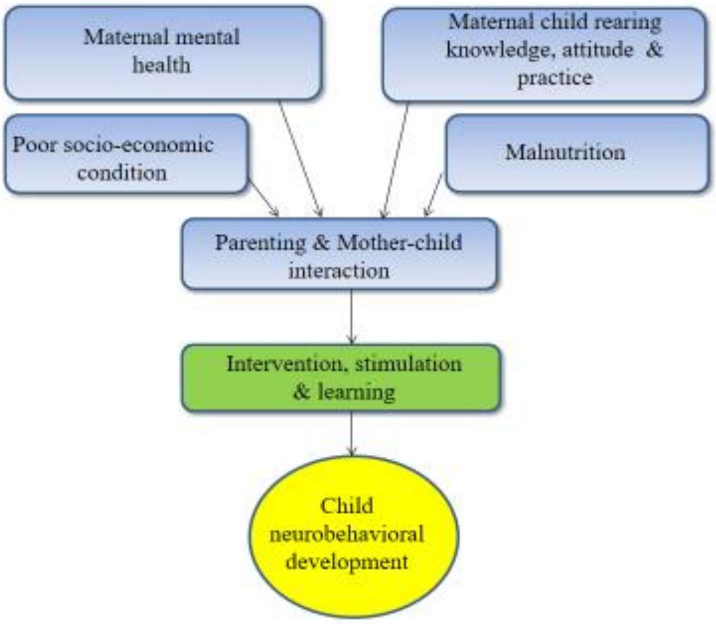


Figure 5. Conceptual framework of factors affecting child neurobehavioral development.

Exposure to arsenic through drinking water has negative consequences on neurodevelopment during childhood. A meta-analysis evaluating pre and post natal exposure to arsenic indicated that a 0.4 decrease in IQ scores is as a result of 50% increase in arsenic concentration in urine (Rodríguez-Barranco, Lacasaña, Aguilar-Garduño, Alguacil, Gil et al., 2013). In a cross-sectional investigation in Bangladesh, researchers reported that arsenic exposure from contaminated water is related to lower intellectual scores in a dose-response manner after adjustment for potential covariates (Wasserman, Liu, Parvez, Ahsan, Factor-Litvak et al., 2004). Similarly, intelligence of children was affected by high concentrations of arsenic in a study in China (Wang, Wang, Cheng, Li, Sang et al., 2007).

1.3.4 Parenting factors. Researches revealed three aspects of parenting associated with young children's cognitive and social-emotional competence: cognitive stimulation, caregiver sensitivity and responsiveness to the child, and caregiver affect (National Research Council and Institute of Medicine, 2000; cited from Walker et al., 2007). Cognitive stimulation or learning opportunities as a part of parenting factor facilitates early cognitive development of children. Several studies examined the effect of stimulation or intervention on children reared in developing countries, including children living in poverty, which strongly supports the importance of early cognitive intervention for facilitating better cognitive and non-cognitive outcomes (Gardner, Walker, Powell, & Grantham-McGregor, 2003; Grantham-McGregor, Powell, Walker, & Himes, 1991). A cohort study in northeast Brazil was conducted to see the impact of psychosocial intervention on cognitive and psychomotor development during childhood in which the researchers obtained significant improvements in cognitive and motor domains of the child development as a result of intervention (Eickmann, Lima, Guerra, Lima, Lira et al., 2003).

Two studies in low-income areas of Istanbul evaluated the long term benefit of early intervention (Kagitcibasi, Sunar, & Bekman, 2001). One study tested the effects of early enrichment comprising mother-focused and child-focused intervention after a gap of over 4 years, and the second study involved a follow-up of study one which was 7 years after the end of intervention. Superior cognitive development and school adjustment were produced by both interventions, and the second study identified the sustained effects of interventions in the light of school attainment, academic grades, and verbal scores. Walker et al. (2007) summarized studies assessed the effect of cognitive stimulation on young children and found that additional learning opportunities or psychosocial interventions cause greater cognitive functioning than non-intervention groups. The range of most effect sizes was between 0.5 SD and 1.0 SD and follow-up studies reported long sustainable effects of early intervention mentioning as long as 17 years of age.

Randomized controlled trials were conducted to investigate the long term effects on cognitive and non-cognitive outcomes from psychosocial intervention. In Jamaica, researchers examined cognitive and non-cognitive (behavior) long term outcomes from psychosocial stimulation in which children in intervention group received psychosocial stimulation for 2 years from their birth (Walker, Chang, Younger, & Grantham-McGregor, 2010). The results showed that visual-spatial memory scores were higher in the intervention group and they experienced lesser behavior problems than the control group. Low birth weight term (LBW-T) infants of home-visiting intervention group exhibited higher scores in the cognitive test and performed well in behavior than control group in a randomized controlled trial (Gardner et al., 2003). These findings support the importance of early psychosocial intervention on neurodevelopment of young children.

Early experience with the family (e.g., caregiver/mother) is important for the neurodevelopment of children. Walker et al. (2007) summarized that more secure infant attachment was related to mother's sensitivity in studies conducted in Chile, Colombia, India, and South Africa and greater cognitive development and fewer behavior problems in early childhood were related to greater levels of maternal responsitivity. Mothers' quality of instruction was associated with IQ and academic achievement in 1st and 3rd grades of their children raised in low-income families and academic scores in 1st grade of children had direct effects on mothers and fathers expectation (Englund, Luckner, Whaley, & Egeland, 2004). In a study of low-income rural families, maternal and paternal sensitive parenting was related to their children's cognitive development (Mills-Koonce, Willoughby, Zvara, Barnett, Gustafsson et al., 2015).

Appropriate caregiver-child interactions facilitate early social-emotional development and learning materials promote age-appropriate language and problem-solving skills (Walker et al., 2007). Furthermore, maternal depression is another risk factor that causes reduced levels of cognitive function and higher levels of behavior problems (Patel, DeSouza, & Rodrigues, 2003). These psychosocial factors discussed above are the part of maternal cognitive function which implies that there might be a link between factors evolved from maternal cognitive state and child neurodevelopment. Rubalcava and Teruel (2004) showed that maternal cognitive ability works as an important factor in progressing children's height, even after controlling for age of children and gender, parental age, mother's and father's years of schooling, and mother's height.

1.3.5 Risk factors. There are some risk factors in different categories which have greatly influence the neurobehavioral development of children. *The Lancet* series (child development in developing countries 2) mentioned that there are some risk factors that contribute to not attaining developmental potential in children under 5 years of age in developing countries (Walker et al., 2007). Risk factors are categorized broadly into two groups, i.e., biological risk factors and psychosocial risk factors. Biological risk factors include nutrition, infectious disease, and environmental exposures. On the other hand, parenting factors and contextual risk factors fall into psychosocial category. Walker et al. (2007) presented a framework showing psychosocial risk factors and biological risk factors as mediators to influence child neurodevelopment from socio-cultural factors (i.e., low maternal education, gender inequity, and reduced access to service) and poverty. The framework is shown in Figure 6.

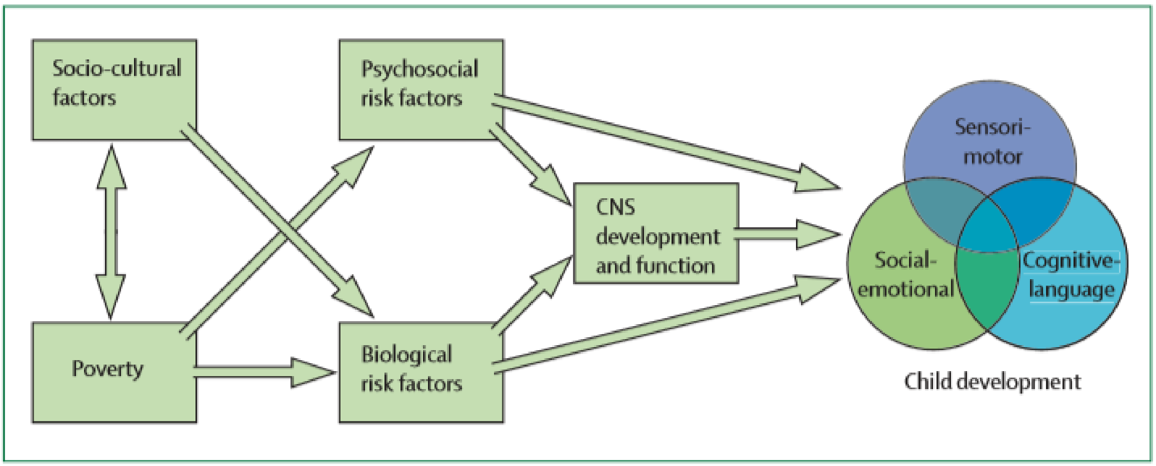


Figure 6. Pathways showing impact of poverty on child development (Walker et al., 2007).

1.4 Consequences of Poor Neurobehavioral Development

In the developing countries, information on early child neurobehavioral development is not convenient as there is no national statistics either in the government level or in any private source, which leads to the darkness of the problem of inadequate neurodevelopment. UNESCO (2016) reported that 263 million children and adolescents do not have currently access to primary and secondary schools and in low-income countries, on present trends only 70% of children will be able to finish elementary school by 2030, which means that the sustainable development goal on education (SDG 4) will not be achieved in time.

Children from sub-Saharan Africa and south Asia dominate those who do not have opportunity to accomplish primary school. In addition, children from U.S. and other developed countries outperformed their peers in science participating from some developing countries in the same grade (Gonzalez, Guzman, Partelow, Pahlke, Jocelyn et al., 2004). Grantham-McGregor et al. (2007) analyzed 12 studies on different African countries where records of grade 6 students described that around 57% children did not have minimum reading ability. Stunting and absolute poverty were identified as the potential indices for poor neurodevelopment which is mentioned earlier, and good predictors of poor educational attainment and cognitive ability because of their consistency in definition all over the world (Grantham-McGregor et al., 2007). Instead of cognitive tests, studies on neurodevelopment frequently evaluate learning and schooling outcomes for instance, school test scores, enrollment status, years of schooling as representations of cognition.

Researches in developed countries showed that early cognitive and socio-emotional ability have significant effect on future educational outcomes (Feinstein, 2003; Currie & Thomas, 1999; Pianta & McCoy, 1997). Two longitudinal studies in developing countries found connection between early child neurobehavioral development and future school achievement.

In Guatemala, cognition of preschool period forecasted the possibility of education beyond primary school (Stith, Gorman, & Choudhury, 2003), and performance in school in adolescence (Gorman & Plollitt, 1996). Liddell and Rae (2001) found that academic achievement in grade 1 and cognitive test scores of rural South African children are strong predictors for their educational retention, which corroborates the finding of developed countries. Grantham-McGregor et al. (2007) analyzed studies conducted on the children of Philippines, Jamaica, and Brazil by following multiple regression of school performance and logistic regression for dichotomous score, which revealed that early intellectual outcome predicts future education after controlling for sex and age of children, mother's education and wealth. In addition, every SD improvement in early cognition or developmental quotient was related to considerably enhance educational achievements.

The significance of supplementary feeding or interventions in early childhood for cognitive and school benefits is proved in some studies. In a longitudinal investigation, early supplementary feeding provided better performance on psychoeducational and information processing tests and highest levels of primary schooling attainment (Pollitt, Gorman, Engle, Martorell, & Rivera, 1993). In a cohort study, stimulation, compared with no intervention group, helped obtain higher scores on cognitive tests as well as educational tests (Walker et al., 2005).

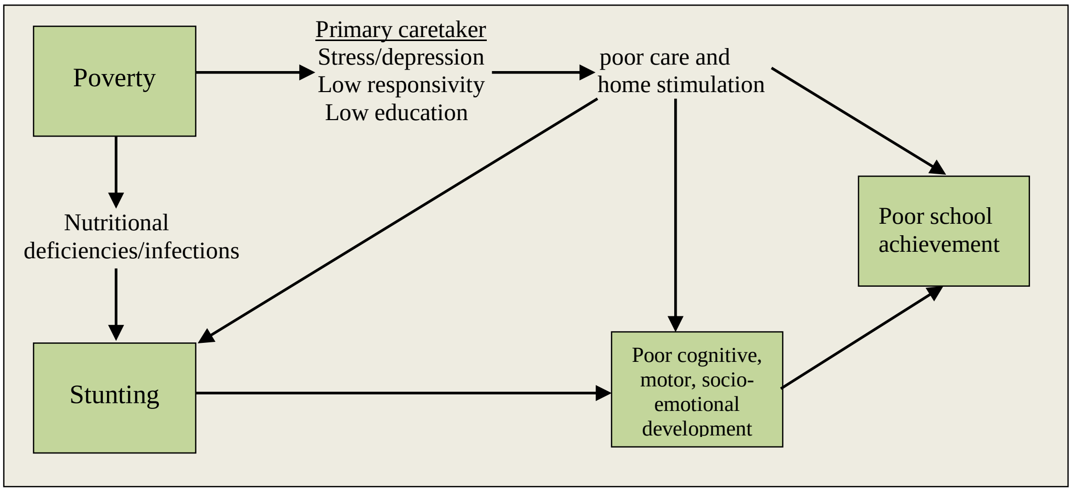


Figure 7. Hypothesized associations among poverty, stunting, child neurodevelopment, and school achievement (Grantham-McGregor et al., 2007).

1.5 Practical Significance of the Study

It is worth mentioning that substantial improvement in child development is unlikely to be made without increasing early learning opportunities (Black, Walker, Wachs, Ulkuer, Gardner et al., 2005), though there has been recent attention to the effect of nutrition on development (Victora, Adair, Fall, Hallal, Martorell et al., 2008). Non-US intervention studies showed that cognitive benefits were better in case of interventions having stimulation and educational components compared with those involving nutrition or economic assistance only (Nores & Barnett, 2010). We have further observed that different early interventions that showed some benefit but a few of them are integrated. Most of the intervention programs include nutritional supplementation, food intake, psychosocial counselling, home stimulation, or parental education. Information is limited regarding the combined contribution of interventions to promote child neurodevelopment.

In Bangladesh, almost 60% children are exposed to the risk of insufficient development caused by high prevalence of LBW, stunting, poverty, and lack of early stimulation due to low parental knowledge. Most of the data from low and middle income countries including Bangladesh mainly focused on the cognitive and motor outcome of children giving less emphasizing on the maternal cognitive function which is crucial for optimum child neurobehavioral development. This is why, in addition to the existing information, we need to assess maternal cognitive function and neurobehavioral development of the underprivileged children in order to prepare appropriate psychosocial intervention formula, particularly for the children living in developmental deficits.

It is clear from the previous studies that underprivileged children require not only good health, nutrition, and wealth but also supportive and caring home environments and cognitive stimulation with a view to achieving their optimum developmental potential as in the case of Bangladesh. According to *The Lancet* review, most disadvantaged children get the maximum benefit of intervention (Engle, Fernald, Alderman, Behrman, O'Gara et al., 2011). Cognitive function of parents, especially mothers, is vital for having the optimum outcome from intervention. It is also mentationable that maternal education emerged as a protective factor in recent researches However, little is known regarding the importance of mothers' cognitive functioning influencing different domains of their young children's neurobehavioral developmental outcome, particularly who are from underprivileged community in Bangladesh. We know of no other study, however, that directly emphasized the relationship between maternal cognitive function and different domains of neurobehavioral development of underprivileged children in Bangladesh.

The present research was, therefore, conducted to examine whether there is any significant association between cognitive function of mothers and neurobehavioral development i.e., cognitive development, language development (receptive and expressive), and motor development (fine and gross motor) of children living in underprivileged environment.

1.6 Hypothesis

Mothers with better cognitive function would have children with better neurobehavioral development even they reside in underprivileged community.

1.7 Objectives

The primary objective of the study was to determine the association between maternal cognitive function and the domains of neurobehavioral development of underprivileged children.

The specific objectives of the study were to:

a. measure the association between maternal cognitive function and children's cognitive development,
b. measure the association between maternal cognitive function and children's language development,
c. measure the association between maternal cognitive function and children's motor development.

Chapter Two: Methods

Methods

2.1 Study Location and Population

The study was conducted in the urban borough of Dhalpur, Jatrabari and Lalmati (Kalshi), Mirpur in Dhaka, Bangladesh. These areas are densely populated regions of Dhaka which are predominantly low level households living in poor slum conditions. The populations of the Dhalpur and Lalmati areas are approximately 450000 and 252000. Most of the dwellings are made of tin or mud brick and open drains flow around the areas.

The main professions of the dwellers are garments workers, transport workers, rickshaw/van pullers, service holders, small traders, construction workers, porter/day labors, domestic aides, street hawkers etc. Drinking water comes from tap or tube-well. Latrine facility is another indicator of socio-economic condition. Sanitary latrine, pit latrine, tin built latrine, hanging/Kutcha latrine are used by the slum dwellers of the two study areas. Kitchen facilities are poor for the slum people. They have shared or independent kitchen, and the kitchens are indoor and outdoor with limited facilities. The slum dwellers use different sources of cooking fuel. Gas, wood/bamboo, hay/leaf/paper and kerosene are the main sources of cooking fuel for them. About 80% of the population is Muslims and the remainders, with few exceptions, are Hindus. Most of the slum dwellers are rootless, shelter less and landless, and they are bound to live in the slum areas for their livelihood.

The study population was drawn from these areas where the inhabitants, in the light of above parameters of living conditions, are considered as underprivileged. The International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) has two field offices at the study locations with data collection facilities.

Figure 8. Living condition of Lalmati study area.

Figure 9. Living condition of Dhalpur study area.

2.2 Study Design

Cross-sectional research design was adopted in the present study.

2.3 Participants

A total of 207 underprivileged mother-child dyads (pair sample) participated in the study. We excluded 3 children who had been observed to have developmental problems at the time of neurodevelopmental assessment. Age range of children was from 12 to 42 months.

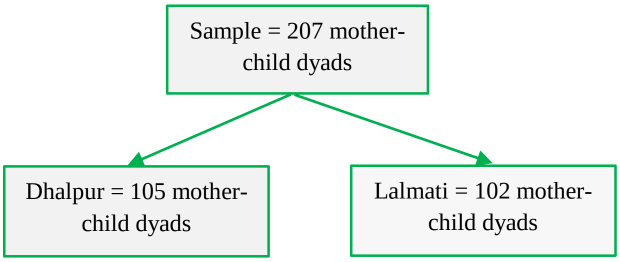


Figure 10. Sample size according to study area.

Inclusion criteria

- Mothers of 12 to 42 months old children,
- Both male and female children,
- Mothers are primary caregiver, and
- Written consent provided by parents.

Exclusion criteria

Any child with –

- Developmental anomalies,
- Known chronic illnesses like epilepsy, tuberculosis etc.,
- Twins and multiple births, and
- Parents not consenting.

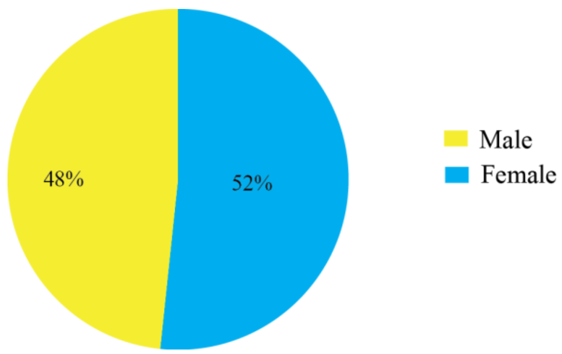


Figure 11. Pie chart of the male and female children.

2.4 Study Development and Training

Two testers, two interviewers, and four field organizers (FOs) were employed to complete the data collection procedures. They all are female having skilled in communication with mothers. The testers were graduated in child development and they had previous experiences on Bayley-III administration under the research projects in icddr,b. The interviewers were also experienced in taking interviews and had previous work experiences in icddr,b. The FOs were familiar with the study locations and had previous knowledge on how to recruit participants according to inclusion criteria. Prior to the start of data collection, they were extensively trained until they achieved 85% agreement with the trainer. The 3-day refresher training integrated how to administer the Bailey-III test, other questionnaires, and specific discussion of participant's enrollment, quality control, documentation, best ethical practices, and proper consenting procedures for illiterate mothers.

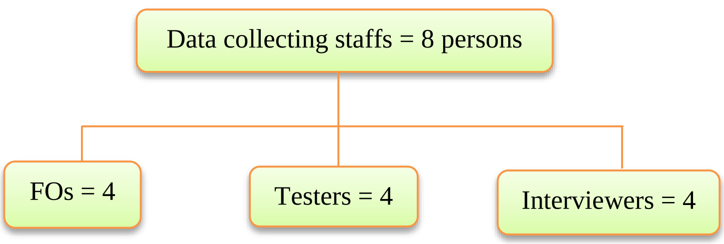


Figure 12. Number of staffs for data collection.

2.5 Procedures

Following the training program, the two slum areas were divided among the four FOs. They along with the researcher (the author) conducted a door-to-door survey in the study areas to identify the mothers having children between 12 to 42 months age range. The participants were selected on the basis of inclusion criteria. The FOs invited them to join the study.

For taking written consent from the mother, the interviewers went to the participants' home at the scheduled time. First, they read out the consent form before the mothers and collected their signature or left thumb impression, if they agreed to participate in the study with their children. This process was done in a manner appropriate for their literacy level. After getting written consent, they were enrolled in the study, interviewed for home visit and given an appointment time for developmental test at field office.

Figure 13. Interview during home visit.

During home visit, the interviewers collected information about socioeconomic status (SES), amount of stimulation children receives at home using modified version of Home Observation for Measurement of Environment (HOME) questionnaire in the presence of their children, parenting information, and information about mother’s self-esteem using Rosenberg Self-esteem Questionnaires.

