Public Health Nutrition: ***27***(e76), 1–9 doi:10.1017/S1368980024000521

Examining the influence of child nutritional disorders on early childhood development in Bangladesh: insights from the multiple indicator cluster survey

Shimlin Jahan Khanam[1] and Md Nuruzzaman Khan[1,2,*]

[1]Department of Population Science, Jatiya Kabi Kazi Nazrul Islam University, Mymensingh, Bangladesh: [2]Centre for Women's Health Research, Faculty of Health and Medicine, School of Medicine and Public Health, The University of Newcastle, Callaghan, Australia

Submitted 26 May 2023: Final revision received 8 November 2023: Accepted 2 February 2024

Abstract

Objective: The objective of this study was to explore the relationship between various forms of child nutritional disorders and early childhood development in Bangladesh.

Design: We analysed data from the nationally representative cross-sectional 2019 Multiple Indicator Cluster Survey. Early childhood development was evaluated using the Early Childhood Development Index (ECDI), which comprised 10 yes-or-no questions across four domains: literacy-numeracy, physical well-being, socio-emotional development, and learning abilities. Nutritional disorders (e.g. stunting, wasting, and underweight) were measured based on the World Health Organization's height and weight guidelines. To investigate the relationships between child development and nutritional disorders, we used multilevel logistic regression models.

Setting: Bangladesh.

Participants: Data of 9,455 children aged 3 and 4 years.

Results: Approximately 38 % of the children analysed experienced a nutritional disorder, with stunting being the most prevalent at 28·15 %. Overall, 25·27 % did not meet expected developmental progress measured by the ECDI. Stunted children were more likely to be off track developmentally, while those without any nutritional disorder were more likely to be on track. Socio-demographic factors, including age, sex, attendance in early childhood education programme, maternal education, maternal functional difficulties, region, and income, were identified as determinants of ECDI.

Conclusions: Childhood nutrition and socio-demographic factors significantly affect multiple developmental domains and overall ECDI among children aged 3–4 years. Prioritising policies and programmes that improve nutrition and address these determinants are crucial for fostering optimal development in children.

Keywords
Child nutritional disorders
Multiple indicators clustering survey
Domains of child development
Early childhood development index
Bangladesh

Early childhood development plays a pivotal role in shaping an individual's lifelong outcomes[1]. It encompasses the period from conception to around eight years of age, during which critical neural, cognitive, and socio-emotional foundations are established[2]. However, earlier age is vital with adverse experiences during this sensitive phase can have lasting consequences on a child's development and well-being[2,3]. Research has consistently demonstrated that children exposed to adverse circumstances, such as poverty, violence, neglect, or inadequate access to healthcare and education, are at a higher risk of experiencing developmental delays, learning difficulties, and social-emotional problems[4]. These adverse consequences not only affect the individual child but also have broader societal implications, as they can perpetuate cycles of disadvantage and inequality[2].

Nutritional disorders pose a persistent threat in low- and lower-middle-income countries (LMICs), including Bangladesh, encompassing a range from malnutrition to overnutrition[5]. Alarming statistics indicate that in 2020, the prevalence of stunting among children under 5 years old reached 34·1 %, with an additional 6·4 % experiencing

*Corresponding author: Email mdnuruzzaman.khan@uon.edu.au

wasting[6]. These numbers translate to a staggering 219 million children, accounting for 39 % of the under-5 population in LMICs[6]. These prevalence rates remain stubbornly high despite the ongoing efforts of the World Health Organization (WHO) to reduce the number of children affected by nutritional disorders to below 100 million by 2025, which is merely two years away[7]. To meet this target, the rates of stunting and wasting must decrease by 40 % and 15 % respectively, which far exceeds the current rates of improvement at 26·6 % and 8·4 % respectively[7]. Unfortunately, LMICs continue to grapple with limited progress in reducing these rates, as the burden of child overnutrition continues to rise[5,8]. This can be attributed to factors such as a growing reliance on fast food, reduced participation in outdoor activities, and the adoption of sedentary lifestyles[5,8]. Such higher prevalence of child malnutrition in LMICs is seen as major to the higher adverse outcomes among children including under-five mortality[9]. Moreover, child malnutrition bears long-term consequences, such as the potential for school dropouts resulting from poor educational performance in later life[10].