Figure 14. Bayley-III assessments at icddr,b field office.

The mothers were invited at the adjacent icddr,b field offices with their children at their earliest available time. Two well-trained testers administered the Bayley-III upon the children when the mothers came to the offices guided by the FOs. The assessment was done in a quiet, well ventilated, and well lightened room with clinical settings.

Figure 15. Head circumference and height measurements of children.

Then the anthropometric measurements of mothers and their children were taken which includes weights, heights, mid-upper arm circumference, and head circumference (OFC) following WHO guidelines. The mothers were then interviewed with the questionnaires comprising modified version of Mini-Mental State Examination (MMSE) and Digit Span scales. Each mother received one liter soybean oil and a beauty-soap, and the child received some biscuits, a standard packet noodles, and chocolates as token gift to spend their valuable time in the study.

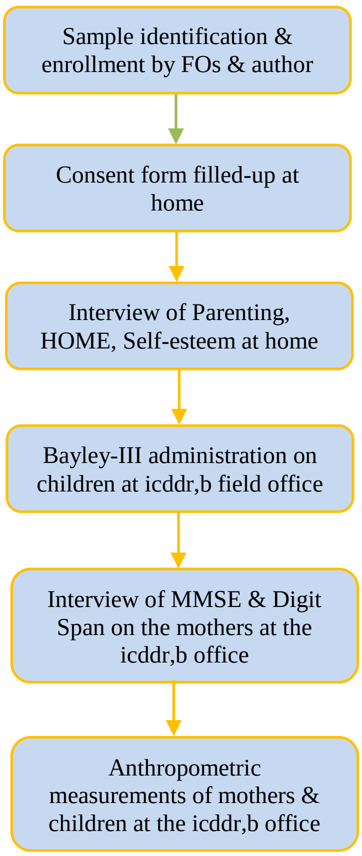


Figure 16. Flow chart of data collection process.

The interviewer assigned an identification number against a mother-child dyad and documented all information comprising address, mobile number etc. in a registered book. The testers summed-up all item raw scores in a subscale to obtain composite score and converted it into scaled score with the help of user manual (Bayley, 2006b). In this way, the tester completed the Bayley-III record form and put it along with other questionnaires in a file.

2.6 Measures

2.6.1 Direct assessments on children. Two different assessments were conducted on children. These are as follows:

2.6.1.1 Neurobehavioral development assessment. Neurobehavioral development of the children was measured with the culturally adapted version of the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III). The Bayley-III is a widely used individually administered instrument that assesses neurobehavioral development of infants and young children aged from 1 month to 42 months. The Bayley-III was culturally adapted by the child development unit of the icddr,b to make it appropriate for the Bangladeshi population. As most of the items are non-verbal, cultural adaptation was done on the basis of modifying some pictures of the books maintaining the original intent of the questions, particularly for language component. This version was not normalized to the Bangladeshi children in spite of cultural adaptation. This adapted version has been used in several researches in rural and urban settings in Bangladesh (e.g., Donowitz, Cook, Alam, Tofail, Kabir et al., 2018; Jiang, Tofail, Ma, Haque, Kirkpatrick et al., 2017). The instrument consists of five scales across different domains: cognitive scale, language scale (expressive communication and receptive communication subtests), motor scale (fine motor and gross motor subtests), social-emotional development scale, and adaptive behavior questionnaire. The first three domains are assessed using items directly administered to the child. The social-emotional and adaptive domains are conducted by a questionnaire responded by primary caregivers (Bayley, 2006a). According to the objective of the study, we used cognitive scale, language scale, and motor scale of the Bayley-III to measure the neurobehavioral development of the children.

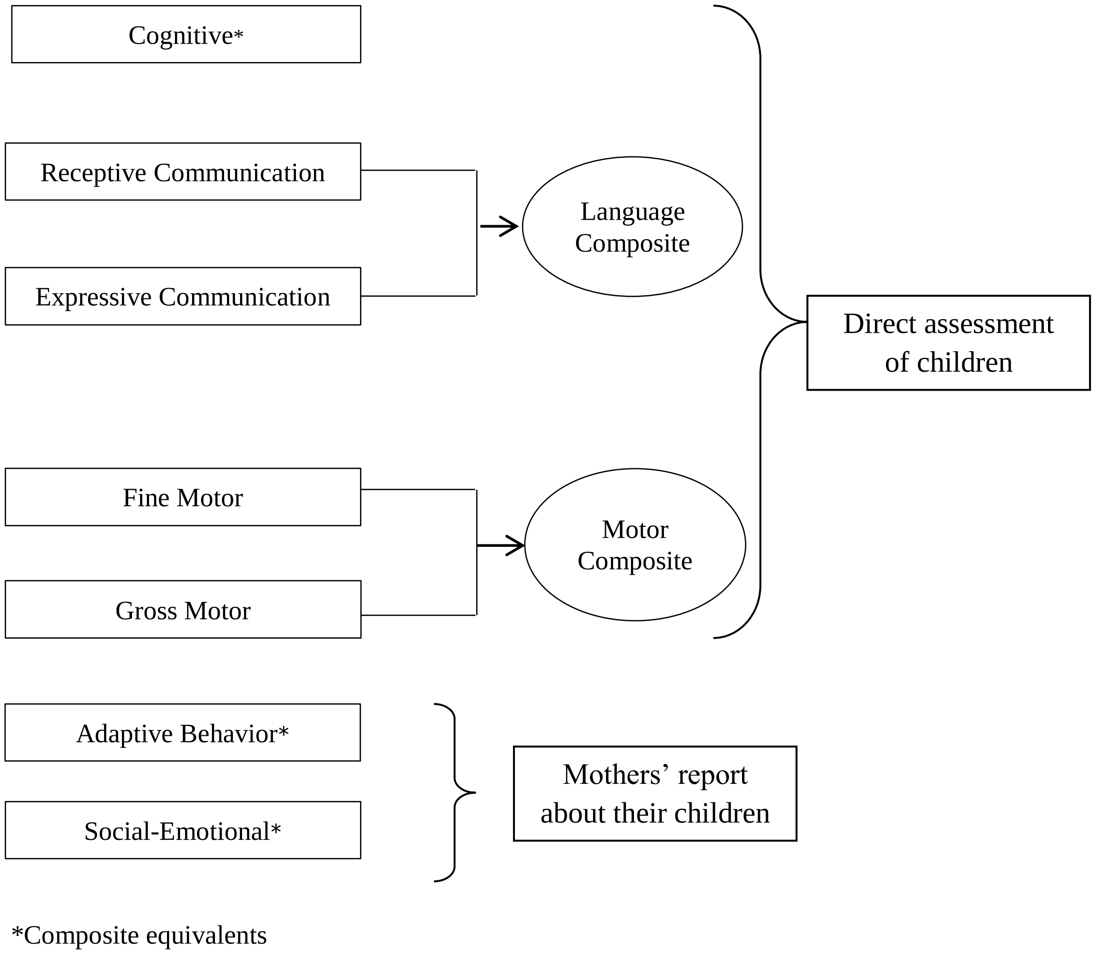


Figure 17. Subtests/Scales of the Bayley–III (Bayley, 2006a).

Cognitive Subtest/Scale. The Cognitive Scale comprised items that assess sensorimotor development, exploration and manipulation, object relatedness, concept formation, memory, and other aspects of cognitive processing. The majority of cognitive items comes from the BSID-II Mental Scale. In addition, the items were rewritten to reduce the effect of motor ability and to further strengthen the uniqueness of the cognitive scale. This part consisted of 91 items.

Language Subtest/Scale. The language scale included receptive communication and expressive communication subtests.

Receptive Communication: It assessed preverbal behaviors and vocabulary development, such as being able to identify objects and pictures that are referenced; vocabulary in relation to morphological development, such as pronouns and prepositions; and understanding of morphological markers. It had a total of 49 items.

Expressive Communication: This subtest includes items that assess preverbal communication and vocabulary development, such as naming objects, pictures, and attributes (e.g., color and size); and morpho-syntactic development. It had a total of 48 items.

Motor Subtest/Scale. The Motor Scale comprised the Fine Motor and Gross Motor subtests. As per the suggestions of content experts items from the BSID-II Motor Scale were moved to appropriate subtest in the Motor Scale. Further, new items were added to strengthen content coverage in line with the arena of motor development.

Fine Motor: The fine motor subtest included prehension, perceptual-motor integration, motor planning, and motor speed. The measurements were visual tracking, reaching, functional hand skills, responses to tactile information and grasping. It had a total of 66 items.

Gross Motor: It mainly measured the movement of the limbs and torso. Items assess static positioning, (e.g., sitting, standing), dynamic movement, balance and motor planning. It had a total of 72 items.

Cultural adaptation of Bayley-III. In the adaptation procedure, no modifications were done for the cognitive and motor subtests of the scales. In the language subtest, the pictures that were not recognized by the children were changed into local pictures so that it could be identified by the children. Some changed pictures are presented here. The whole process of this cultural adaptation was done by the child development unit of icddr,b.

(A)

(B)

Figure 18. Two examples of items from cognitive scale (A), and motor scale (B).

Examples of Expressive Language:

Original Picture

Changed Picture

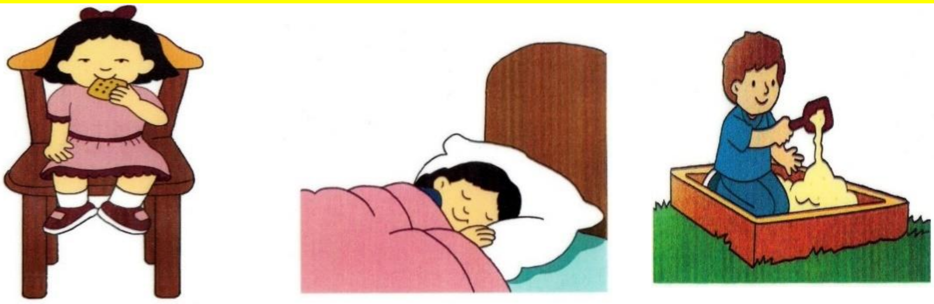
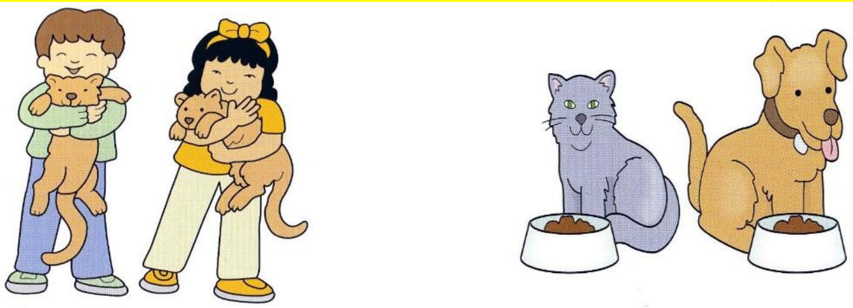


Figure 19(A). Chair, table and feature of picture (item # 34) were changed into Bangladeshi culture to make it more appropriate.

Original Picture



Changed Picture

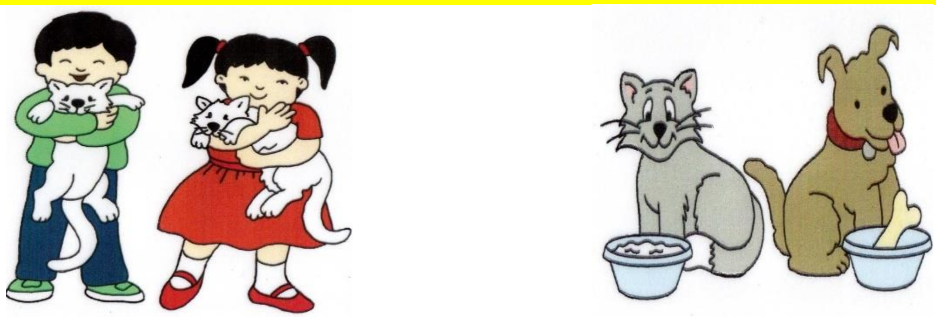


Figure 19(B). Food of dog & cat (item # 40) was replaced with bone & milk and dress of the girl was changed.

Examples of Receptive Language:

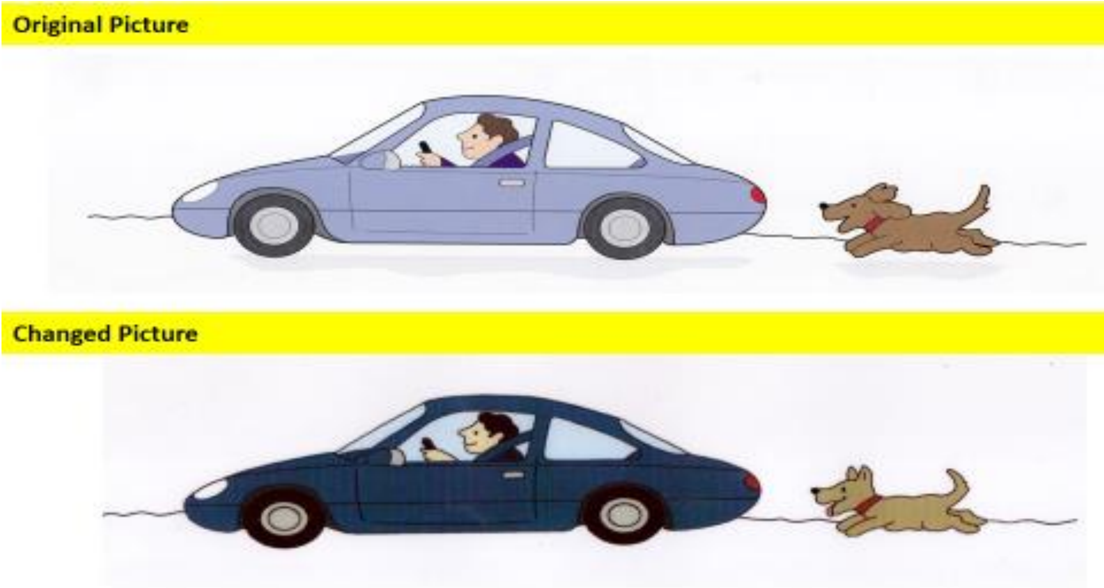


Figure 20(A). Picture of car and dog (item # 28) was modified into that of local culture.

Figure 20(B). Picture of children and toys was changed into Bangladeshi culture.

Scoring system of Bayley-III test. Trained testers, blinded to the children's histories and clinical parameters, administered the Bayley-III to the children in a clinical setting in the presence of their mothers. It took approximately 60 minutes to test one child. Reversal and discontinue rules for all subtests were applied to ensure that the most appropriate items are administered to the child. According to reversal rule, the child must get a score of 1 on the first three consecutive items at his or her age-specific start point to go forward. If the child receives a score of 0 on any of the first three items, move to the start point for the immediate before age and administer those items in a forward way. The reversal rule continues until the child become successful to the first three items at any age. As per discontinue rule the tester ends administration if the child obtains scores of 0 for the five consecutive items. The total raw scores for each subtest were calculated by adding the total number of items for which the child obtained a score of 1 along with the unadministered items preceding the basal.

Then the total raw scores of cognitive, language, and motor scales were converted to norm-referenced standardized scores for composite scores. The composite scores were prepared on a scale to a metric with a mean of 100 and a SD of 15, and range from 40-160. This normative information was prepared on a sample of 1700 children aged 1 month through 42 months from U.S. population (Bayley, 2006b). The Bayley-III has been used in studies of child development in many LAMI after minor adaptation using the normative information based on U.S. population.

Psychometric properties of Bayley-III: The short-term test-retest reliability of the Bayley-III test was determined by administering the test two times on an interval of 7 days. The reliability coefficients were satisfactory for cognitive scale (r = .53), language scale (r = .50), and motor scale (r = .78). Inter-observer reliability (intraclass correlation) between tester and trainer was high (r = .99). Ten percent of all tests were observed by Dr. Fahmida Tofail, the co-supervisor of the present study.

2.6.1. Behavioral Assessment. Children's behavior during Bayley test was assessed by the modified version of Wolke's Behavior Rating Scales (Wolke, Skuse, & Mathisen, 1990). The Wolke's behavior rating scales were developed by Wolke for Western children and was prepared to some extent on the basis of Bayley. The behavior rating scales have been used in several studies in Bangladesh after adaptation (e.g., Nahar, Hamadini, Ahmed, Tofail, Rahman et al., 2009). These scales assesse five specific behaviors (given below) and each of which has 9-point rating options. The behavioral subscales are:

Approach scale. This scale measures the initial response of a child to the tester in the first 10 minutes only. It measures if the child is avoiding, hesitant, accepting, friendly or inviting. The tester starts observing the child soon after the child enters the test room and looks at the tester. To pick up this behavior, at the starting of the Bayley test, the examiner makes a few introductory remarks to the child. Then she hands a toy to the child and starts talking with the mother. The examiner rates child's approach immediately after the initial 10 minutes in a 9 point scale, ranging from "avoiding=1", to "friendly and inviting=9".

The activity scale. This measure of the rating scales includes how physically active the infant is during an observation period e.g., the total testing session of Bayley-III. This assessment is mainly based on gross motor activities, self-initiated movements and wiggling of child during test period (roughly 45 min in Bayley tests). It covers activity level of the child in 9 point ratings, ranging from "very still=1", to "overactive=9".

The scale for emotional tone. This scale measures the general emotional tone (e.g., how unhappy, fussy, cheerful or happy) of the child during any time / test period. It covers emotional tone of the child in 9 point ratings, ranging from "unhappy and crying and fussing for long periods = 1", to "radiates happiness and not upset = 9".

The scale for vocalization. This scale measures the non-crying utterances or to recognizable utterances embedded in crying for the sake of conversing / chatting. These behaviors covered cooing, babbling, consonant sounds or words. It covers vocalization of the child in 9 point ratings, ranging from "definitely quiet = 1", to "excessive vocalizations = 9".

The scale for cooperation. Cooperation includes a measure of how well the children cooperates with the tester and complied with her requests. It covers co-operation of the child with tester in 9 point ratings, ranging from "resists all suggestions = 1", to "always complies = 9".

Psychometric properties of Wolke's behavior scales. Inter-observer reliability (intraclass correlation) between tester and trainer was high (r = .99). Ten percent of all tests were observed by the co-supervisor of the present study.

2.6.2 Direct assessments on mothers. Maternal cognitive function was measured by the direct assessments on mothers.

2.6.2.1 Cognitive function. Cognitive function of mothers was measured with two different tests. The tests are described as follows:

Neuropsychological test for cognitive abilities. The modified version of Mini-Mental State Examination scale was used to measure the cognitive function of mothers. MMSE (Folstein, Folstein, & McHugh, 1975) is a commonly used brief global instrument that measures five areas of cognitive functioning. This scale included orientation to time and place, memory and attention, language skills, and visuo-spatial abilities. It was reported that modest to high correlations were obtained between the total score of MMSE and other tests of intelligence, memory, attention, and executive functioning e.g., The Wechsler Adults Intelligence Scale (Rush, First, & Blacker, 2000).

The Bangla version of MMSE was adapted by Kabir & Herlitz (2000) and named after the Bangla Adaptation of Mini-Mental State Examination (BAMSE). Later this scale was modified by the child development unit of icddr,b to make it appropriate for the underprivileged population of Bangladesh. The BAMSE was designed in such a way that it could be culturally appropriate for literate and illiterate individual in Bangladesh. The modified version of MMSE covered a broad areas of cognitive functions. The areas of the cognitive functions measured by the items of the scale are presented concisely in Table 2.

Table 2

Description of the items of the modified version of MMSE scale

Item No.	Areas of cognitive function	Content of items
1-4	Orientation to time (4)	Day, date, month, year,
5-8	Orientation to place (4)	Country, thana, village, name of Prime Minister
	Three objects registration	Orange, house, cat
9-14	Calculation (6)	I have 20 taka and give you 5 taka. How much do I have left? ……..
15(A)-15(C)	Recall (3)	Name the three objects (orange, house, cat) learned earlier.
16a-16c	Attention (3)	Subtract 7 from 100. Then subtract 7 from this answer. Again subtract 7 from the second answer.

17-22	Naming (6)	Pen, watch, tool, knuckles, elbow, shoulder
23	Repetition (1)	Repeat 'Paka papay kaca papaya'
24-26	Three-step task (3), sequencing and memory	Individual is asked to follow the interviewer's instruction: 'Take the paper in your right hand, fold the paper in half, and put the paper on lap'.
27-32	Copying a story (6)	The individual is asked to remember a short story. The story is: 'Three children were alone in a house and the house caught on fire. A brave person managed to climb and carry them to safety. Aside from minor cuts and bruises, all the people were well.'

The number of total items of the modified version of MMSE scale was 36 and total score was 36. There were two type of answer options in the questions. Out of 36 questions, two answer options (yes or no) were for 6 questions and three answer options (yes, no, & don't know) for 30 questions of the scale. In case of correct answer the respondent was given a score of 1, for wrong answer the item received a score of 0 and 99 was given if respondent replied "don't know". At the time of scoring the '99' was recoded to '0'. Then the total score was computed by adding the individual score of each item.

Psychometric properties of the modified version of MMSE: A good association (r = 0.57) was found between the MMSE and BAMSE instruments (Kabir & Herlitz, 2000). Test-retest reliability of BAMSE was satisfactory (r = 0.70), and it was reported that BAMSE was less sensitive to age and education than the MMSE (Kabir & Herlitz, 2000).

The instrument demonstrated good internal consistency reliability (Cronbach Alpha = .79). Further, each interviewer achieved high inter-observer reliability (intraclass correlation) with the trainer before the study began ($r > .85$).

Neuropsychological test for short-term verbal memory. Bangla version Digit span scale (forward & backward) was also used to measure the cognitive function of mothers. It is a common global instrument to measure the cognitive function, where subjects were asked to recall some digits of different span in a forward or backward way. The Digit Span scale consisted of digits forward subscale and digits backward subscale. The digits forward scale had 7 pairs (Part A & Part B) of items comprising different digits and in each pair possesses equal number of digits. The interviewer read the number and the respondent was asked to recall it in the same direction the interviewer pronounced. The first item consisted of 3 digits and the last item had 9 digits. The respondents were given a score of 1 score for correct response and 0 for wrong answer in each item. When the respondent gave incorrect response to any pair of items the test was stopped.

The digits backward was the similar of digits forward. The first pair of items consisted of 2 digits. In this case the respondents were asked to recall the digits in the backward direction. The scoring and rule were same as the digits forward. The total score was computed by adding the individual item score.

Psychometric properties of the Digit Span scale: The scale showed high internal consistency reliability (Cronbach Alpha = .84). In addition, inter-observer reliability (intraclass correlation) between interviewer and trainer was perfect ($r = 1$).

2.6.3 Other measurements. The other measurements included anthropometry of both mothers and children, socioeconomic status, home stimulation, parenting practices, and self-esteem of mothers. The home stimulation, parenting, and mothers' self-esteem were taken as covariates in the present study.

2.6.3.1 Anthropometry. Weights, heights, MUAC, and OFC of all the study children, and weights, heights, and MUAC of their mothers were measured by the testers after completing the Bayley-III tests according to standard techniques (Lohman, Roche, & Martorell, 1989; WHO, 1983). The testers were trained on anthropometric measurements according to WHO guidelines. Body Mass Index (BMI) of all mothers was calculated using the formula as weight (kg)/height $(m)^2$. Afterwards, anthropometric measures of children were converted into HAZ, WAZ, and weight-for-height (WHZ) scores using WHO Anthro-software, version 3.0.1.

2.6.3.2 Socioeconomic status (SES). Information of socioeconomic status was obtained on the families' house-hold possessions, standard of housing, family structure, and parental education and occupation. The indices described was calculated to measure the socioeconomic status of the family: (a) housing, on the basis of the condition of the roof and walls of the house and presence or absence of electricity in the house; (b) utility index, according to electricity connection and water sources; (c) assets, based on the possession of certain household items; (d) crowding, composed of the number of people per room.

2.6.3.3 Home environment/home stimulation. Home environment or quality of home stimulation was assessed using modified version of Caldwell's Home Observation for Measurement of Environment scale (Caldwell, 1967). The scale was developed in 1965 for use in Head Start and the intention was to describe the environment of the children. We used the following subscales of HOME:

- Emotional and verbal responsivity of caregiver,
- Avoidance of restriction and punishment,

- Caregiver promotes child development,
- Organization of physical and temporal environment, and
- Provision of appropriate play materials.

The HOME was modified and adapted by the child development unit of icddr,b for the use in Bangladesh and this scale has been used in many research conducted by icddr,b. The number of total items was 36 and answer option was dichotomous (e.g., yes = 1/no = 0). Total score was computed by adding the individual item score. The items of the HOME were based on the combination of interview and observation. The data collectors/interviewers were trained on how to interview and observe mothers at home in the presence of their children.

Psychometric properties of HOME. Short-term test-retest reliability (within 7 days) was high for the modified version of HOME ($r = .86$, $p < .01$), and the scale demonstrated high internal consistency reliability (Cronbach Alpha = .92). Inter-observer reliability (intraclass correlation) between interviewer and trainer was high ($r = .94$).

2.6.3.4 Parenting. The parenting style was measured using the modified version of parenting questionnaire originally developed in Jamaica by Prof Sally Grantham McGregor's group. This questionnaire was adapted by the child development unit of icddr,b for the use in Bangladeshi population and has been used in many studies of icddr,b. The parenting questionnaire consisted of 20 questions about positive and negative parenting practices e.g., expressing love and care, help children learning through play, praising children, giving psychosocial stimulation to the children, learning technique, forcing, maltreating, pushing towards early academics etc. Responses are in 4 point Likert scale (0 to 3) with sum of score giving a total score of parenting practices, indicating higher is better.

Psychometric properties of parenting scale. The short term test-retest reliability of the parenting questionnaire was high (r = .79), and the scale had adequate internal consistency reliability (Cronbach Alpha = .67). Inter-observer reliability (intraclass correlation) between interviewer and trainer was high (r = .98).

2.6.3.5 Self-esteem of mothers. The self-esteem of mothers was assessed using Bangla version (Uddin, 2014) of the Rosenberg Self-Esteem Scale (Rosenberg, 1965). It is a widely used instrument to measure self-esteem for research purpose. It was an 8-item scale and there were 4 positive and 4 negative items in the scale. The total score of the five-point Likert type scale was calculated by summing the individual item score.

Psychometric properties of the self-esteem scale. The short term test-retest reliability of the self-esteem scale was high (r = .88) and it demonstrated adequate internal consistency reliability (Cronbach alpha = .64). In addition, inter-observer reliability (intraclass correlation) between interviewer and trainer was high (r = .99).

2.7 Ethical Approval

The study was reviewed and approved by the ethical review committee of the Faculty of Biological Sciences, University of Dhaka. This study was registered with ClinicalTrials.gov of US National Institutes of Health (NIH), and the ID: NCT03321591.

2.8 Statistical Analysis

Participants' responses were scored according to the scoring systems of the Bayley-III, MMSE, Digit span, HOME, Parenting, and self-esteem. Data were then fed into the SPSS, version 20.0 of a personal computer and converted to STATA, version 14.0 for analyzing the data. All data were checked for normality. According to the design of the study, Pearson bivariate correlation was conducted between maternal cognitive function and neurobehavioral outcomes of children, and partial correlation was conducted controlling for age of the children. Graphs showing Mean and SD of the outcome variables were prepared using Adobe Illustrator. Multiple regression analysis was performed by taking neurobehavioral development as outcome variable and maternal cognition and other covariates as predictors. In the multiple regression analysis, residual diagnosis was done by creating histogram and normal P-P plot of standardized residuals. Finally, bivariate correlations were conducted among maternal cognition, mother's BMI, child HAZ, child WAZ, and child WHZ.

Chapter Three: Results

Results

3.1 Sample Characteristics

The characteristics of the 207 mothers and 207 children who were tested are shown in Table 3. The sample came from underprivileged family.

Table 3

Characteristics of the Study Sample

Characteristics	*M*	*SD*	*Min-Max*	*SE*
Maternal Age (years)	25.08	4.84	18-42	0.337
Maternal Education (years)	5.12	3.56	0-16	0.248
Mother's Height (cm)	150.41	6.41	137.50-193.40	0.446
Mother's Weight (kg)	53.41	10.38	30.50-86.20	0.721
Mother's MUAC (cm)	27.17	3.88	15.50-39.40	0.270
Mother's BMI	23.63	4.45	10.53-35.57	0.309
Child's Age (months)	31.43	6.40	16.23-41.26	0.445
Child's Height (cm)	86.11	6.26	45.40-98.40	0.437
Child's Weight (kilogram)	11.24	1.84	7.20-19.10	0.128
Child's MUAC (cm)	15.17	3.93	11.50-45.80	0.274
Child's Head Circumference (cm)	45.68	4.42	14.20-51.00	0.308
Housing Index	9.40	1.46	1.30-11.00	0.101
Crowding Index	3.72	1.68	1.00-14.00	0.117
Utility Index	11.38	0.87	8-13	0.061
Asset Index	7.67	4.95	1-26	0.344
Child WHZ	-.76	1.22	-4.32-3.1	0.085
Child HAZ	-1.77	1.47	-13.01-3.32	0.103
Child WAZ	-1.47	1.19	-4.16-3.48	0.083

3.2 Graphical Presentation of Data

The mean and standard deviation of housing index, crowding index, utility index, and asset index representing the characteristics of socioeconomic status, are shown in the bar diagram (Figure 21).

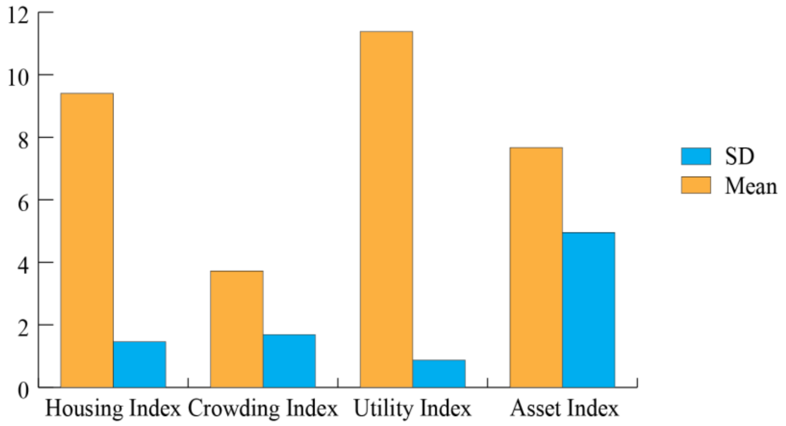


Figure 21. Bar diagram showing mean and SD of different characteristics of SES.

The graphical presentation of the mean and standard deviation of MMSE and Digit Span is shown in the bar diagram in Figure 22.

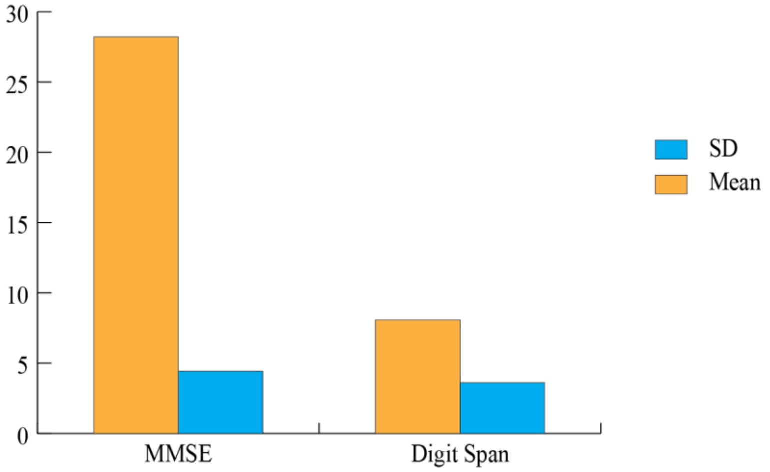


Figure 22. Bar diagram showing Mean and SD of MMSE and Digit Span.

The graphical presentation of mean and standard deviation of the cognitive composite score, language composite score and motor composite score of the children are shown in bar diagram in Figure 23.

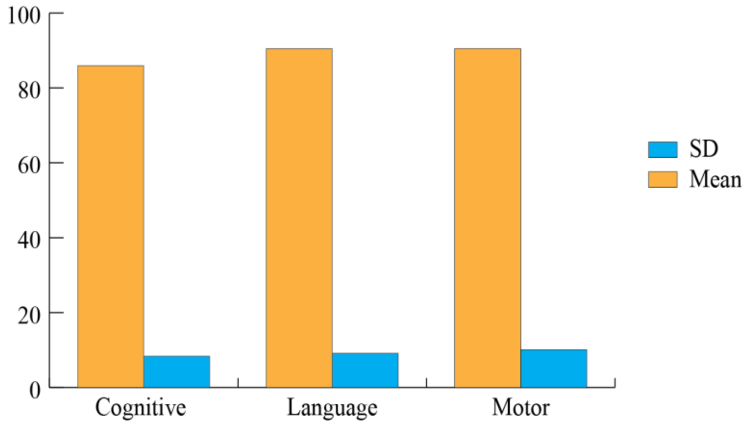


Figure 23. Bar diagram showing mean and SD of neurodevelopment.

The mean and standard deviation of the behavior ratings representing approach, emotion, activity, cooperation, and vocalization are displayed in bar diagram in Figure 24.

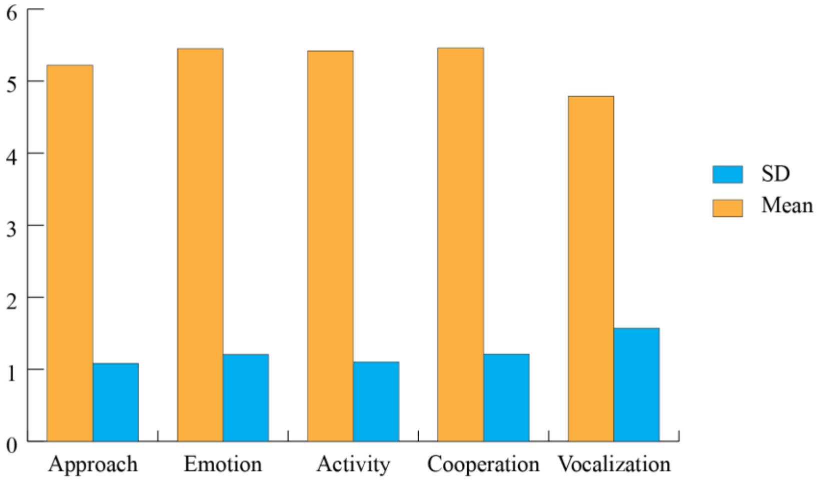


Figure 24. Bar diagram of mean and SD showing behavior ratings.

The graphical presentation of SD of nutritional characteristics representing WHZ, HAZ, and WAZ of the children is shown in Figure 25.

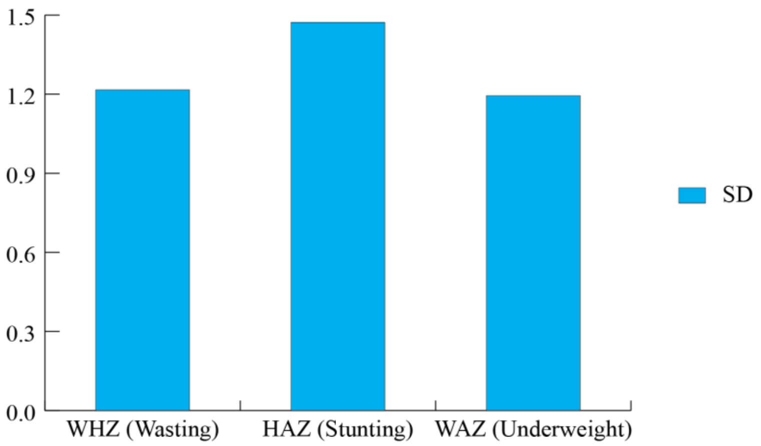


Figure 25. Bar diagram showing SD of WHZ, HAZ, and WAZ of children.

Nutritional status (BMI) of the mothers is shown according to the number of underweight, healthy weight, ideal weight and obese mothers in bar diagram in Figure 26.

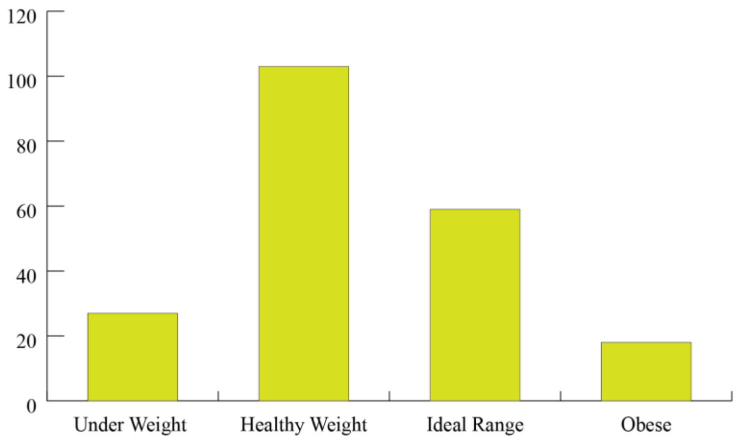


Figure 26. Bar diagram showing nutritional characteristics of mothers.

3.3 Correlation of Maternal Cognition with Child Neurobehavioral Development

Bivariate correlation analysis was conducted to measure the association between maternal cognitive function and the domains of neurobehavioral development of underprivileged children (Table 4). Positive significant correlations were found between the MMSE of mothers and cognitive composite ($r = .26$, $p < .01$), language composite ($r = .23$, $p < .01$), and motor composite scores (r = .22, p < .01) of children. Similarly, the analysis revealed that Digit Span of mothers is positively and significantly correlated to cognitive composite (r = .22, p < .01), language composite (r = .19, p < .01), and motor composite scores (r = .18, p < .01) of children.

Table 4

Correlation Matrix of Cognitive, Language, & Motor Composite, Behavior Ratings, MMSE, and Digit Span (N = 207)

Variables	1	2	3	4	5	6	7	8	9	10
1. Cognitive Composite	-									
2. Language Composite	.55**	-								
3. Motor Composite	.64**	.56**	-							
4. Approach	.27**	.35**	.26**	-						
5. Emotional tone	.31**	.34**	.34**	.54**	-					
6. Activity	-.08	.08	.01	.09	-.04	-				
7. Cooperation	.37**	.32**	.31**	.45**	.73**	-.15*	-			
8. Vocalization	.16*	.45**	.23**	.52**	.46**	.32**	.35**	-		
9. MMSE	.26**	.23**	.22**	.09	.10	-.04	.07	.02	-	
10. Digit Span	.22**	.19**	.18**	.02	.07	-.07	.12	.03	.63**	-

Note. MMSE = Mini-Mental State Examination.

*p < .05. **p < .01.

MMSE of mothers showed poor positive correlations with approach (r = .09), emotional tone (r = .10), cooperation (r = .07), and vocalization (r = .02) ratings of children. Similarly, Digit Span of mothers was poorly positively associated with the behavior ratings of approach (r = .02), emotional tone (r = .07), cooperation (r = .12), and vocalization (r = .03) of children. Conversely, activity behavior was negatively correlated to MMSE (r = -.04), and Digit Span (r = -.07) of mothers.

Table 5

Matrix of Partial Correlation of Cognitive, Language, & Motor Composite, Behavior Ratings, MMSE, and Digit Span Controlled for Child's age (N = 207)

Variables	1	2	3	4	5	6	7	8	9	10
1. Cognitive Composite	-									
2. Language Composite	.54**	-								
3. Motor Composite	.67**	.58**	-							
4. Approach	.30**	.36**	.26**	-						
5. Emotional tone	.35**	.37**	.33**	.54**	-					
6. Activity	-.08	.08	.01	.09	-.04	-				
7. Cooperation	.43**	.35**	.31**	.44**	.72**	-.16*	-			
8. Vocalization	.22**	.49**	.23**	.52**	.45**	.32**	.33**	-		
9. MMSE	.24**	.22**	.22**	.10	.11	-.04	.09	.05	-	
10. Digit Span	.20**	.19**	.19**	.03	.09	-.07	.14*	.04	.62**	-

Note. MMSE = Mini-Mental State Examination.

*$p < .05$. **$p < .01$.

A further bivariate correlation analysis was performed after controlling for the age of children. The correlations existed in the same pattern even after controlling for the children's age (Table 5). Positive significant correlations obtained between MMSE and cognitive composite ($r = .24$, $p < .01$), language composite ($r = .22$, $p < .01$), and motor composite scores ($r = .22$, $p < .01$). Similarly, the analysis divulged that Digit Span was positively and significantly correlated to cognitive composite ($r = .20$, $p < .01$), language composite ($r = .19$, $p < .01$), and motor composite scores ($r = .19$, $p < .01$) of children. Corresponding to behavior ratings, poor positive correlations were obtained between MMSE and approach ($r = .10$), emotional tone ($r = .11$), cooperation ($r = .09$), and vocalization ratings ($r = .05$). In parallel, Digit Span showed poor positive association with behavior ratings of approach ($r = .03$), emotional tone ($r = .09$), and vocalization ($r = .04$), but significant association with cooperation ($r = .14$, $p < .05$). Activity rating was negatively correlated to MMSE ($r = -.04$) and Digit Span ($r = -.07$) of mothers.

3.4 Associations Among Child Neurodevelopment, MMSE, and Covariates

Linkage between the neurodevelopmental outcomes and the covariates were showed in the bivariate correlation analysis (Table 6). The results indicated significant positive correlations between HOME and cognitive composite ($r = .24$, $p < .01$), and language composite score ($r = .18$, $p < .01$) of children. Parenting was positively and significantly associated with cognitive ($r = .21$, $p < .01$), language ($r = .21$, $p < .01$), and motor composite scores ($r = .21$, $p < .01$). Motor composite score of children was positively and significantly correlated to self-esteem of mothers ($r = .26$, $p < .01$). Poor positive correlations were observed between HOME and motor score ($r = .08$), self-esteem of mothers and cognitive score ($r = .10$), and language score ($r = .03$). Moreover, MMSE showed positive significant correlations with HOME ($r = .26$, $p < .01$), parenting ($r = .37$, $p < .01$), and self-esteem of mothers ($r = .22$, $p < .01$). Digit Span also showed positive significant correlations with HOME ($r = .18$, $p < .05$), parenting ($r = .28$, $p < .01$), and self-esteem of mothers ($r = .24$, $p < .01$).