The association between nutritional disorders and early childhood development has emerged as a prominent focus within the field of child health and development[11,12]. Inadequate nutrition during the early childhood period has been identified as a leading factor contributing to stunted growth, cognitive impairments, developmental delays, and heightened vulnerability to infections[10,11]. These consequences have far-reaching implications for multiple domains of early childhood development, encompassing physical, cognitive, and socio-emotional aspects[12]. However, despite the recognition of this association, there remains a significant knowledge gap, particularly with regard to evidence from Bangladesh where both nutritional disorders and poor early childhood development persist as pressing issues[13,14]. Existing research on this topic has yielded conflicting findings, largely due to variations in methodologies employed and inconsistent consideration of confounding factors[15–19]. Disparities in the prevalence of under-nutrition across countries where relevant studies have been conducted, as well as variations in governmental policies and programmes related to early childhood development, further contribute to this inconsistency[15,17,19]. Consequently, there is a pressing need to conduct a dedicated study in the context of Bangladesh. This study aims to investigate the association between child nutritional disorders and children's development while accounting for relevant socio-demographic factors.

Methods

Data

The data for this study were derived from the nationally representative 2019 Multiple Indicator Cluster Survey (MICS), which was conducted by the United Nations Children's Fund (UNICEF) in collaboration with the Bangladesh Bureau of Statistics. This is a nationally representative household survey conducted every four years to collect the nationally representative data on several women's and children's health issues. The survey employed a two-stage stratified random sampling approach. In the first stage, 3,220 primary sampling units (PSUs) were randomly selected from a list of 293 579 PSUs generated during the Bangladesh national population census conducted in 2011. Subsequently, in the second stage, 20 households were systematically chosen from each PSU using probability proportional to the sampling size. This meticulous process yielded a total of 64 400 households, out of which 61 242 were occupied (Fig.1). Among the selected households, there were 24 686 children aged five years or below, and data pertaining to child-related variables were successfully collected for 23 402 of these children. Details of sampling procedure have been published elsewhere[20].

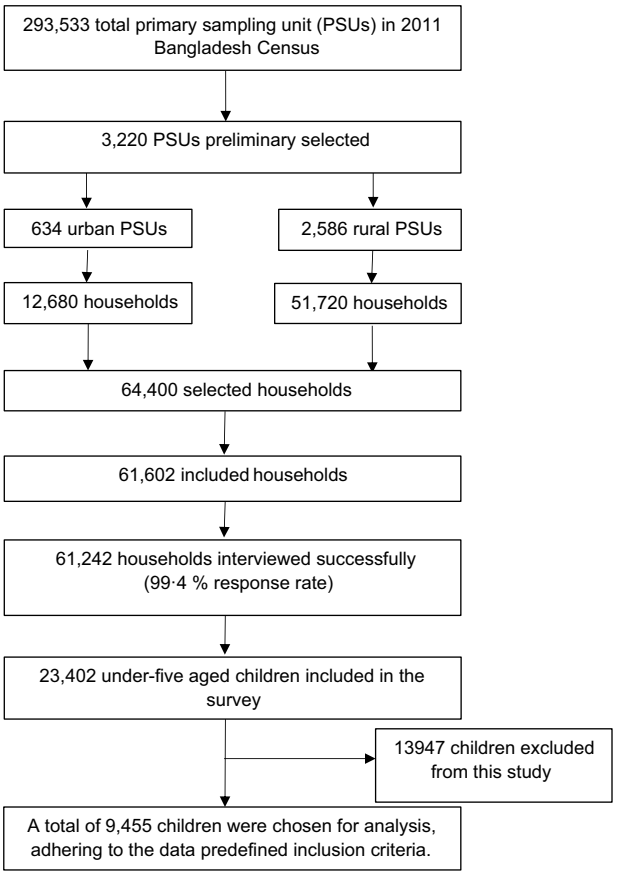

Fig. 1 Sample selection procedure to study association between child nutritional disorders and early child development

Analysed sample

A total of 9,455 children were included in this study, selected from the original sample based on two specific criteria (Fig.1). These include (i) inclusion of children aged

https://doi.org/10.1017/S1368980024000521 Published online by Cambridge University Press

3–4 years, from whom data were collected to assess early childhood development using the Early Childhood Development Index (ECDI) developed by UNICEF[21], and (ii) availability of recorded nutritional status data for the selected children.