Table 6

Correlation Matrix of Child Neurodevelopment, MMSE, HOME, Parenting, and Self-Esteem of Mothers (N = 207)

Variables	1	2	3	4	5	6	7	8
1. Cognitive Composite	-							
2. Language Composite	.55**	-						
3. Motor Composite	.64**	.57**	-					
4. MMSE	.26**	.23**	.22**	-				
5. Digit Span	.22**	.19**	.18**	.63**	-			
6. HOME	.24**	.18**	.08	.26**	.18*	-		
7. Parenting	.21**	.21**	.21**	.37**	.28**	.40**	-	
8. Self-Esteem	.10	.03	.26**	.22**	.24**	-.09	.28**	-

Note. MMSE = Mini-Mental State Examination.

HOME = Home Observation for Measurement of Environment.

**p* < .05. ***p* < .01.

3.5 Child Behavior Ratings and Covariates

Correlation analysis was conducted to see the relationship between five scales of behavior ratings and the covariates (Table 7). The results divulged that cooperation is positively and significantly correlated to parenting ($r = .15$, $p < .05$) and self-esteem of mothers ($r = .16$, $p < .05$). Poor positive correlations were observed between approach and HOME ($r = .07$), Parenting ($r = .11$), and self-esteem of mothers ($r = .01$). Similarly, emotional tone is poorly positively correlated to HOME ($r = .02$), Parenting ($r = .07$), and self-esteem of mothers ($r = .10$). In addition, poor positive correlations were found between activity and self-esteem of mothers ($r = .02$), and between vocalization of children and parenting ($r = .03$). Conversely, a significant negative correlation was obtained between activity and HOME ($r = -.16$, $p < .05$), and HOME showed weak negative association with cooperation ($r = -.01$), and vocalization (*r* = -.07). Further, poor negative correlations were found between activity and parenting (*r* = -.05), and between vocalization and self-esteem of mothers (*r* = -.03).

Table 7

Correlation Matrix of Child's Behavior, Home Environment, Parenting, and Mothers' Self-Esteem (N = 207)

Variables	1	2	3	4	5	6	7	8
1. Approach	-							
2. Emotional tone	.54**	-						
3. Activity	.09	-.04	-					
4. Cooperation	.45**	.73**	-.15*	-				
5. Vocalization	.52**	.46**	.32**	.35**	-			
6. HOME	.07	.02	-.16*	-.01	-.07	-		
7. Parenting	.11	.07	-.05	.15*	.03	.40**	-	
8. Self-Esteem	.01	.10	.02	.16*	-.03	-.09	.28**	-

Note. HOME = Home Observation for Measurement of Environment.

*p < .05. **p < .01.

3.6 Correlations of Maternal Cognitive Function and Nutrition of Children

Pearson bivariate correlation was computed to explore the relationship between maternal cognitive function and WHZ, HAZ, and WAZ of children (Table 8). Positive significant correlations were obtained between MMSE, and HAZ (*r* = .27, *p* < .01) and WAZ (*r* = .22, *p* < .01). Digit Span showed positive significant association with HAZ (*r* = .19, *p* < .01) and weak positive correlation with WAZ (*r* = .13). The matrix further showed a poor positive correlation between MMSE and WHZ of children (*r* = .08).

Table 8

Correlations Among MMSE, Digit Span, and Child Nutrtion (N = 207)

Variables	1	2	3	4	5
1. MMSE	-				
2. Digit Span	.63**	-			
3. WHZ	.08	.01	-		
4. HAZ	.27**	.19**	.08	-	
5. WAZ	.22**	.13	.80**	.66**	-

Note. MMSE = Mini-Mental State Examination;
WHZ = weight-for-height *z* score; HAZ = height-for-age *z* score;
WAZ = weight-for-age *z* score.

**p* < .05. ***p* < .01.

3.7 Correlations of Neurobehavioral Development with Nutrition

Bivariate correlation analysis was computed among the three domains of neurobehavioral development and WHZ, HAZ, and WAZ of the children (Table 9). The result showed a positive significant correlation between language score and WAZ (r = .15, p < .05). Cognitive score was poorly positively correlated to WHZ (r = .01), HAZ (r = .11), and WAZ (r = .08) of children. Similarly, poor positive correlations were found between motor score and WHZ (r = .06), HAZ (r = .13), and WAZ (r = .12). Language score was poorly positively associated with WHZ (r = .12), and HAZ (r = .09).

Table 9

Correlations of Child Neurodevelopment with Nutrition (N = 207)

Variables	1	2	3	4	5	6
1. Cognitive Composite	-					
2. Language Composite	.55**	-				
3. Motor Composite	.64**	.57**	-			
4. WHZ	.01	.12	.06	-		
5. HAZ	.11	.09	.13	.08	-	
6. WAZ	.08	.15*	.12	.80**	.66**	-

Note. WHZ = weight-for-height *z* score; HAZ = height-for-age *z* score; WAZ = weight-for-age *z* score.

**p* < .05. ***p* < .01.

3.8 Correlations of Behavior Ratings with Child Nutrition

The correlation analysis revealed no significant relation between five scale of child behavior and WHZ, HAZ, and WAZ (Table 10). The matrix showed weak positive correlations between WHZ and approach (*r* = .02), cooperation (*r* = .01), and vocalization (*r* = .09) of children. Activity behavior rating was poorly positively associated with the WHZ (*r* = .09), HAZ (*r* = .04), and WAZ (*r* = .10). Emotional tone was poorly negatively associated with WHZ (*r* = -.05), HAZ (*r* = -.07), and WAZ (*r* = -.08) of children. Poor negative correlations were obtained between approach and HAZ (*r* = -.02), and between cooperation and HAZ (*r* = -.04), and WAZ (*r* = -.03). Vocalization was poorly positively associated with WAZ (*r* = .05) but negatively with HAZ (*r* = -.01).

Table 10

Correlations of Behavior Ratings with Nutrition (N = 207)

Variables	1	2	3	4	5	6	7	8
1. Approach	-							
2. Emotional tone	.54**	-						
3. Activity	.09	-.04	-					
4. Cooperation	.45**	.73**	-.15*	-				
5. Vocalization	.52**	.46**	.32**	.35**	-			
6. WHZ	.02	-.05	.09	.01	.09	-		
7. HAZ	-.02	-.07	.04	-.04	-.01	.08	-	
8. WAZ	.01	-.08	.10	-.03	.05	.80**	.66**	-

Note. WHZ = weight-for-height *z* score; HAZ = height-for-age *z* score; WAZ = weight-for-age *z* score.

$^{*}p < .05$. $^{**}p < .01$.

3.9 Impact of Maternal Cognition and Covariates on Neurobehavioral Development

Simultaneous multiple regression analyses were conducted to examine the impact of changes in MMSE, HOME, Parenting, and mother's self-esteem (predictors) on the neurobehavioral development.

3.9.1 Impact of maternal cognition and covariates on cognitive development. The *R*-squared value of the multiple linear regression model (Table 11) revealed that MMSE, HOME, Parenting, and mothers' self-esteem together explained an estimated 10.58% of the variability in cognitive development of children, and the highly significant global F-test ($p < .001$) indicated that the model fits the data better than the intercept only model.

The model further divulged that both MMSE and HOME are statistically significant predictors of cognitive development of children with *p* values < .05. The coefficient value of MMSE indicated that one unit increase in MMSE results in .35 unit gain in cognitive development of children on average, and the coefficient value of HOME suggested that .21

unit increase, on average, in cognitive development is caused by one unit improvement in HOME score.

Table 11

Regression of Cognitive Scores on MMSE, HOME, Parenting, and Self-Esteem of Mothers

Source	SS	df	MS			
				Number of obs	=	207
				F(4, 202)	=	5.98
Model	1523.23707	4	380.809269	Prob > F	=	0.0001
Residual	12868.0673	202	63.7033033	R-squared	=	0.1058
				Adj R-squared	=	0.0881
Total	14391.3043	206	69.8607007	Root MSE	=	7.9814

Cognitive_~e	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
MMSE	.3516703	.1387429	2.53	0.012	.0781003	.6252404
HOME	.2145729	.0943478	2.27	0.024	.0285401	.4006058
Parenting	.0767337	.1207419	0.64	0.526	-.1613425	.3148099
Self_Esteem	.1004567	.1198876	0.84	0.403	-.135935	.3368484
_cons	66.23198	4.464483	14.84	0.000	57.42901	75.03495

3.9.1.1 Model diagnosis of regression of cognition. Model diagnostics were done to check the validity of the underlying assumptions of the regression model. It was conducted on the basis of residual analysis which is usually done graphically to assess normality. In the present research the graph showed that histogram produces normality of residuals (Figure 27).

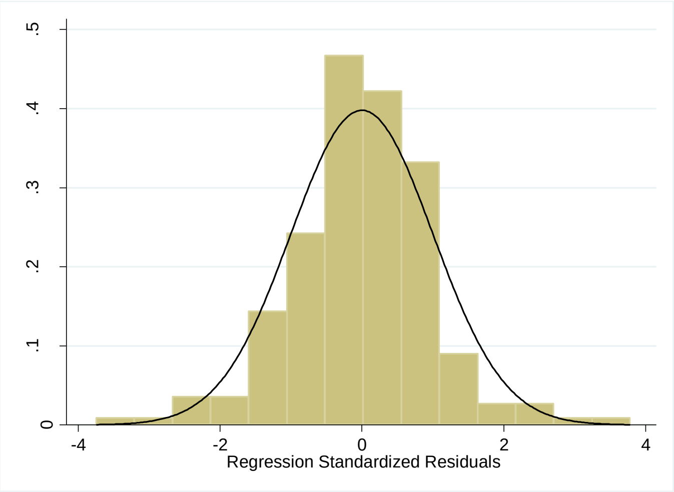


Figure 27. Histogram showing residuals of regression of child cognitive development.

In addition, The P-P plot of regression standardized residuals of cognition showed normality of residuals (Figure 28). So the model diagnosis indicated that the regression model does not violate the assumptions.

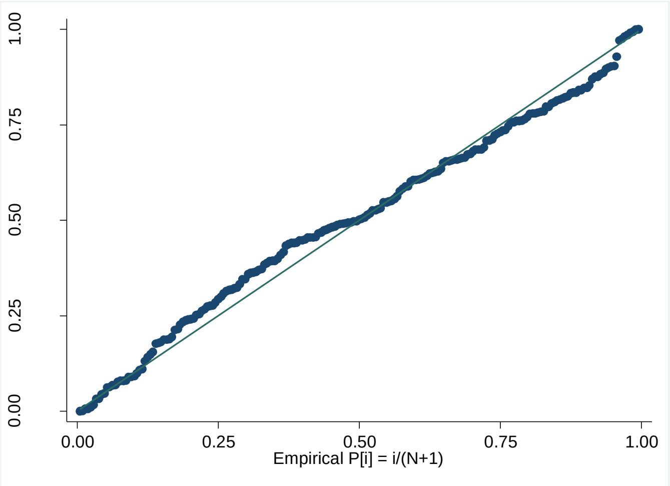


Figure 28. Normal P-P plot of residuals showing regression of child cognitive development.

3.9.2 Impact of maternal cognition and covariates on language development. The *R*-squared value of the multiple linear regression model (Table 12) showed that MMSE, HOME, Parenting, and mother's self-esteem together explained an estimated 7.94% of the variability in language development of children and the significant global F-test ($p < .01$) suggested that the model fits the data better than the intercept only model.

According to the model, MMSE is the only statistically significant predictor of language development of children with *p* values < .05. The coefficient value of MMSE indicated that one unit increase in MMSE produces .35 unit improvement, on average, in language development of the underprivileged children.

Table 12

Regression of Language Scores on MMSE, HOME, Parenting, and Self-Esteem of Mothers

Source	SS	df	MS			
				Number of obs	=	207
				F(4, 202)	=	4.35
Model	1357.34142	4	339.335355	Prob > F	=	0.0021
Residual	15745.876	202	77.949881	R-squared	=	0.0794
				Adj R-squared	=	0.0611
Total	17103.2174	206	83.0253271	Root MSE	=	8.8289

Language_C~e	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
MMSE	.3460274	.1534749	2.25	0.025	.0434091	.6486458
HOME	.1211102	.1043659	1.16	0.247	-.0846761	.3268965
Parenting	.2010659	.1335626	1.51	0.134	-.0622898	.4644215
Self_Esteem	-.0617563	.1326176	-0.47	0.642	-.3232487	.199736
_cons	74.90825	4.938533	15.17	0.000	65.17057	84.64594

3.9.2.1 Model diagnosis of regression of language development. Model diagnostics were orchestrated on the basis of residual analysis which is generally done graphically to assess normality of residuals. In Figure 29, the graph depicted that histogram produces a normal curve which confirms the normality of residuals.

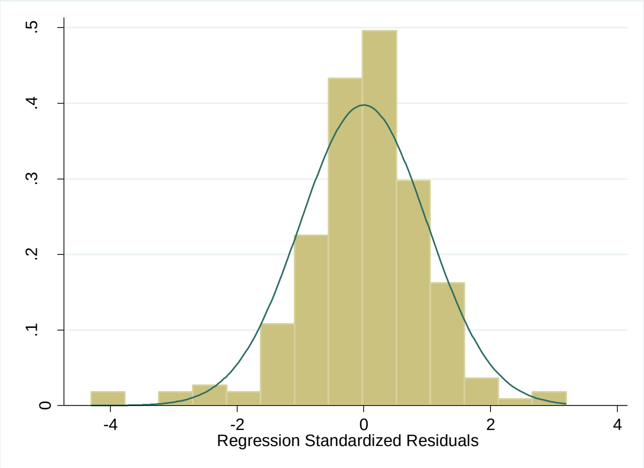


Figure 29. Histogram showing residuals of regression of language development.

The P-P plot of regression standardized residuals indicated normality of residuals (Figure 30). So the residual analysis revealed that the regression model follows the underlying assumptions.

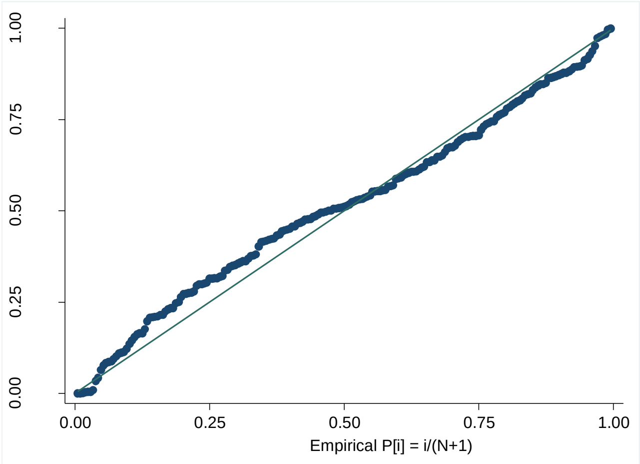


Figure 30. Normal P-P plot showing residuals of regression of language development.

3.9.3 Impact of maternal cognition and covariates on motor development. The *R*-squared value of multiple linear regression model (Table 13) revealed that 10.24% of the variability in motor development of children can be explained by MMSE, HOME, Parenting, and mother's self-esteem together and the highly significant global F-test ($p < .001$) indicated that the model fits the data better than the intercept only model.

The model further divulged that mother's self-esteem is the only statistically significant predictor of motor development of children with *p* values < .01. The coefficient value of self-esteem indicated that one unit increase in self-esteem causes .41 unit gain in motor development of children, on average.

Table 13

Regression of Motor Scores on MMSE, HOME, Parenting, and Self-Esteem of Mothers

Source	SS	df	MS			
				Number of obs	=	207
				F(4, 202)	=	5.76
Model	2131.43688	4	532.859221	Prob > F	=	0.0002
Residual	18692.2153	202	92.5357193	R-squared	=	0.1024
				Adj R-squared	=	0.0846
Total	20823.6522	206	101.08569	Root MSE	=	9.6195

Motor_Comp~e	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
MMSE	.2909012	.1672185	1.74	0.083	-.0388165	.6206189
HOME	.0311162	.1137118	0.27	0.785	-.1930981	.2553305
Parenting	.1806409	.145523	1.24	0.216	-.1062981	.46758
Self_Esteem	.4050688	.1444934	2.80	0.006	.1201599	.6899776
_cons	67.53733	5.380776	12.55	0.000	56.92763	78.14702

3.9.3.1 Model diagnosis of regression of motor development. Model diagnostics were conducted based on residual analysis. The analysis checked the normality of residuals graphically. The graph showed that the standardized residuals produces histograms of a normal curve which detects the normality of residuals (Figure 31).

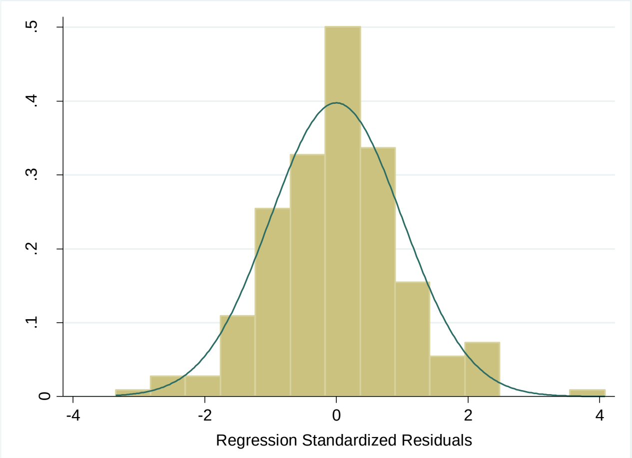


Figure 31. Histogram showing residuals of regression of motor development.

The P-P plot of regression standardized residuals of motor development showed normality of residuals in Figure 32. However, the residual analysis confirmed that the regression model of motor development fulfill the underlying assumptions.

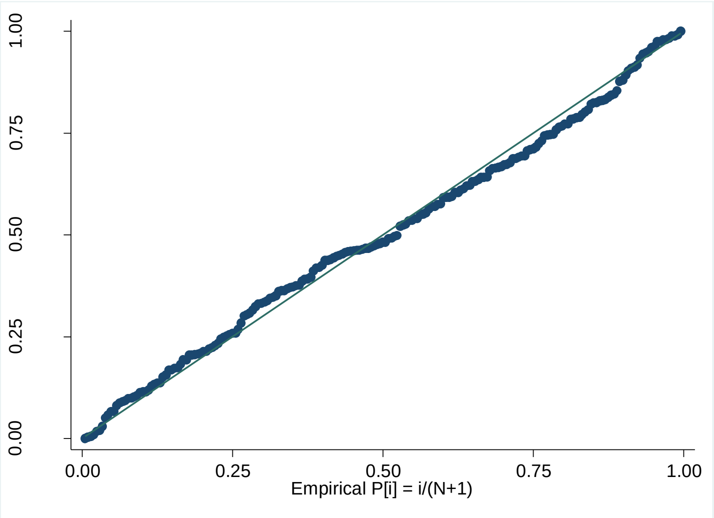


Figure 32. Normal P-P plot showing residuals of regression of motor development.

Chapter Four: Discussion

Discussion

The objective of the present study was to examine whether there is any association between maternal cognitive function and neurobehavioral development of underprivileged children. The neurobehavioral development of the children consisted of cognitive, communication, and motor development of children. In the light of the objective, simple correlation, partial correlation, matrix of correlation, and multiple regression were computed.

In the following sections I will describe correlation of maternal cognitive function with

- Child cognitive development
- Child language development
- Child motor development

In each section I will also describe independent as well as combined association of other factors related to maternal cognition e.g., home environment, parenting practices and maternal self-esteem. In the other sections, the association of child behavior with maternal cognitive function and the covariates will be discussed. The results of correlation between maternal cognitive function and child nutrition will be described in the final section.

4.1 Maternal Cognitive Function and Child Cognitive Development

The bivariate correlation revealed that maternal cognitive function measured with MMSE and Digit Span scale is positively related to cognitive development measured with Bayley-III scale of underprivileged children as expected. The positive association existed even after controlling for age of the children in partial correlation. The matrix of correlation showed that home environment and parenting practices are positively related to maternal cognitive function and cognitive development of children. Mothers' self-esteem was positively associated with maternal cognitive function. Considering the significant results of correlation, simultaneous multiple regression analysis was conducted to obtain the independent effect of maternal cognitive function and the covariates. The multiple regression indicated that maternal cognitive function, quality of home environment, parenting practices, and mothers' self-esteem jointly explained 10.58% variability in cognitive development of children living in disadvantaged community. Maternal cognitive ability and home environment were the strong predictors of cognitive development in this model.

This finding is consistent with the result of the multi country study conducted by the MAL-ED network investigators (2018) on LMICs including Bangladesh. They found that maternal reasoning ability is positively related to child cognitive development which is measured by the Bayley-III. The emerging knowledge of gene research suggested that X chromosome from their mothers contributes to cognitive function of children (Gecz & Mulley, 2000). Though it remains unclear as to what portion of variability in a population's IQ is attributable to the effects of genetic factor (Devlin, Daniels, & Roeder, 1997). Some other research reported the similar associations in children at age 5. Maternal intellectual ability is an important predictor of intellectual development of very preterm (VPT) and full-term children at age 5 (Lean, Paul, Smyser, & Rogers, 2018), and maternal intellectual ability had a unique connection to children's cognitive development (Bacharach & Baumeister, 1998; Tong, Baghurst, Vimpani, & McMichael 2007).

Early parental interventions are vital for brain development in the early stages (Barros, Matijasevich, Santos, & Halpern, 2010), and maternal cognitive ability is a key determinant of neurocognitive development of the early stages of life (Forns, Julvez, García-Esteban, Guxens , Ferrer et al., 2012). Every child grows up in a family with a close contact to his or her mother who is the primary caregiver. In a common sense, a child's development is affected by the behavior pattern of the mother and surrounding stimulating environment of the child. The behavior pattern includes the way of interaction, the style of parenting (mother-child synchrony), the way of sharing information, the nature of play with the child, the arrangement of playing instruments, and the cognitive stimulation projected to the child. These all things together influence the cognitive development of a child.

A mother's good understanding ability, in other words high cognitive function, is key to improving all these facets of behavior. By way of explanation, the mother from underprivileged community lacks of having the playing materials or stimulation items or other proper knowledge to deal with her child. To overcome this shortage, the disadvantaged mother needs to apply her understanding ability to manage the surroundings for optimum outcome. This is why maternal cognitive function is positively associated with the cognitive development of disadvantaged children.

Mothers of the present study were from underprivileged community having low level education provides poor cognitive stimulation for children. Previous research in this regard found that socioeconomic status and low maternal education are strong predictors of child neuropsychological development (Barros, Matijasevich, Santos, & Halpern, 2010; Forns et al., 2012). Studies further suggested that mothers with poor educational attainments lack cognitive skills essential for stimulating their children (Hackman, & Farah, 2009). Forns et al. (2012) concluded in their study that mothers with better intelligence have children with better intelligence, regardless of maternal educational level and these mothers can provide more stimulating environment for their children by giving better opportunities for their cognitive development.

Tong et al. (2007) reported that maternal intellectual ability and home environment (measured by HOME scale) are positive predictors of cognitive development of children even after adjustmenting for different confounding factors. Therefore, the higher the maternal IQ, the better is the home environment, and the greater the cognitive performance of the children (Tong et al., 2007). In a recent study, the role of home environment (providing cognitive stimulation) on cognitive skills of children living in poverty and suffering from frequent infections was investigated (Nampijja, Kizindo, Apule, Lule, Muhangi et al., 2018). The result showed that the data describe a good fit to the model where home environment (measured by HOME score) mediates the combined effect of SES and child health on cognitive performance.

Early years of life are a crucial period for every child to receive parenting as it has great impact on developmental outcome and their personality pattern in later life. In our study, bivariate correlation showed that parenting practices is associated with cognitive development of the children. Whereas independent contribution of parenting practices was not significant in the regression model, which is paradox to the findings of previous research on parenting and its relationship with cognitive ability of children (Lugo-Gil & Tamis-LeMonda, 2008; Merz, Zucker, Landry, Williams, Assel et al., 2015). Parents of our study might not provide optimal learning environments required for child cognitive development as the mothers of the children lacked of good education and proper knowledge on parenting practices. Mothers with a higher education would be more knowledgeable to rear and learn their children in an appropriate way. Perhaps, the effect of parenting is mediated by other variables like child characteristics or personality of parent. On the other hand, most of the previous research on parenting and children's cognitive development were of longitudinal nature which would allow researchers to make better inferences of causality.

Mother's self-esteem, as per our analysis, also was not a significant predictor of cognitive development of disadvantaged children. No previous study is available that investigated directly the impact of mother's self-esteem on the cognitive development of underprivileged children. In a cohort study in Mexico, the results showed an association between maternal self-esteem and cognitive development of lead exposed children at the age of 24 months (Surkan, Schnaas, Wright, Téllez-Rojo, Lamadrid-Figueroa et al., 2008). Our findings are not supported by the study of Surkan et al. (2008). Mother's self-esteem may work through a behavioral pathway. In addition, mother's self-esteem was associated with parenting in our study.

4.2 Maternal Cognitive Function and Child Language Development

The simple correlation showed that maternal cognitive function is positively associated with language development (both comprehensive and expressive language measured with Bayley-III) of the underprivileged children as hypothesized. The positive correlation existed even after adjusting for age of the children. The matrix of correlation further showed that home environment and parenting are positively related to maternal cognitive function and language development of children. Mothers' self-esteem was positively associated with maternal cognitive function. Additionally, we have conducted simultaneous multiple regression analysis to obtain the independent effect of maternal cognitive function and the covariates. The multiple regression analysis showed that maternal cognitive function, home environment, parenting, and self-esteem of mothers together accounted for 7.94% of the variance in language development of children living in underprivileged community.

However, maternal cognitive function appeared as the only significant predictor of child language development in this model.

Prior research is very limited that explored directly the relationship between maternal cognitive function and language development of children living in adversity. Our finding is consistent with the result of the study conducted on the children reared-up in the affluent society of Italy (Ronfani, Vecchi Brumatti, Mariuz, Tognin, Bin et al., 2015). Ronfani et al. (2015) have shown that maternal intelligence is related to child language development at 18 months in a cohort study. Maternal intellectual ability predicted the language development of VPT children at the age of 5 years and maternal full scale intelligence quotient score were positively related to VPT children's language score (Lean et al., 2018). In addition, Luster and dubow (1992) indicated that maternal intellectual ability is a significant predictor of children's verbal ability at the age of 3 to 5 years measured by the Peabody Picture Vocabulary Test – Revised when the effect of home environment was statistically controlled.

Bivariate correlation further revealed that cognitive development of the underprivileged children is positively correlated with their language development. It can be speculated that mothers with higher intellectual ability can have good verbal ability, and they spend more quality time and interacted more with their children when they share good verbal information with their children. As a result, the children receive lots of communication knowledge that helps increase their ability to communicate. In the underprivileged community, a child has less opportunity to develop language ability at home. Mother's company and interaction is the main source of learning communication knowledge of these children. So, mothers' effective input style which depends on the cognitive function influences language development of the children. It is evident that parental language input style is modestly but significantly correlated with the language development of children (Dale, 2015). Rowe (2012) demonstrated that quantity of parental input and diversity of parental vocabulary are the predictors of vocabulary growth between 18 and 42 months of children. It can easily be assumed that maternal language input style, amount of input, diversity of maternal vocabulary, and interaction all these things are the outcome of good maternal cognitive function.

Home environment and parenting are positively correlated with language development of the children in our study. The independent effect of the two variables was not found when we considered the other two covariates in the regression analysis. Home environment, parenting practices, and mother's self-esteem were not uniquely predictive of language development of the children in this model. Concerning home environment, our finding is contrary to the result of the study conducted by Luster and dubow (1992). They found that home environment, measured by the shorter version of HOME, is significantly associated with verbal intelligence of children when maternal intelligence is statistically controlled, and the contribution of home environment was greatest for preschool children around age of 3 to 5 years. One plausible explanation is related to the age of assessment of the children. Our children were younger compared to that study. Second possible explanation is concerned with the socioeconomic status of the children. The children in our study has been reared up in underprivileged community but their children came from various socioeconomic conditions. Thirdly, nutritional status could be another underlying cause. Around two-third of our children were moderate to severely malnourished.

Parenting practices have been connected to early language outcome of children rearing in low-income families (Dodici, Draper, & Peterson, 2003; Mistry, Biesanz, Taylor, Burchinal, & Cox, 2004). This finding is consistent with our result. Maternal sensitivity, a factor of parenting, was uniquely associated with language development of children living in low-income and middle-income families (Pungello, Iruka, Dotterer, Mills-Koonce, & Reznick, 2009). The independent contribution of parenting practices was not found in our study. The possible explanation of the finding could be associated with the way of measuring the parenting practices. In the previous studies, parenting practices was determined by measuring the factors of parenting like maternal sensitivity, negative intrusive parenting etc. Furthermore, prior studies suggested that cultural differences may alter the effects of parenting practices (Deater-Deckard & Dodge, 1997). Finally it was maternal report and could be respondent bias.

4.3 Maternal Cognitive Function and Child Motor Development

The bivariate correlation indicated that maternal cognitive function is positively associated with motor development of the underprivileged children as expected. The positive correlation existed even after adjusting for age of the children. As evident in the correlation matrix, parenting and mothers' self-esteem were positively related to maternal cognitive function and motor development of children. Home environment was positively associated with maternal cognitive function. Additionally, simultaneous multiple regression analysis was conducted to obtain the independent effect of maternal cognitive function and the covariates.

Multiple regression analysis showed that maternal cognitive function, home environment, parenting, and self-esteem of mothers jointly explained 10.24% of the variance in motor development of children living in underprivileged community. After adjusting for the covariates, the effect of maternal cognitive function was restricted and didn't act as a significant predictor, whereas the contribution of mothers' self-esteem was significant in this model.

To our knowledge, prior studies are very limited that explored the connection between maternal cognitive function and motor development of disadvantaged children. Similar to our finding was reported in a mediation analysis conducted by Ronfani et al. (2015). They found that maternal intelligence affects motor development of children, measured by Bayley-III, at 18 months in a cohort study in Italy. A recent prospective large-scale birth cohort study also divulged the relationship between maternal IQ and motor development of children at 18 months; children born to greater IQ mothers had lower frequency of motor delay in contrast to those born to lower IQ mothers (Ye, Yan, Huang, Mao, Ge et al., 2019). However, relevant available research concentrated on the impact of maternal stress, depression, personality trait or self-esteem, maternal education on the language development of children (Saccani, Valentini, Pereira, Muller, & Gabbard, 2013; Valla, Birkeland, Hofoss, & Slinning, 2017; Ye et al., 2019).

The role of mothers' self-esteem is more important for the child motor development. Mothers with greater intellectual ability possesses higher self-esteem and are thus more likely to communicate positive attitude and good interactions that help develop motor ability of children. Previous literature reported that home environment and parent-child interaction may play a vital role in the development of motor ability (Miquelote, Santos, Cacola, Montebelo, & Gabbard, 2012; Saccani et al., 2013). Surkan et al. (2008) found that mothers' self-esteem is positively correlated with neurodevelopment of children, and after controlling for covariates, an increase of one standard deviation on the self-esteem score in mothers was associated with two unit increase in motor development score of children, which is in line with our finding in relation to the effect of mother's self-esteem.

In our study, self-esteem was positively associated with parenting, and parenting was positively correlated with motor development of the children. Self-esteem is a marker of parenting qualities, and it is speculated that high maternal self-esteem provides positive mother-child interactions leading to better motor development. In another explanation, higher self-esteem mothers may have less depression and stress that in turn provide good intellectual stimulation and emotional support which could be beneficial for motor development (Surkan et al. 2008). However, the present study does not address the issue of maternal depression and stress as intervening variables between mother's self-esteem, and intellectual stimulation and emotional support.

4.4 Maternal Cognitive Function, Covariates, and Child Behavior

Child behavior was measured by five behavior rating scales including approach, emotional tone, activity, cooperation, and vocalization of the underprivileged children. The matrix of correlation divulged that approach, emotional tone, cooperation, and vocalization of children were poorly positively associated with maternal cognitive function, measured by both MMSE and Digit Span scale. Activity was positively correlated with home environment of the children. In addition, cooperation was positively associated with parenting practices and mothers' self-esteem of the children. We didn't find any study that investigated the relationship between maternal cognitive function and child behavior. Furthermore, no study is available focusing on the association between child behavior and home environment, parenting, or mothers' self-esteem.

4.5 Maternal Cognitive Function and Nutrition of Children

Matrix of correlation reported that maternal cognitive function was positively related to HAZ (stunting) and WAZ (underweight) of the underprivileged children. There are only few studies that investigated the association between maternal cognitive function and nutrition of children in the LMICs. One corroborative evidence was found in the study conducted by Wachs, Creed-Kanashiro, Cueto, & Jacoby (2005) in which they highlighted the importance of maternal characteristics (maternal education and maternal intelligence) for the diet and nutritional status of offspring. They found that maternal education and intelligence independently contribute to the nutrition of children. However, it can be assumed that mothers with higher cognitive function have better understanding ability which maximizes child food intake that, in turn, contributes to achieve good nutrition status.

4.6 Strengths and Limitations

The major strengths of this study include the use of Bayley-III, considered as the Gold Standard of neurodevelopmental assessment, which was adapted to Bangladeshi children. Data collectors have intensive training and previous experiences in the field of child development researches. Before the inception of data collection, we have confirmed inter-rater agreement and test-retest reliability. Inclusion of the participants, interviews, and test administration were monitored, that further strengthens the quality of the study. All possible covariates were controlled at the time of data analysis.

Despite the strengths, design of the study had a number of limitations. The study didn't involve any control group comprising children and mothers from well-off families to compare with the children from underprivileged conditions. We cannot select large sample due to limited budget and time constraint. We were therefore unable to detect the mediating factors of child neurobehavioral development using SEM. The outcome variables are measured at only a one-time point assessment, and we are unaware of the neurodevelopmental status over time, especially into the schooling years. The Bayley-III, used to assess neurobehavioral development, was not standardized for Bangladesh. We also do not have information about maternal depression as a covariate of early child neurodevelopment.

Chapter Five: Conclusion

Conclusion

The findings of the study revealed that maternal cognitive function is associated with neurobehavioral development of underprivileged children living in urban slums at a very young age. We found that cognitive, language, and motor development of the children are significantly correlated to their mother's cognitive function, and the correlation exists significantly even after adjusting for the age of children. According to our knowledge, the association we found is the first report of its kind in Bangladesh. Multiple regression analysis further revealed that maternal cognition independently contributes to the cognitive and language development of children, but not to their motor development. It is uncovered that maternal self-esteem is a strong predictor of child motor development. We also found that both home environment and parenting are correlated to cognitive and language domains of neurodevelopment, and maternal cognitive function is connected to child nutrition (HAZ and WAZ). Key learning from the study has been that to optimize child neurobehavioral development we require good maternal cognitive function. Now, an important next step would be to prepare policies and programs to generate maternal cognition and then the comprehensive interventions for the children would be more effective. Thus, the child neurobehavioral development can ultimately be improved.

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Appendices

Appendix A

সম্মতি পত্র

গবেষণার শিরোনাম: ম্যাটারনাল কগনিটিভ ফাংশন এন্ড নিউরোবিহেভিয়েরাল ডিভেলপম্যান্ট অব আনডারপ্রিভিলেজড চিলড্রেন।

তত্ত্বাবধায়ক: অধ্যাপক ডঃ মোঃ কামাল উদ্দিন

যুগ্ম-তত্ত্বাবধায়ক: ডাঃ ফাহমিদা তোফায়েল

গবেষক: আবু ইউসুফ মাহমুদ

প্রতিষ্ঠান: মনোবিজ্ঞান বিভাগ, ঢাকা বিশ্ববিদ্যালয়

গবেষণার উদ্দেশ্যঃ

আস্‌সালামু আলাইকুম/নমস্কার, আমার নাম .... এবং আমি ঢাকা বিশ্ববিদ্যালয়ে পিএইচ.ডি. গবেষক/গবেষকের প্রতিনিধি হিসেবে কাজ করছি। এই গবেষণার মাধ্যমে আমরা দেখতে চাই যে, মায়েদের বুদ্ধির সাথে শিশুদের সার্বিক বিকাশের সম্পর্ক আছে কিনা।

সূচনাঃ

বাংলাদেশে পাঁচ বছরের নিচের শিশুদের অনেকেরই সার্বিক বিকাশ পরিপূর্ণ হয় না। শিশুদের লালন পালন সবসময় সঠিকভাবে হয় না। শিশু লালন পালন সম্পর্কিত পর্যাপ্ত তথ্য না জানার ফলে এবং মায়েদের হতাশা I দুশ্চিন্তা থাকলে এবং মায়েদের বুদ্ধি সঠিকভাবে কাজ না করলে শিশুদের লালন পালন সব সময় সঠিকভাবে হয় না। এর ফলে মা ও শিশু দুজনই স্বাস্থ্যগত দিক থেকে ক্ষতিগ্রস্ত হয়, এর প্রভাব শিশুর প্রারম্ভিক বিকাশের উপর পড়ে। সচেতনতা বাড়ানো ও বুদ্ধির কার্যক্ষমতা স্বক্রিয় করার মাধ্যমে এই পরিস্থিতির খুব সহজেই সমাধান করা যায়।

কেন আপনাকে এই সাক্ষাৎকারে অংশগ্রহণের জন্য আহবান করা হচ্ছেঃ

আমরা আপনাকে এই সাক্ষাৎকারে অংশগ্রহণ করার জন্য আমন্ত্রণ করছি যেহেতু আপনার **১২-৪২** মাস বয়সের শিশু আছে।

কার্যপ্রণালীঃ

আপনি যদি এই গবেষণায় অংশগ্রহণের জন্য রাজি থাকেন তাহলে এই গবেষণায় আমরা আপনার সাথে কিছু কাজ করব। আমরা আপনার শিশুর মানসিক, পেশিগত, ভাষাগত এবং আচরণগত বিকাশ পরিমাপ করব। এছাড়াও আপনার আর্থসামাজিক অবস্থা, আত্মবিশ্বাস, শিশুর পরিচর্যা সম্পর্কিত জ্ঞান-বিশ্বাস, ও চর্চা, বাড়িতে কি ধরনের পরিবেশে শিশু বসবাস করে সে বিষয়ে কিছু প্রশ্ন করব। সম্পূর্ণ পরীক্ষণটি সম্পন্ন হওয়ার জন্য খুব বেশি হলে এক থেকে দেড় ঘন্টা সময় লাগতে পারে।

ঝুঁকি এবং সুবিধাদি ঃ

এই সাক্ষাৎকারে অংশগ্রহণে আপনার কোন ক্ষতি হবে না। গবেষণা চলাকালীন সময়ে আপনার কোন অসুবিধা বা সমস্যা হয় তবে তা আমাদেরকে জানাবেন যাতে আমরা তা সমাধান করতে পারি।

গোপনীয়তা, নামহীনতা ও বিশ্বস্ততা ঃ

আপনার থেকে নেয়া গবেষণা সম্পর্কিত সকল তথ্যের গোপনীয়তা রক্ষা করা হবে।

তথ্যের ভবিষ্যৎ ব্যবহার ঃ

আপনার কাছ থেকে নেয়া তথ্য শুধুমাত্র গবেষণার কাজে ব্যবহার করা হবে। গবেষণালব্ধ তথ্যাদি হয়তোবা অন্যকোন গবেষকদের সাথে উপস্থাপন করা যেতে পারে তবে সেক্ষেত্রে অবশ্যই আপনার নাম পরিচয়ের গোপনীয়তা রক্ষা করা হবে।

গবেষণায় অংশগ্রহণ ও প্রত্যাহারের অধিকার ঃ

এই গবেষণায় অংশগ্রহণ করা সম্পূর্ণ আপনার পছন্দ ও ঐচ্ছিক। আপনি চাইলে কোন বা সব প্রশ্নের উত্তর নাও দিতে পারেন। গবেষণা থেকে যে কোন সময় অংশগ্রহণ না করার সিদ্ধান্ত নিতে পারেন এমনকি গবেষণার মধ্যবর্তী সময়েও আপনি নিজেকে প্রত্যাহার করতে পারবেন।

অংশগ্রহণে আপনার প্রাপ্তি ঃ

পরীক্ষণের সময় আপনার মূল্যবান সময়ের বিনিময়ে ১৫০/- এর সমমানের উপহার ও খাবার দেয়া হবে।

কে এই গবেষণা সম্বন্ধে আমার প্রশ্নের উত্তর দিতে পারবে?

আপনার যদি কোন প্রশ্ন থাকে আমাদেরকে জিজ্ঞাসা করতে পারেন। আপনি এই ফোন নম্বরে +০১৯১৯-৪১২৩৪৩ গবেষণা সংশ্লিষ্ট কোন প্রশ্ন থাকলে জিজ্ঞাসা করতে পারেন। অধিকন্তু আপনি সরাসরি অধ্যাপক ডঃ কামাল উদ্দিনকেও (অধ্যাপক, মনোবিজ্ঞান বিভাগ, ঢাকা বিশ্ববিদ্যালয়) জিজ্ঞাসা করতে পারেন।

আপনি যদি এই গবেষণায় অংশগ্রহণে রাজি থাকেন তাহলে, নীচে স্বাক্ষর দিন অথবা বাম হাতের বৃদ্ধাঙ্গুলির ছাপ দিন। আপনার সহযোগিতার জন্য অনেক ধন্যবাদ।

অংশগ্রহণকারীর নিজের স্বাক্ষর/বাম বৃদ্ধাঙ্গুলির ছাপ	সাক্ষীর স্বাক্ষর/ বাম বৃদ্ধাঙ্গুলির ছাপ	গবেষকের/প্রতিনিধির স্বাক্ষর

Appendix B

"Maternal Cognitive Function and Neurobehavioral Development of Underprivileged Children" Study

1. Name of the Child: ___________________________________
2. Sex of the child: Male=1, Female=2 | _ |
3. Date of birth (Day/Month/Year): | _ | _ |/ | _ | _ | / | _ | _ | _ | _ |
4. Age of the child: _______
5. HH head name: ___________________________________
6. Mother's name: ______________________________
7. Mother's age: ______
8. Mother's education: _________________
9. Address & Mobile No. _________________
10. Date of Interview (Day/Month/Year): | _ | _ |/ | _ | _ | / | _ | _ |
11. Child's Preschool Name: _________________
12. Start Time: / ___ / ___ /. / ___ / ___ / am/pm
13. End time: /___ /___/. /___/___/ am/pm.
14. Tester/Interviewer name & code: ___________________

Edited by: _______________	Date: _____/________/________
Data entered by: ______________	Date: _____/________/________

Appendix C

Socio-Demographic and Economic Information

প্রশ্নসমূহ	কোডিং ক্যাটাগরিসমূহ
১. পরিবারের মোট সদস্য সংখ্যা (কতজন সদস্য একই পাতিলে খায়?)	|___|___|
২. আপনার ধর্ম কি? **১= ইসলাম, ২= হিন্দু, ৩= বৌদ্ধ, ৪= খ্রীস্টান, ৭৭= অন্যান্য উল্লেখ করুন**_______________	|___|___|
৩. বাড়ীর মধ্যে মোট শিশুর সংখ্যা **(শূণ্য থেকে পাঁচ বছর বয়সের)**	|___|___|
৪. মায়ের মোট গর্ভধারণের সংখ্যা **(যতবার অন্তঃসত্ত্বা হয়েছেন)**	|___|___|
৫. তার মোট ছেলে সন্তানের সংখ্যা	|___|___|
৬. তার মোট মেয়ে সন্তানের সংখ্যা	|___|___|
৭. পিতার মূল পেশা কি? **(যদি একটির বেশি পেশা হয়, তাহলে যেটা প্রধান তা উল্লেখ করুন)** **০= বেকার** **১= অনিয়মিত চাকুরী (দিন মজুর, অদক্ষ শ্রমিক, গৃহস্থালী শ্রমিক, রিকশা/ভ্যান চালক, জেলে, অন্যের জমিতে কাজ করেন, সরবরাহকারী প্রভৃতি)** **২= নিয়মিত চাকুরী (নিজস্ব ব্যবসা, দোকানদার, কারুশিল্পী, প্রাইভেট চাকুরী, বেতনভূক্ত, কারখানা এবং অফিসের দক্ষ কর্মচারী, বিক্রয়কর্মী)** **৭৭= অন্যান্য (উল্লেখ করুন)** ____________________	|___|___|
৮. মাতার মূল পেশা কি? **(যদি একটির বেশি পেশা হয়, তাহলে যেটা প্রধান তা উল্লেখ করুন)** **০= গৃহিনী** **১= অনিয়মিত চাকুরী (গৃহস্থালী, অন্যের খামারে কাজ করেন প্রভৃতি)** **২= নিয়মিত চাকুরী (নিজস্ব জমিতে কৃষি কাজ করেন, নিজস্ব ব্যবসা, দোকানদার, কারুশিল্পী, প্রাইভেট চাকুরী, বেতনভুক্ত, কারখানা এবং অফিসের দক্ষ কর্মচারী, মহিলা বিক্রয়কর্মী, সরকারী চাকুরীজীবী)** **৭৭= অন্যান্য (উল্লেখ করুন)** ____________________	|___|___|
৯. মায়ের শিক্ষাগত যোগ্যতা (যে কয় বছর বিদ্যালয়ে পড়েছেন) **১২+ ডিগ্রী/ পাসকোর্স পাশ(পুরানো)= ২ বছর** **১২+ ডিগ্রী/ পাসকোর্স পাশ (নতুন)=৩ বছর** **১২+ অনার্স= ৪ বছর**	|___|___|
১০. পিতার শিক্ষাগত যোগ্যতা (যে কয় বছর বিদ্যালয়ে পড়েছেন) **১২+ ডিগ্রী/ পাসকোর্স পাশ(পুরানো)= ২ বছর** **১২+ ডিগ্রী/ পাসকোর্স পাশ (নতুন)=৩ বছর** **১২+ অনার্স= ৪ বছর**	|___|___|
১১. প্রতি মাসে পরিবারে কত টাকা আয় হয়	
১১.১ প্রতি মাসে পরিবারে কত টাকা ব্যয় হয়	
১২. বিগত ছয় মাসের আয়-ব্যায়ের ঘাটতি (মনে করুন) **১= সবসময় ২= মাঝে মধ্যে ৩ =কখনোই না**	|___|___|
১৩. ঘরের ছাদ কি দিয়ে তৈরী **১= খড় , ২= টিন, ৩= সিমেন্ট, ৭৭= যদি অন্য কিছু হয় উল্লেখ করুন** _______________	|___|___|
১৪. ঘরের মেঝে কি দিয়ে তৈরী **১= মাটি, ২= খড়/বাঁশ, ৩=কাঠ, ৪= সিমেন্ট, ৭৭= যদি অন্য কিছু হয় উল্লেখ করুন** _____	|___|___|
১৫. ঘরের দেয়াল কি দিয়ে তৈরী **১= মাটি, ২= খড়/বাঁশ, ৩= সিমেন্ট, ৭৭= যদি অন্য কিছু হয় উল্লেখ করুন** ____________	|___|___|

১৬. আপনার ঘরে কতগুলো রুম আছে? (শুধু মাত্র যে ঘরগুলো থাকার জন্য ব্যবহার করা হয়, রান্নাঘর অন্তর্ভুক্ত হবে কিন্তু বাথরুম, গোসল খানা অন্তর্ভুক্ত হবে না)	|___|___|
১৭. আপনার ঘরে কি বিদ্যুৎ সংযোগ আছে? **১= না, ২= হ্যাঁ**	|___|
১৮. পানীয় জলের উৎস কি? **১= পুকুরের পানি , ২= সাপ্লাই পানি , ৩= টিউবওয়েলের পানি**	|___|
১৯. সাধারণত কোথায় রান্না করা হয়? **১= যে ঘরে থাকা হয় বা ঘুমানো হয়** **২= একই ঘরে আলাদা রুম রান্নাঘর হিসেবে ব্যবহার হয়** **৩= আলাদা ঘর রান্নাঘর হিসেবে ব্যবহার হয়** **৪= ঘরের বাহিরে** **৭৭= অন্যান্য (উল্লেখ করুন)** ____________________	|___|
২০. আপনার ঘরে কি ধরণের টয়লেট সুবিধা আছে? **১=কোন নির্দিষ্ট জায়গা নেই (কোন টয়লেট সুবিধা নেই, ঝোপঝাড়, মাঠ)** **২=কাঁচা খোলা পায়খানা (ঝুলন্ত, খোলা,খোলা গর্ত)** **৩=সেমি-সেনিটারী (পানি সিল করার ব্যবস্থা আছে)** **৪=সেনিটারী (সেপটিক ট্যাঙ্ক, আধুনিক টয়লেট)**	|___|
২১.আবাসন/বাড়ি- **১= অন্যের জায়গায় ফ্রি থাকে** **২= ভাড়া,** **৩ =নিজের বাড়ী** **৭৭= অন্যান্য (উল্লেখ করুন)** ____________________	|___|

২২. আপনার ঘরে (বা ঘরের যেকোন সদস্যের) কতগুলো জিনিস আছে?

২২.১. আলমারি	হ্যাঁ	না	|___|___|
২২.২. টেবিল	হ্যাঁ	না	|___|___|
২২.৩. ড্রেসিং টেবিল	হ্যাঁ	না	|___|___|
২২.৪. খাবার টেবিল	হ্যাঁ	না	|___|___|
২২.৫. বেঞ্চ বা চেয়ার বা টুল	হ্যাঁ	না	|___|___|
২২.৬. খাট বা বিছানা	হ্যাঁ	না	|___|___|
২২.৭. রেডিও	হ্যাঁ	না	|___|___|
২২.৮. টেলিভিশন	হ্যাঁ	না	|___|___|
২২.৯. ফ্রিজ	হ্যাঁ	না	|___|___|
২২.১০. মোবাইল ফোন	হ্যাঁ	না	|___|___|
২২.১১. বাই সাইকেল	হ্যাঁ	না	|___|___|
২২.১২ রিকশা / ভ্যান	হ্যাঁ	না	|___|___|
২২.১৩ কার / মাইক্রোবাস / মোটর সাইকেল	হ্যাঁ	না	|___|___|
২২.১৪ কম্পিউটার/ ল্যাপটপ	হ্যাঁ	না	|___|___|

২৩. নিচের প্রাণীগুলোর মধ্যে আপনার কয়টি গৃহপালিত পশু-পাখি আছে?

২৩.১. গরু/মহিষ	হ্যাঁ	না	|___|___|
২৩.২. ছাগল	হ্যাঁ	না	|___|___|
২৩.৩. ভেড়া	হ্যাঁ	না	|___|___|
২৩.৪. মুরগী	হ্যাঁ	না	|___|___|
২৩.৫. হাঁস	হ্যাঁ	না	|___|___|
২৩.৬. কবুতর	হ্যাঁ	না	|___|___|

Appendix D

শিশুর পরিচর্যা বিষয়ে প্রশ্নাবলী

(Parenting)

তথ্য প্রদানকারীকে বলুন: "এখানে কোন সঠিক বা ভুল উত্তর বলে কিছু নেই। আমরা শুধু আপনার মতামত জানতে চাই । আমি আপনাকে একটি প্রশ্ন করব, অত:পর প্রশ্নটির কয়েকটি সম্ভাব্য উত্তর বলব। আপনি আপনার জন্য প্রযোজ্য উত্তরটি আমাকে বলবেন।"

P_01	বাচ্চার (নাম) মধ্যে ভালো কিছু দেখলে যেমন; সুন্দর কাপড় বা জামা পরলে অথবা বাচ্চা কোন ভাল কাজ করলে আপনি কি তখন তাকে প্রশংসা করেন?	কখনও প্রশংসা করি না = ০, খুব কম প্রশংসা করি= ১, মাঝে মাঝে করি= ২, সব সময় প্রশংসা করি = ৩	|__|
P_02	বাচ্চারা কথা না শুনলে বা দুষ্টামি করলে কেউ কেউ মারধর করেন, আপনি কি মনে করেন?	অবশ্যই মার দেওয়ার দরকার আছে=০ মাঝে মাঝে মারতে হয়=১, একটু আধটু মারতে হয়=২, একদম মার দেওয়া উচিৎ না=৩	|__|
P_03	আপনি যতই ব্যস্ত থাকেন না কেন, বাড়ীর কাজের সময় যেমন -ঘর পরিষ্কার বা রান্না করার সময় বাচ্চার (নাম) সাথে কতটা কথা বলেন ?	এত ব্যস্ত যে কথা বলার সময় পাইনা =০ খুব কম কথা বলি =১ মাঝে মাঝে কথা বলি =২ বেশীর ভাগ সময় কথা বলি =৩	|__|
P_04	আপনি যতই ব্যস্ত থাকেন না কেন কাজের ফাঁকে ফাঁকে যেমন- ঘর পরিস্কার বা রান্না করার সময় বাচ্চার (নাম) সাথে কতটা খেলা করেন?	এত ব্যস্ত যে খেলা করার সময় পাইনা =০ ওর সাথে খুব কম খেলি =১ মাঝে মাঝে খেলা করি =২ বেশীর ভাগ সময় ওর সাথে খেলা করি =৩	|__|
P_05	তিন বছরের নীচের বাচ্চাদের লেখাপড়া শেখানো যেমন অ, আ, ক, খ বা যোগ বিয়োগ শেখানো কতটা দরকার বলে আপনি মনে করেন?	জানিনা/অবশ্যই শেখানো দরকার=০, মাঝে মাঝে শেখানো দরকার=১, একটু আধটু শেখাতে পারি=২, তিন বছরের আগে শেখানো উচিৎ না=৩	|__|
P_06	লবণে আয়োডিন আছে কিনা তা ঘরে বসে পরীক্ষা করা সম্ভব। আপনি কি পরীক্ষা করে দেখেছেন ?	কখনো পরীক্ষা করিনি =০, খুব কম করি=১ মাঝে মধ্যে করি =২ সব সময় করি =৩	|__|
P_07	বাচ্চাদের অসুখের সময়, যেমন- জ্বর,কাশি ঠান্ডা ডায়রিয়ায় কোন কোন মা বাচ্চাকে বুকের দুধ বন্ধ করে দেয়, আপনি কি করেন/ করেছেন?	জানিনা/বুকের দুধ বন্ধ করে দেই/দিয়েছি =০, বেশীরভাগ সময়ের জন্য বন্ধ করে দেই/ দিয়েছি =১, মাঝে মাঝে বন্ধ করে দেই/দিয়েছি =২ অসুস্থ থাকলেও বন্ধ করা উচিৎ না =৩	|__|

P_08	উচ্চতার সাথে বাচ্চাদের বুদ্ধি বিকাশের কোন সম্পর্ক আছে বলে কি আপনি মনে করেন?	জানিনা/ না=০, হ্যাঁ=১	|__|
P_09	ওজনের সাথে বাচ্চাদের বুদ্ধি বিকাশের কোন সম্পর্ক আছে বলে কি আপনি মনে করেন?	জানিনা/ না=০, হ্যাঁ=১	|__|
P_10	বাচ্চাদের বুদ্ধি বিকাশের জন্য খাবারের মধ্যে আয়রণ বা আয়রণ সমৃদ্ধ খাবারের কি দরকার আছে?	জানিনা/কোন দরকার নেই =০ একটু আধটু দরকার =১ কিছুটা দরকার =২ যথেষ্ট আয়রন দরকার =৩	|__|
(নীচের উত্তরগুলো পড়ে শুনাবেন না , মায়ের উত্তরগুলো লিখুন এবং নীচের উত্তরের সাথে মিলিয়ে স্কোর করুন)			
P_11	কোন কাজ শেখাতে গেলে বাচ্চা কিছুটা ঠিক ভাবে করে কিছুটা ভুল ভাবে করে। এখন কোন কাজ পুরোটা ঠিক ভাবে শেখানোর জন্য আপনি কি করেন?	যেটুকু ঠিক ভাবে করতে পেরেছে তার জন্য বার বার প্রশংসা করি=১ যেটুকু ভুল করেছে তা বার বার ঠিক করে করতে বলি =০	|__|
P_12	খাওয়ানোর সময় বাচ্চা যদি ঠিকমত খেতে না চায় তবে কি কি কায়দা করে খাওয়ান ? ক) অল্প অল্প করে খাওয়াই/ বারে বারে ধৈর্য্য ধরে খাওয়াই/ বিভিন্ন রকমের খাবার দেই খ) আদর যত্ন করি/ কোলে নিয়ে বসাই গ) গল্প করি/ গান গাই/ ছড়া বলি গ) এটা ওটা দেখাই/ অভিনয় করি/ খেলা করি অন্যান্য (উল্লেখ করুন) __________	জোর করে খাওয়াই, মার দেই, বকা দেই, ভয় দেখাই, লোভ দেখাই + অন্য যেকোন উত্তর =০ একটি উত্তর বা টিকের জন্য=১ , দুটি উত্তর বা টিকের জন্য =২ , দুয়ের অধিক =৩	|__|
P_13	বাচ্চা যাতে সময়মত কথা বলতে এবং বুঝতে পারে সে জন্য আপনি কি কি করেন ? ক) বিভিন্ন জিনিস (যেমন: ছবির নাম / রং এর নাম/ মানুষের নাম/পশুপাখীর নাম ইত্যাদি) এর নাম শিখাই খ) কথা বলতে বলতে শিখাই / বারে বারে কথা বলি গ) গল্প/ছড়া/কবিতা/গান করি ঘ) অভিনয় করি/ খেলা করি অন্যান্য (উল্লেখ করুন) __________________	কিছু করি না,কথাতো এমনি এমনি শিখবে =০, একটি উত্তর বা টিকের জন্য=১, দুটি উত্তর বা টিকের জন্য=২, দুয়ের অধিক=৩	|__|
P_14	আপনার বাচ্চাকে (নাম) ছবির বই দেখিয়ে কি কি করেন বা শেখান ? ক) জিনিসের নাম যেমন;ছবির নাম / রং এর নাম/ মানুষের নাম/পশুপাখীর নাম) শেখাই খ) কবিতা/ গান/ গল্প করে শেখাই গ)অভিনয়/ খেলা করে শেখাই অন্যান্য (উল্লেখ করুন) ________________________	শিখাই না বা শেখানো যায় না =০ একটি উত্তর বা টিকের জন্য =১, দুটি উত্তর বা টিকের জন্য=২, দুয়ের অধিক=৩	|__|
P_15	আপনার বাচ্চার (নাম) সাথে পুতুল দিয়ে কি কি করেন বা শেখান ? ক) বিভিন্ন জিনিসের নাম (যেমন: শরীরের অংশ, কাপড়ের নাম ইত্যাদি) শেখাই খ) আদর করা/প্রশংসা করা শেখাই গ) গল্প/ছড়া/ গান/ কবিতা বলি ঘ) খেলা করি অন্যান্য (উল্লেখ করুন) _______________________	আমি কিছু করিনা, ও নিজে নিজে খেলতে থাকে=০, একটি উত্তর বা টিকের জন্য=১, দুটি উত্তর বা টিকের জন্য=২, দুয়ের অধিক =৩	|__|
P_16	আপনার বাচ্চার (নাম) হাতে কাগজ কলম দিয়ে কিছু কি শেখান বা ওকে সাথে নিয়ে কিছু করেন?	আমি কিছু করিনা =০, ও নিজে নিজে আঁকাআঁকি করে =০,	|__|

	ক) দাগাদাগি করা শেখাই খ) কলম ধরা শেখাই গ) কাগজ দিয়ে কিছু বানানো শেখাই ঘ) রংয়ের নাম শেখাই ঙ) আদরকরি/প্রশংসা করি; অন্যান্য (উল্লেখ করুন) _____	লেখালেখি শেখাই =০ একটি উত্তর বা টিকের জন্য = ১, দুটি উত্তর বা টিকের জন্য =২, দুয়ের অধিক =৩	
P_17	আপনার বাচ্চাকে (নাম) কাপড় পড়ানোর সময় কি কি করেন বা শেখান? ক) বিভিন্ন জিনিসের নাম (যেমনঃ শরীরের বিভিন্ন অংশের নাম, কাপড়ের নাম, রংয়ের নাম ইত্যাদি) শেখাই খ) কাপড় পরা শেখাই, গ) আদর করি/ প্রশংসা করি ঘ) গল্প/ছড়া/ গান/ কবিতা বলি ঙ) খেলা করি/ অভিনয় করি অন্যান্য (উল্লেখ করুন) ______________________	কিছু করিনা বা শেখাইনা =০ একটি উত্তর বা টিকের জন্য = ১, দুটি উত্তর বা টিকের জন্য =২, দুয়ের অধিক =৩	|__|
P_18	আপনার বাচ্চাকে (নাম) গোসল করাবার সময় ওকে নিয়ে কি কি করেন এবং ওকে কি কি শেখান? ক) বিভিন্ন জিনিষের নাম (যেমন; শরীরের অংশের নাম , মগ / বালটির নাম,কাপড়ের নাম ইত্যাদি) শেখাই খ) ময়লা / পরিস্কার নিয়ে কথা বলি/ গরম- ঠান্ডা ইত্যাদি নিয়ে কথা বলি গ) খেলা করি/ অভিনয় করি, ঘ) গান করি/ছড়া/গল্প/ কবিতা বলি অন্যান্য (উল্লেখ করুন) ___________________	কিছু করিনা বা শেখাইনা =০, একটি উত্তর বা টিকের জন্য= ১, দুটি উত্তর বা টিকের জন্য =২, দুয়ের অধিক =৩	|__|
P_19	আপনার বাচ্চাকে (নাম) কি বাইরে বেড়াতে নিয়ে যান বা ঘুরাতে নিয়ে যান, তখন ওর সাথে কি কি করেন বা ওকে কি কি শেখান ? ক) বিভিন্ন জিনিষ দেখিয়ে নাম (যেমনঃ আশেপাশের মানুষের, জীবজন্তুর নাম ইত্যাদি) শেখাই খ) খেলা করি গ) আদর করি/ প্রশংসা করি ঘ) গল্প/ কবিতা/ গান করি ঙ) আদব কায়দা শেখাই চ) দিন/রাত, ঠান্ডা/গরম, আলো/অন্ধকার সম্পর্কে ধারনা দেই অন্যান্য (উল্লেখ করুন) _________________________	কিছু করি না বা শেখাইনা =০ একটি উত্তর বা টিকের জন্য = ১ , দুটি উত্তর বা টিকের জন্য =২, দুয়ের অধিক =৩	|__|
P_20	বাচ্চাকে যখন কিছু শেখাতে চাচ্ছেন, তখন যদি সে ঐ কাজটা না করে অন্য কিছু করতে চায়, তখন আপনি কি করেন? ক) আদর করে শিখাই/ ভালোবেসে/ ধৈর্য্য ধরি খ)মজার মজার কথা বলে বাচ্চার মনোযোগ আকর্ষন করার চেষ্টা করি গ) খেলার মাধ্যমে আনন্দ দিয়ে বাচ্চার মনোযোগ আকর্ষন করার চেষ্টা করি ঘ) ও যেটা করতে চায় সেটা নিয়ে তাকে শেখানোর জন্য চেষ্টা করি; অন্যান্য (উল্লেখ করুন)________________	এমনি ছেড়ে দেওয়া /জোর করা/মার দেওয়া/বকা দেওয়া = ০, জোর করা/মার দেওয়া/বকা দেওয়া + অন্য যে কোন উত্তর =০ একটি উত্তর বা টিকের জন্য = ১, দুটি উত্তর বা টিকের জন্য =২, দুইয়ের অধিক =৩	|__|

Appendix E

নং	প্রশ্ন	কোড	উত্তর
	Child Care Infant/Toddler HOME		
	Emotional and Verbal Responsivity of Caregiver		
H_1	পরিদর্শন চলাকালীন সময়ে বাবা মা বাচ্চার সাথে সাক্ষাৎকারের সময় ২ বার স্বতঃস্ফূর্ত ভাবে কথা বলেন। **O** *(স্বতঃস্ফূর্তভাবে উত্তর দিলে বা আওয়াজ করলে=1, (স্বতঃস্ফূর্তভাবে উত্তর না দিলে বা আওয়াজ না করলে=0।)*	১= হ্যাঁ, ০= না	__
H_2	বাচ্চা মুখে কথা বললে/ শব্দ করলে মা মৌখিকভাবে সাড়া দেন। **O**	১= হ্যাঁ, ০= না	__
H_3	পরিদর্শন চলাকালীন সময়ে বাবা মা বাচ্চাকে শেখানোর উদ্দেশ্যে কোন জিনিসের নাম বা ব্যক্তির নাম বলেছে। **O** *(এর উত্তর হ্যাঁ হলে 19 নম্বর প্রশ্নেও স্কোর পাবে।)*	১= হ্যাঁ, ০= না	__
H_4	বাবা মার কথা স্পষ্ট, পরিষ্কার এবং সহজে শোনা যাচ্ছিল। **O**	১= হ্যাঁ, ০= না	__
H_5	বাবা-মা নিজ থেকেই পরিদর্শনকারীর সাথে কথোপকথন শুরু করে। **O** *(প্রশ্নের উত্তরের বাইরে মতামত দিলে=1, না দিলে=0)*	১= হ্যাঁ, ০= না	__
H_6	বাবা মা কোন সংকোচ ছাড়াই সহজভাবে পরিদর্শনকারীর সাথে বিশদভাবে মতামত দিচ্ছিল। **O** *(সংক্ষিপ্ত উত্তরের চেয়ে বেশী কথা বলছিল বা এক শব্দের বেশী কথা বলে বা একটু বেশী কথা বলে উত্তর দিলে=1, না দিলে=0)*	১= হ্যাঁ, ০= না	__
H_7	পরিদর্শন চলাকালীন সময়ে বাবা মা স্বতঃস্ফূর্তভাবে বাচ্চার গুণাবলী বা আচরণ নিয়ে কমপক্ষে দুইবার প্রশংসা করেছিল। **O**	১= হ্যাঁ, ০= না	__
H_8	বাবা-মার কথায় বা বাচ্চার সাথে কথা বলার সময় ইতিবাচক অনুভূতি প্রকাশ পাচ্ছিল। **O**	১= হ্যাঁ, ০= না	__
H_9	পরিদর্শন চলাকালীন সময়ে বাবা- মা কমপক্ষে একবার বাচ্চাকে আদর করেছিল। **O** *(চুমা দেওয়া, হাত বুলানো, জড়ায় ধরা বা হাল্কা চাপড়)*	১= হ্যাঁ, ০= না	__
H_10	পরিদর্শন চলাকালীন সময়ে পরিদর্শনকারী বাচ্চার কোন প্রশংসা করলে পরিচর্যাকারী খুশীর ভাব বা ইতিবাচক প্রতিক্রিয়া প্রকাশ করেছিল। **O** *(পরিচর্যাকারী যদি সাথে সাথে একমত পোষণ করলে=1, না করলে=0)*	১= হ্যাঁ, ০= না	__
H_11	পরিদর্শনকালীন সময়ে বাবা-মা বাচ্চার সাথে হেসেছিল বা বাচ্চার দিকে তাকিয়ে হেসেছিল।	১= হ্যাঁ, ০= না	__
	Avoidance of Restriction and Punishment		
H_12	বাবা-মা বাচ্চার সাথে চিৎকার করে নাই । **O**	১= হ্যাঁ, ০= না	__
H_13	বাবা-মা বাচ্চার প্রতি খুব বেশী বিরক্ত / আক্রমনাত্বক আচরণ দেখায় নাই। **O**	১= হ্যাঁ, ০= না	__
H_14	পরিদর্শন চলাকালীন সময়ে বাবা- মা শিশুকে চড়/ পাছায় থাপ্পর কোনটাই দেয় নাই। **O**	১= হ্যাঁ, ০= না	__
H_15	গত সপ্তাহে বাচ্চাকে (নাম) একবারও শারীরিক শাস্তি (আস্তে বা হাল্কা) দিয়েছিলেন? **I**	১= হ্যাঁ, ০= না	__
H_16	পরিদর্শন চলাকালীন সময়ে বাবা- মা শিশুকে বকা দেয় নাই/ শিশুর সমালোচনা করে নাই।**O**	১= হ্যাঁ, ০= না	__
	Caregiver Promotes Child Development		
H_17	পরিদর্শন চলাকালীন সময়ে বাবা- মা বাচ্চার প্রতি খেয়াল রেখেছিলো এবং তার দিকে বার বার তাকাচ্ছিল। **O**	১= হ্যাঁ, ০= না	__

H_18	বাবা-মা কি ঘরের কাজ করার সময় বাচ্চার (নাম) সাথে কথা বলেন? **I**	১= হ্যাঁ, ০= না	|__|
H_19	বাবা-মা সচেতনভাবে বা বুঝেশুনে বাচ্চাকে (নাম) কিছু শেখানোর জন্য উৎসাহ দেন? **I** *(যেমন হাত, পা, 1 , 2 শেখানো, মা-বাবার নাম শেখানো, বিভিন্ন জিনিসের নাম শেখানো)*	১= হ্যাঁ, ০= না	|__|
H_20	বাচ্চা(নাম) দিনে কি কি করে? যেমন ঘুম থেকে উঠে কি কি করে? **I** *(নির্দিষ্ট নিয়ম থাকলে=1, না থাকলে=0)*	১= হ্যাঁ, ০= না	|__|
H_21	আপনার বাচ্চা(নাম) কিভাবে কোন কাজ করা শিখেছে? যেমন নিজের হাতে খাওয়া। **I** *(মা শিখিয়েছে, দেখে শিখেছে, অন্য কেউ শিখিয়েছে=1, মা জানেনা =0)*	১= হ্যাঁ, ০= না	|__|
Organization of Physical and Temporal Environment			
H_22	আপনি যখন বাচ্চাকে(নাম) রেখে বাড়ির বাইরে যান তখন কে বাচ্চাকে দেখাশুনা করে? **I** *(নিয়মিত 1-3 জন দেখাশুনা করলে = 1, যেকোনো একজন বা কেউ নাই বা আমি জানি না = 0)*	১= হ্যাঁ, ০= না	|__|
H_23	বাচ্চাকে(নাম) কি অন্য কোন বাচ্চা দেখাশুনা করে? তার বয়স কত? **I** *(যদি কমপক্ষে 12 বছর হয় =1, যদি বয়স 12 বছরের নিচে হয় = 0)*	১= হ্যাঁ, ০= না	|__|
H_24	বড় বাচ্চা বা বাড়ির অন্য কেউ বাচ্চাকে (নাম) অস্বাভাবিকভাবে (এলোমেলোভাবে) ধরে না বা নাড়াচাড়া করেনা, তাইনা ? **I**	১= হ্যাঁ, ০= না	|__|
H_25	বাচ্চাকে(নাম) কি প্রায়ই মার্কেটে বা বাজারে সাথে করে নিয়ে যান? **I** *(সপ্তাহে কমপক্ষে একবার = 1, না = 0)*	১= হ্যাঁ, ০= না	|__|
H_26	আপনি বাচ্চাকে(নাম) কতবার স্বাস্থ্যকেন্দ্রে নিয়ে গিয়েছেন (টিকা দিতে বা ওজন নিতে)?**I** *(নিয়মিত পরীক্ষা-নিরীক্ষার জন্য নিয়ে গেলে/ ই, পি, আই টীকা সব দিলে = 1, না গেলে = 0)*	১= হ্যাঁ, ০= না	|__|
H_27	বাচ্চার(নাম) খেলনা বা জিনিসপত্র রাখার জন্য নির্দিষ্ট কোন জায়গা আছে কি? **E** *(নির্দিষ্ট কোন জায়গা থাকলে = 1, না থাকলে = 0)*	১= হ্যাঁ, ০= না	|__|
H_28	বাচ্চার খেলার পরিবেশ নিরাপদ বা ঝামেলামুক্ত কিনা? **O**	১= হ্যাঁ, ০= না	|__|
H_29	চুলা অপেক্ষাকৃত উচু বা নিরাপদ স্থানে আছে? **O**	১= হ্যাঁ, ০= না	|__|
H_30	ঘরে পর্যাপ্ত আলো আছে? **O**	১= হ্যাঁ, ০= না	|__|
H_31	ঘরে পর্যাপ্ত বাতাস চলাচল করে? **O**	১= হ্যাঁ, ০= না	|__|
H_32	বাড়িঘর মোটামুটি পরিস্কার? **O**	১= হ্যাঁ, ০= না	|__|
H_33	বাড়িঘর মোটামুটি গোছানো? **O**	১= হ্যাঁ, ০= না	|__|
Provision of Appropriate Play Materials			
H_34	বাচ্চা(নাম) কি কি দিয়ে খেলতে পছন্দ করে? **E** *(কোন কিছুর নাম বললে = 1, না বললে = 0)*	১= হ্যাঁ, ০= না	|__|
H_35	যে সব খেলনা বা খেলনা সামগ্রী দিয়ে খেলার জন্য পেশী সঞ্চালন হয় সে সব খেলনা আছে কি? **E**	১= হ্যাঁ, ০= না	|__|
H_36	পরিদর্শন চলাকালীন সময়ে বাবা-মা বাচ্চাকে কোন খেলনা দিয়েছে? **O**	১= হ্যাঁ, ০= না	|__|

***** O = Observation, I = Interview, E = Either**

Appendix F

HOW I THINK ABOUT MYSELF (Self-Esteem)

আপনার নিজের সম্পর্কে আপনি কি ভাবেন, সে ব্যাপারে আমি আপনাকে কিছু কথা বলবো। আপনি খুব মন দিয়ে শুনবেন। সেই সাথে আমি আপনাকে কিছু মতামত বলবো তা আপনার মতের সাথে মিলতেও পারে নাও পারে। আপনার কাছে যে মতামত সঠিক বলে মনে হবে বা যেটা আপনার মতের সাথে মিলবে তা আমাকে বলবেন । যদি কোন কথা বুঝতে অসুবিধা হয় তবে আমাকে জিজ্ঞাসা করবেন।

No	Question	পুরোপুরি মানি	কিছুটা মানি	ভাবি নাই	কিছুটা মানিনা	পুরোপুরি মানিনা	উত্তর
SE_1	আপনি **মানুষের উপকারে** আসতে পারেন। (মানুষ মানে আপনার ঘরের ও বাইরের সবাই)	৪	৩	২	১	০	
SE_2	আপনার বয়সী **অন্যান্যরা কোন কাজ যত ভালভাবে** করতে পারে **আপনিও** সেরকম পারেন ।	৪	৩	২	১	০	
SE_3	(আমরা অনেক কিছু করি বা আমাদের অনেক কিছু আছে যা নিয়ে গর্ব করি। তবে গর্ব বলতে অহংকার, দেমাগ বা গরিমা বলছিনা) আপনার মধ্যে **গর্ব করার মত** তেমন কিছুই নাই। (মা যদি বলেন 'মানি' তখন মাকে বলবেন, তাহলে আপনি বলতে চাচ্ছেন আপনার মধ্যে **গর্ব করার মত** তেমন কিছুই নাই?)	০	১	২	৩	৪	
SE_4	মাঝে মাঝে মনে হয় আপনি **কোন কাজেরই না**। (মা যদি বলেন 'মানি' তখন মাকে বলবেন, তাহলে আপনি বলতে চাচ্ছেন আপনি **কোন কাজেরই না?**)	০	১	২	৩	৪	
SE_5	আপনি মনে করেন আপনি আর পাঁচটা **ভালো মানুষের মতই** একজন ভালো মানুষ।	৪	৩	২	১	০	
SE_6	আপনার মনে হয় আপনি কোন **কিছুই ঠিকমত** করতে পারেন না। (মা যদি বলেন 'মানি না' তখন মাকে বলবেন, তাহলে আপনি বলতে চাচ্ছেন আপনি সব **কিছুই ঠিকমত** করতে পারেন?)	০	১	২	৩	৪	
SE_7	আপনি যখনই কিছু করেন তা **সবসময়ই** ভালোভাবে করেন।	৪	৩	২	১	০	
SE_8	আপনি আসলে জীবনে **কিছুই করতে** পারেন নাই। (মা যদি বলেন 'মানি ' তখন মাকে বলবেন, তাহলে আপনি বলতে চাচ্ছেন - আপনি জীবনে কোন **কিছুই করতে** পারেন নাই?)	০	১	২	৩	৪	

Appendix G

Mini–Mental State Exam

To the interviewer: Please take note of the special instruction in the administration manual provided in your kit. Make sure you have the right tools with you before giving this assessment.

সাক্ষাৎকারগ্রহীতার প্রতি নির্দেশনা: দয়া করে আপনাকে দেয়া ম্যানুয়ালের বিশেষ নির্দেশনা মেনে চলুন, মূল্যায়ন শুরুর পূর্বে নিশ্চিত হোন যে আপনার কাছে সঠিক টুলগুলো আছে। যেমন: ঘড়ি, সাদা কাগজ, বিশ টাকার নোট ইত্যাদি।

হ্যাঁ=১, না=০, জানি না=৯৯

MMSE				
MQ1	What day of the week is it? (can give English or Bangla) আজকে সপ্তাহের কোন্ দিন ? (বাংলা বা ইংরেজীতে দেয়া যাবে)	0	1	99
MQ2	What is the day today? (can give English or Bangla) আজকে কত তারিখ? (বাংলা বা ইংরেজীতে দেয়া যাবে)	0	1	99
MQ 3	What is the month? (can give English or Bangla) এটা কোন্ মাস (বাংলা বা ইংরেজীতে দেয়া যাবে)	0	1	99
MQ4	What is the year? (can give English or Bangla) এটা কোন বছর? (বাংলা বা ইংরেজীতে দেয়া যাবে)	0	1	99
MQ5	What country are we in? আমরা কোন্ দেশে আছি?	0	1	99
MQ6	What thana are we in? আমরা কোন্ থানাতে আছি?	0	1	99
MQ7	What is the name of the village you are in now? আপনি এখন যে এলাকাতে আছেন তার নাম কি?	0	1	99
MQ8	What is the name of the Prime Minister of this country? এই দেশের প্রধানমন্ত্রীর নাম কি? **সাক্ষাৎকার গ্রহণকারী ঃ উত্তর হবে শেখ হাসিনা**	0	1	99
	Interviewer: Answer is Sheikh Hasina			
Interviewer Say: *"I am going to name three objects. After I have said them. I want you to repeat them. Remember what they are because I am going to ask you to name them again in a few minutes:* ***Orange, House, Cat****."* **সাক্ষাৎকার গ্রহণকারী বলবেন/বলুন ঃ** *আমি তিনটি জিনিসের নাম বলব। আমি বলার পর আপনি পুনরায় বলবেন এবং সেগুলো কি তা মনে রাখবেন- কারণ কয়েক মিনিট পর আপনাকে আবার জিজ্ঞেস করব: কমলা, বাসা, বিড়াল*				
Interviewer Say: *"Now we are going to play some games with numbers. This is sometimes hard for people, just try to do the best you can."* **সাক্ষাৎকার গ্রহণকারী বলবেন/বলুন ঃ** *এখন আমরা সংখ্যা দিয়ে কিছু খেলা খেলব। কারো কারো জন্য এটা একটু কঠিন হতে পারে, তবে আপনার সাধ্যমত চেষ্টা করবেন।*				
MQ9	If I have 20 taka and give you 5 taka, how much do I have left? আমার কাছে যদি ২০ টাকা থাকে এবং আপনাকে ৫ টাকা দেই, আমার কাছে কত থাকবে?	0	1	99
	Interviewer: Answer is 15 Tk **সাক্ষাৎকার গ্রহণকারী ঃ সঠিক উত্তর হল ১৫ টাকা।**			
MQ10	If one kilogram of rice costs 20 Taka, how much would 2 kilograms of rice cost? **Interviewer: Answer is 40 Tk** যদি এক কেজি চালের দাম ২০ টাকা হয়, তবে দুই কেজি চালের দাম কত? **সাক্ষাৎকার গ্রহণকারী ঃ সঠিক উত্তর হল ৪০ টাকা।**	0	1	99

MQ11	How much would three kilograms of rice cost? **Interviewer: Answer is 60 Tk** তিন কেজি চালের দাম কত? **সাক্ষাৎকার গ্রহণকারী ঃ সঠিক উত্তর হল ৬০ টাকা।**	0	1	99
MQ12	How much would four kilograms of rice cost? **Interviewer: Answer is 80 Tk** চার কেজি চালের দাম কত? **সাক্ষাৎকার গ্রহণকারী ঃ সঠিক উত্তর হল ৮০ টাকা।**	0	1	99
MQ13	**Interviewer: Show the subject a 20 Tk piece.** How many 20 taka pieces does it take to make 100 taka? **Interviewer: Answer is 5 20-Tk pieces.** **সাক্ষাৎকার গ্রহণকারী ঃ সাবজেক্টকে একটি ২০ টাকার মুদ্রা দেখান। কয়টা ২০ টাকা মিলে একশ টাকা হয়? সাক্ষাৎকার গ্রহণকারী ঃ সঠিক উত্তর হল ২০ টাকার ৫ টি নোট।**	0	1	99
MQ14	If someone gave you this amount of change from 100 taka, how much would you have spent? **Interviewer: Answer is 80 Tk** যদি আপনাকে কেউ একশ টাকা থেকে ২০ টাকা ফেরত দেয় ,তাহলে আপনি কত টাকা খরচ করেছেন ? **সাক্ষাৎকার গ্রহণকারী ঃ সঠিক উত্তর হল ৮০ টাকা।**	0	1	99
MQ15	Do you remember the three objects I asked you to remember a few minutes ago? **(Interviewer circle all the objects they remember)** কিছুক্ষন আগে যে তিনটি জিনিসের নাম বলেছি ,আপনার কি সেগুলো মনে আছে ? **(তারা যেগুলো মনে করতে পারবে, সাক্ষাৎকার গ্রহণকারী সেগুলো গোল দাগ দিবে।** A. Orange (**কমলা**)	0	1	99
	B. House (বাসা)	0	1	99
	C. Cat (বিড়াল)	0	1	99
MQ16a	Now can you subtract 7 from 100? এখন আপনি কি ১০০ থেকে ৭ বিয়োগ করতে পারবেন?	0		1
	Interviewer: Answer is 93 **সাক্ষাৎকার গ্রহণকারী : উত্তর হল ৯৩**			
MQ16b	Can you subtract 7 from this answer?			
	Interviewer: Answer is 86. Answer is also correct if difference between answer in 16a and 16b is 7 even if 16a was incorrect. আপনি কি এই উত্তর থেকে ৭ বিয়োগ করতে পারবেন? সাক্ষাৎকার গ্রহণকারী ঃ উত্তর হল ৮৬। 16a এর উত্তর ভুল হওয়া সত্ত্বেও সঠিক হিসেবে গন্য হবে যদি 16a এবং 16b এর উত্তরের পার্থক্য ৭ হয়।	0		1
MQ16c	Can you subtract 7 from this answer?	0		1
Interviewer: Answer is 79. Answer is also correct if difference between answer in 16a and 16b is 7 even if 16a was incorrect. আপনি কি এই উত্তর থেকে ৭ বিয়োগ করতে পারবেন? সাক্ষাৎকার গ্রহণকারী ঃ উত্তর হল ৭৯। 16a এবং 16b এর উত্তর ভুল হওয়া সত্ত্বেও সঠিক হিসেবে গন্য হবে যদি 16b এবং 16c এর উত্তরের পার্থক্য ৭ হয়।				
Interviewer Say: *"I will now point to some things and I would like you to tell me the name of the objects"* **সাক্ষাৎকার গ্রহণকারী বলবেন ঃ** *এখন আমি আপনাকে কিছু জিনিস ইশারা করে দেখাব এবং আপনি আমাকে জিনিস গুলোর নাম বলবেন।*				
MQ 17	**(Interviewer. Hold up a pen**) What is this called? (**সাক্ষাৎকার গ্রহণকারী ঃ একটি কলম ধরুন**) এটা কি?	0	1	99
MQ18	**(Interviewer. Point to watch)** What is this called? (**সাক্ষাৎকার গ্রহণকারী ঃ ঘড়ির দিকে ইশারা করুন**) এটার নাম কি?	0	1	99
MQ19	**(Interviewer. Point to tool)** What is this called? (**সাক্ষাৎকার গ্রহণকারীঃ পিড়ির দিকে ইশারা করুন**) এটার নাম কি?	0	1	99
MQ20	**(Interviewer. Show your knuckles)** What do we call these? (**সাক্ষাৎকার গ্রহণকারীঃ আপনার হাতের কড়া দেখান**) আমরা এগুলোকে কি বলি?	0	1	99
MQ21	**(Interviewer. Point to your elbow)** What do we call these? (**সাক্ষাৎকার গ্রহণকারীঃ আপনার হাতের কনুই দেখান**) আমরা এগুলোকে কি বলি?	0	1	99

MQ22	**(Interviewer, Point to your shoulder)** What do we call this part of our body? **(সাক্ষাৎকার গ্রহণকারীঃ আপনার কাঁধের দিকে ইশারা করুন)** আমাদের শরীরের এই অংশকে আমরা কি বলি?	0	1	99
MQ23	Now I am going to say some words and I would like you to repeat them back to me: Paka papay kaca papaya **Interviewer: allow only 1 trial. Code "1" requires perfect articulation of the words.** এখন আমি আপনাকে কিছু শব্দ বলব এবং শব্দগুলো আপনি আবার আমাকে বলবেন । পাকা পেঁপে, কাঁচা পেঁপে । **সাক্ষাৎকার গ্রহণকারী ঃ শুধুমাত্র একবার ট্রায়াল দেবেন। '১' স্কোর পেতে হলে শব্দগুলো একেবারে সঠিকভাবে উচ্চারণ করতে হবে।**	0	1	99

Interviewer. Read the full statement below and then hold out a blank piece of paper and tell the following instructions to the respondent. Do not repeat the instructions, give demonstrations or coach the respondent. Give the instruction ONLY ONCE. "*Take this piece of paper in your right hand, fold the paper in half, and put the paper down on your lap."* **সাক্ষাৎকার গ্রহণকারী ঃ নিচের সম্পূর্ণ লেখাটা পড়ুন, তারপর একটি সাদা কাগজ ধরুন এবং নিম্নের নির্দেশনা অংশগ্রহনকারীকে বলুন। নির্দেশনা পুনরাবৃত্তি করা অথবা শিখিয়ে দেয়া যাবেনা ।** *"কাগজটি ডান হাতে নিন, কাগজটি অর্ধেক ভাঁজ করুন এবং কাগজটি কোলের উপর রাখুন"*	***Score*** **স্কোর ঃ**

MQ24	(Respondent takes the piece of paper in right hand) **(অংশগ্রহণকারী কাগজটি ডান হাতে নিবে)**	0	1
MQ25	(Respondent folds paper in half) **(অংশগ্রহণকারী কাগজটি অর্ধেক ভাঁজ করবে)**	0	1
MQ26	(Respondent put the piece of paper on lap) **(অংশগ্রহণকারী কাগজটি কোলের উপর রাখবে)**	0	1

Interviewer Say: "Now I would like to ask you to try to remember a short story. I am going to read you the story first and when I am through, I am going to wait a few second and then ask you to tell me as much as you can remember. The story is: Three children were alone in a house and the house caught on fire. A brave person managed to climb and carry them to safety. Aside from minor cuts and bruises, all the people were well." (Wait a few seconds then say). "Please tell me the story."
Interviewer: Write the subjects response verbatim in the space below. Then score the six basic ideas of the story as present or absent.

সাক্ষাৎকার গ্রহণকারী বলবেন ঃ *"এখন আমি আপনাকে একটি ছোট গল্প বলব যা আপনি মনে রাখার চেষ্টা করবেন। প্রথমে আমি আপনাকে গল্পটা পড়ে শোনাব এবং যখন আমার শেষ হবে আমি কয়েক সেকেন্ড অপেক্ষা করব এবং তারপর আপনাকে জিজ্ঞেস করব -- গল্পটা যতটুকু মনে আছে আমাকে বলুন।*
গল্পটা হলো ঃ " তিনটি বাচ্চা একটি বাড়িতে একা ছিল এবং বাড়িতে আগুন লাগল। একজন সাহসী মানুষ কষ্ট করে বেয়ে উঠল এবং তাদের নিরাপদ জায়গায় নিল। সামান্য কাটা - ছেঁড়া ছাড়া বাকীরা সবাই ভাল ছিল।"
(কয়েক সেকেন্ড অপেক্ষা করে তারপর বলুন) *"অনুগ্রহ করে গল্পটি আমাকে বলুন "*
সাক্ষাৎকার গ্রহণকারী ঃ সাবজেক্টের উত্তরগুলো হুবহু নিচের খালি জায়গায় লিখুন। এরপর গল্পের ছয়টি মৌলিক ধারণা উল্লেখ করেছে কিনা - তা স্কোর করুন ।

MQ 27 Three children ৩টি বাচ্চা	0	1	99
MQ 28 House on fire বাড়িতে আগুন লেগেছিল	0	1	99

MQ 29 Person climbed in ব্যক্তিটি বেয়ে উঠল	0	1	99
MQ 30 Children rescued বাচ্চাদের উদ্ধার করা হল	0	1	99
MQ 31 Minor injuries সামান্য কাটা - ছেঁড়া	0	1	99
MQ 32 Everyone well সবাই ভাল ছিল	0	1	99

Result : Completed =1, Incomplete=2, Refused = 3 ফলাফল: সম্পূর্ণ হয়েছে =১, অসম্পূর্ণ=২, প্রত্যাখান করেছেন=৩	1	2	3
<u>INOB Interview Observation:</u> Attention during the test was? Appropriate = 1, Somewhat distracted = 2, Very distracted = 3 টেস্ট চলাকালীন সময়ে সাক্ষাৎকারদাতার মনোযোগ ছিল? যথাযথ=১, কিছুটা অমনোযোগী=২, খুব বেশী অমনোযোগী = ৩	1	2	3

Comments:

Appendix H

DIGITS FORWARD

READ EACH DIGIT SPAN ONLY ONCE AT AN EVEN RATE OF 1 DIGIT PER SECOND. READ PART A OF QUESTION; PAUSE FOR RESPONSE, THEN SCORE. READ PART B OF QUESTION; PAUSE FOR RESPONSE, THEN SCORE. IF MOTHER DOES NOT RESPOND, DO NOT ENCOURAGE FURTHER.

একটি ডিজিট স্প্যান বলার সময় একবারই বলতে হবে এবং প্রতিটি ডিজিট বলার সময় এক সেকেন্ড সময় নিতে হবে। পার্ট A করার সময় কিছুটা সময় নিয়ে তারপর স্কোর করতে হবে। পার্ট B করার সময় কিছুটা সময় নিয়ে তারপর স্কোর করতে হবে। মা যদি কোনো উত্তর দিতে না চায় তবে তাকে জোর করা যাবে না।

STOP WHEN CHILD MISSES PART A AND PART B OF ANY ONE QUESTION.
পার্ট A বা B এর মধ্যে কোনো প্রশ্ন যদি মিস হয়ে যায় তবে টেস্ট বন্ধ করতে হবে।

I am going to say some numbers. Listen carefully, and when I am through, say them right after me. SAY: "Ready" BEFORE EACH QUESTION

আমি এখন আপনাকে কিছু নম্বর বলব। মনোযোগ দিয়ে শুনবেন এবং আমি নম্বরগুলো বলার পর আপনি আমাকে নম্বরগুলো বলবেন। এখন তাহলে আমরা শুরু করি।

	Correct (সঠিক)=1	**Wrong (ভুল)=0**
1A. ৩ - ৮ - ৬ 1A. 3 - 8 - 6		
1B. ৬ - ১ - ২ 1B. 6 - 1 - 2		
If both 1A and 1B are wrong, skip to reverse items **যদি 1A এবং 1B দুটিই ভুল হয় তবে টেস্টটি বন্ধ করতে হবে**		
2A. ৩ - ৪ - ১ - ৭ 2A. 3 - 4 - 1 - 7		
2B. ৬ - ১ - ৫ - ৮ 2B. 6 - 1 - 5 - 8		
If both 2A and 2B are wrong, skip to reverse items **যদি 2A এবং 2B দুটিই ভুল হয় তবে টেস্টটি বন্ধ করতে হবে**		
3A. ৮ - ৪ - ২ - ৩ - ৯ 3A. 8 - 4 - 2 - 3 - 9		
3B. ৫ - ২ - ১ - ৮ - ৬ 3B. 5 - 2 - 1 - 8 - 6		
If both 2A and 2B are wrong, skip to reverse items **যদি 3A এবং 3B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
4A. ৩ - ৮ - ৯ - ১ - ৭ - ৪ 4A. 3 - 8 - 9 - 1 - 7 – 4		
4B. ৭ - ৯ - ৬ - ৪ - ৮ - ৩ 4B. 7 - 9 - 6 - 4 - 8 – 3		

If both 4A and 4B are wrong, skip to reverse items **যদি 4A এবং 4B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
5A. ৫ - ১ - ৭ - ৪ - ২ - ৩ -৮ 5A. 5 - 1 - 7 - 4 - 2 - 3 - 8		
5B. ৯ - ৮ - ৫ - ২ - ১ - ৬ - ৩ 5B. 9 - 8 - 5 - 2 - 1 - 6 – 3		
If both 5A and 5B are wrong, skip to reverse items **যদি 5A এবং 5B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
6A. ১ - ৬ - ৪ - ৫ - ৯ - ৭ - ৬ - ৩ 6A. 1 - 6 - 4 - 5 - 9 - 7 - 6 - 3		
6B. ২ - ৯ - ৭ - ৬ - ৩ - ১ - ৫ - ৪ 6B. 2 - 9 - 7 - 6 - 3 - 1 - 5 - 4		
If both 6A and 6B are wrong, skip to reverse items **যদি 6A এবং 6B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
7A. ৫ - ৩ - ৮ - ৭ - ১ - ২ - ৪ - ৬ - ৯ 7A. 5 - 3 - 8 - 7 - 1 - 2 - 4 - 6 - 9		
7B. ৪ - ২ - ৬ - ৯ - ১ - ৭ - ৮ - ৩ - ৫ 7B. 4 - 2 - 6 - 9 - 1 - 7 - 8 - 3 - 5		

DIGITS BACKWARD

Now I am going to say some more numbers, but this time when I stop, I want you to say them backward. For example, if I say 9-2-7, what would you say? I said 9-2-7, so to say it backward you would say 7-2-9. Now try these numbers. Remember, you are to say them backward: 3-6-5.

এখন আমি আরো কিছু নম্বর বলব, কিন্তু এখন আমি বলা শেষ করলে আপনি উল্টো দিক থেকে বলা শুরু করবেন। যেমন আমি যদি বলি ৯-২-৭, তাহলে আপনি কি বলবেন? যদি মা সঠিক বলে তাহলে আমরা টেস্ট এ চলে যাব। যদি মা ভুল বলে তবে আমরা সঠিকটা বলে দেব। যেমন আমরা বলব, ৯-২-৭ এর উল্টো দিক থেকে বলা শুরু করলে তা হবে, ৭-২-৯। এখন আপনি এই নম্বরগুলো উল্টোভাবে বলেন তো, দেখি এবার আপনি সঠিকটা বলতে পারেন কিনা। এখন আপনি বলুন, ৩-৬-৫ এর উল্টো করলে কি হবে?

	Correct (সঠিক)=1	Wrong (ভুল)=0
8A. ২ - ৫ 8A. 2 - 5		
8B. ৬ - ৩ 8B. 6 - 3		
IF BOTH A & B ARE CODED WRONG, STOP TEST. **যদি 8A এবং 8B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
9A. ৫ - ৭ - ৪ 9A. 5 - 7 - 4		
9B. ২ - ৫ - ৯ 9B. 2 - 5 - 9		
IF BOTH A & B ARE CODED WRONG, STOP TEST. **যদি 9A এবং 9B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
10A. ৭ - ২ - ৯ - ৬ 10A. 7 - 2 - 9 - 6		
10B. ৮ - ৪ - ৯ - ৩ 10B. 8 - 4 - 9 - 3		
IF BOTH A & B ARE CODED WRONG, STOP TEST. **যদি 10A এবং 10B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
11A. ৪ - ১ - ৩ - ৫ - ৭ 11A. 4 - 1 - 3 - 5 - 7		
11B. ৯ - ৭ - ৮ - ৫ - ২ 11B. 9 - 7 - 8 - 5 - 2		
IF BOTH A & B ARE CODED WRONG, STOP TEST. **যদি 11A এবং 11B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
12A. ১ - ৬ - ৫ - ২ - ৯ - ৮ 12A. 1 - 6 - 5 - 2 - 9 - 8		
12B. ৩ - ৬ - ৭ - ১ - ৯ - ৪ 12B. 3 - 6 - 7 - 1 - 9 - 4		
IF BOTH A & B ARE CODED WRONG, STOP TEST. **যদি 12A এবং 12B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
13A. ৮ - ৫ - ৯ - ২ - ৩ - ৪ - ২ 13A. 8 - 5 - 9 - 2 - 3 - 4 - 2		
13B. ৪ - ৫ - ৭ - ৯ - ২ - ৮ - ১ 13B. 4 - 5 - 7 - 9 - 2 - 8 - 1		
IF BOTH A & B ARE CODED WRONG, STOP TEST. **যদি 13A এবং 13B দুটিই ভুল হয় তবে টেস্ট টি বন্ধ করতে হবে**		
14A. ৬ - ৯ - ১ - ৬ - ৩ - ২ - ৫ - ৮ 14A. 6 - 9 - 1 - 6 - 3 - 2 - 5 - 8		
14B. ৩ - ১ - ৭ - ৯ - ৫ - ৪ - ৮ - ২ 14B. 3 - 1 - 7 - 9 - 5 - 4 - 8 - 2		

Appendix I

Nutritional Information of Mother and Child

মা এবং শিশুর পুষ্টি তথ্য

No	Respondent's Anthropometries	Responses
Anthro_1	Mother's Height in **centimetre**(cm) মা উচ্চতা (সেমি.)	|___|___|___|
Anthro_2	Mother's MUAC in **centimetre**(cm) মা (সেমি.)	|___|___|. |___|
Anthro_3	Mother's Weight in **Kg** মা ওজন (কেজি)	|___|___|. |___|___|___|
Anthro_4	Weight of child in **gram** শিশুর ওজন (গ্রাম)	|___|___|___|___|
Anthro_5	Height /Length of child in **centimetre**(cm) শিশুর উচ্চতা (সেমি.)	|___|___|. |___|
Anthro_6	MUAC of child in **centimetre**(cm) শিশুর (সেমি.)	|___|___|. |___|
Anthro_7	Head Circumference in **centimetre** (cm) শিশুর (সেমি.)	|___|___|. |___|

Appendix J

Wolke's Behaviour Ratings

Approach

Initial response to the examiner. The examiner addresses a few introduction remarks to the child and then talks with the mother after giving the child a toy.

Response in the first 5 to 10 minutes is rated. It should be rated immediately, not at the end of the test.

1. Avoiding: shows stray signs of fear - clinging onto the mother/fussing /looking away, withdrawing.
2. Between 1and 3.
3. Hesitant: some fear/obviously worried/ wary and watchful/not happy /not smiling/ not fussing/ not readily playing but may be slight touching of toy. May look fleetingly at examiner.
4. Between 3 and 5.
5. Accepting: No sign of fear but aware of examiner /not offering/vocalising or smiling at examiner / but looking at her from time to time without fear. Plays with toy but not with vigour.
6. Between 5 and 7.
7. Friendly: Not afraid. May smile or vocalise or offer toy to examiner after a few minutes, plays with toy or readily .
8. Between 7 and 9.
9. Inviting: Fully accepts examiner, happily. Interacts with her smiling, vocalizing and/ or approaching. Obviously enjoys toy, may show enthusiasm in playing.

General Emotional Tone

This scale refers to how unhappy and fussy or cheerful and happy the infant appeared during the examination.

1. Child seems unhappy throughout assessment, gets very upset, cries and fusses for long periods or frequently may protest and wail.
2. Between 1and 3.

3. At times rather unhappy begins to fuss with cries. Short verbal protest but may respond happily to some procedures.
4. Between 3 and 5.
5. Moderately happy or contented (may smiles once or twice and positively vocalises occasionally in response to some tasks), may become upset occasionally but recovers fairly easily.
6. Between 5 and 7.
7. Generally appears to be in a happy state of well being. Smiles often with some excitement. Only becomes briefly unhappy once or twice during the whole assessment.
8. Between 7 and 9.
9. Radiates happiness, highly excited, nothing is upsetting (never becomes upset), animated, expressive, smiling and gleeful.

Activity

This scale refers to how physically active the infant was during the testing (gross motor activity).

1. Very still, little gross motor movement. Stays quietly in one place, with practically no self–initiated movement, never wiggles around.
2. Between 1 and 3.
3. Usually quiet and inactive, rarely wiggles but responds appropriately in situations calling for some gross motor activities (motor task)
4. Between 3 and 5.
5. Moderate activity, wiggles occasionally and may get up or change position a number of times, can be quieted for sedentary tests without much difficulty.
6. Between 5 and 7.
7. In action during much of the assessment period, gets up frequently, moves around the room, wiggles, and movements are consolable and can be quieted for sedentary tests, however with difficulties sometimes.
8. Between 7 and 9.
9. Overactive, on the move all the time, wiggles a lot, cannot be quieted for most of the sedentary tests.

Co-operation

This is a measure of how well the infant co-operates with the examiner and complies with her requests.

1. Resists all suggestions or requests, which are assessment related, very resisting and uncooperative.
2. Between 1 and 3.
3. Refuses or resists several specific examinations initially or refuses to co-operate during part of the session (e.g., initially or towards the end).
4. Between 3 and 5.
5. Accepts the assessment or situation, neither cooperative nor resistant in relation to examiner, may occasionally say" No" but will conform.
6. Between 5 and 7.
7. Seems to enjoy the interaction with the examiner, is happy to participate most of the time.
8. Between 7 and 9.
9. Enjoys the session and always complies, readily accepts the examiner's manipulation.

Vocalisation

Vocalizations refer to non-crying utterances or to recognisable utterances embedded in crying. These may be cooing, babbling, consonant sounds or words. Crying per se, no matter how varied, does not qualify.

1. Definitely quiet, 1 or 2 vocalizations.
2. Between 1 and 3.
3. Few vocalisations and of short duration.
4. Between 3 and 5.
5. Vocalisations occur as part of the activities but too intermittent to constitute vocal excitement, chatter or the like.
6. Between 5 and 7.
7. Vocalisations constitute an obvious part of the infant's activity: infant vocalizes for the sake of vocalizing.
8. Between 7 and 9.
9. Excessive vocalisations, high vocal excitement.

Appendix K

Bayley™
Scales of Infant and Toddler Development™
THIRD EDITION

Record Form

Child's name: ____________
Sex: ☐ M ☐ F ID #: ____________
Examiner's name: ____________
School/Child care program: ____________
Reason for referral: ____________

Subtest Summary Scores

Subtest	Total Raw Score	Scaled Score	Composite Score	Percentile Rank	Conf. Interval (___%)
Cognitive (Cog)					
			Use Table A.5		
Language (Lang)					
Receptive Communication (RC)					
Expressive Communication (EC)					
Sum					
			Use Table A.4		
Motor (Mot)					
Fine Motor (FM)					
Gross Motor (GM)					
Sum					
			Use Table A.4		
Social-Emotional (SE)					
			Use Table A.5		
Adaptive Behavior					
*Communication (Com)					
Community Use (CU)					
Functional Pre-Academics (FA)					
Home Living (HL)					
*Health and Safety (HS)					
*Leisure (LS)					
*Self-Care (SC)					
*Self-Direction (SD)					
*Social (Soc)					
*Motor (MO)			(GAC)		
Sum					
			Use Table A.6		

*For children younger than one year, the GAC is calculated using only those skill areas indicated by an asterisk.

Calculate Age and Start Point

	Years	Months	Days
Date Tested			
Date of Birth			
Age			
Age in Months and Days	Years × 12 + months		
Adjustment for Prematurity	Adjust through 24 months		
Adjusted Age			
Start Point	Calculate start point according to chart below		

Age	Start Point
16 days–1 month 15 days	A
1 month 16 days–2 months 15 days	B
2 months 16 days–3 months 15 days	C
3 months 16 days–4 months 15 days	D
4 months 16 days–5 months 15 days	E
5 months 16 days–6 months 15 days	F
6 months 16 days–8 months 30 days	G
9 months 0 days–10 months 30 days	H
11 months 0 days–13 months 15 days	I
13 months 16 days–16 months 15 days	J
16 months 16 days–19 months 15 days	K
19 months 16 days–22 months 15 days	L
22 months 16 days–25 months 15 days	M
25 months 16 days–28 months 15 days	N
28 months 16 days–32 months 30 days	O
33 months 0 days–38 months 30 days	P
39 months 0 days–42 months 15 days	Q

PEARSON

14 15 16 17 18 19 20 A B C D E

PsychCorp

ISBN 015402723-5
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Appendix L

ডিন অফিস
জীববিজ্ঞান অনুষদ
ঢাকা বিশ্ববিদ্যালয়, ঢাকা-১০০০, বাংলাদেশ

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নং - 22 -----------/ জীবঃ অনুঃ/২০১৬-২০১৭ তারিখ: ১৬/০৫/২০১৭

Professor Dr. Md. Kamal Uddin
Department of Psychology
University of Dhaka
Dhaka-1000.

Sub: Ethical Clearance of Research Proposal entitled "Maternal cognitive function and neurobehavioral development of underprivileged children".

Dear Professor Kamal,

I am happy to inform you that your proposal entitled **"Maternal cognitive function and neurobehavioral development of underprivileged children"** was placed in the Ethical Clearance Certificate for Human Participants Committee meeting held on 16.05.2017 and has been approved for conducting your research project.

I wish for the success of your research project.

Professor Dr. M. Imdadul Hoque
Dean, Faculty of Biological Sciences
University of Dhaka
Dhaka-1000.

Appendix M

ClinicalTrials.gov PRS
Protocol Registration and Results System

ClinicalTrials.gov Protocol Registration and Results System (PRS) Receipt
Release Date: October 27, 2017

ClinicalTrials.gov ID: NCT03321591

Study Identification

Unique Protocol ID:	89/2015-16
Brief Title:	Maternal Cognitive Function and Neurobehavioral Development of Underprivileged Children
Official Title:	Maternal Cognitive Function and Neurobehavioral Development of Underprivileged Children
Secondary IDs:	

Study Status

Record Verification:	October 2017
Overall Status:	Recruiting
Study Start:	September 12, 2017 [Actual]
Primary Completion:	December 31, 2017 [Anticipated]
Study Completion:	February 28, 2018 [Anticipated]

Sponsor/Collaborators

Sponsor:	University of Dhaka
Responsible Party:	Principal Investigator Investigator: Abu Yusuf Mahmud [amahmud] Official Title: Principal Investigator Affiliation: University of Dhaka
Collaborators:	

Oversight

U.S. FDA-regulated Drug:	No
U.S. FDA-regulated Device:	No
U.S. FDA IND/IDE:	No
Human Subjects Review:	Board Status: Not required
Data Monitoring:	No
FDA Regulated Intervention:	No

- Page 1 of 7 -

-The End-