Outcome variables

Our primary exposure variable in this study was child nutritional disorder, which encompassed three categories: stunting, wasting, and underweight. We determined these variables by comparing the height-for-age (HAZ), weight-for-age (WAZ), and weight-for-height (WHZ) measurements, respectively, against age and gender-specific *Z*-scores provided by the WHO[22]. Children with HAZ, WHZ, and WAZ below -2 standard deviations from the median are considered stunted, wasted, and underweighted, respectively[22]. We further derived three additional exposure variables: the presence of any of these three forms of nutritional disorder (yes, no), the absence of all three forms of nutritional disorder (yes, no), and the presence of all three forms of nutritional disorder (yes, no). These variables were generated based on the responses related to stunting, wasting, and underweight.

Explanatory variable

The explanatory variable in our study was the ECDI, which classified children as either developmentally on track (1) or not (0). The ECDI was derived from a set of 10 assessment items encompassing four domains: literacy-numeracy (three items), physical (two items), socio-emotional (three items), and learning (two items)[21]. To be classified as developmentally on track in a specific domain, children needed to provide positive responses to at least two items in literacy-numeracy and socio-emotional domains, as well as at least one item in the physical and learning domains[21,23]. These domain-specific classifications were then combined to generate the overall ECDI, where children who were developmentally on track in at least three out of the four domains were considered positively classified. Detailed information regarding the generation of these indexes can be found in a separate publication[21].

Covariates adjustment

In this study, several confounding variables were taken into account, based on a comprehensive review of existing research conducted in LMICs[15–19]. These variables encompassed various aspects related to children, their mothers, households, and communities. Regarding children's characteristics, age categories were considered (3 year, 4 year), along with children's sex (male, female), and attendance in an early childhood education programme (yes, no). Maternal characteristics included mother's education level (pre-primary or none, primary, secondary, higher secondary, and more) and whether the mother had any functional difficulties (yes, no). Household-level adjustments were made using the household wealth quintile index. Community-level characteristics comprised the place of residence and division of residence.

Statistical analysis

Characteristics of the respondents were described using descriptive statistics. Prevalence and the corresponding 95 % confidence interval (95 % CI) of the explanatory and major exposure variables were estimated, taking into account the survey sampling structure. The data used in this study exhibited a clustering nature, with children nested within households and households nested within clusters (PSUs). This clustering introduces dependencies among the data, where individuals within a specific household or PSU tend to share similar characteristics compared to those from different households and PSUs. This renders the use of a simple logistic regression model methodologically incorrect and may potentially result in underestimation or overestimation of the true associations[24]. To address this issue, we employed a multilevel framework to analyse the data, specifically utilising a multilevel binary logistic regression model to assess the targeted associations. Separate models were performed for the ECDI and its four domains to determine their associations with each of the generated exposure variables. The results were reported as OR with their corresponding 95 % CI. All statistical analyses were conducted using Stata version 15·1.

Results

A total of 9,455 children were analysed, with an equal distribution across the age groups of 3 years (49·93 %) and 4 years (51·07 %) (Table 1). The gender distribution was also balanced, with males accounting for 51·74 % and females for 49·36 % of the sample. Upon analysing the children's developmental progress using the ECDI, it was observed that approximately one-quarter of the children were not on the developmentally expected track (Table 1, Fig.2). Specifically, a majority of the children (71 %) were found to be below the expected levels in the literacy-numeracy domain. Furthermore, the prevalence of nutritional disorders among the analysed children was significant, with over 38 % of them reporting at least one form of nutritional disorder. Stunting was the most prevalent nutritional disorder, affecting 28·15 % of the children, followed by wasting, which affected 24·45 % of them. Notably, each specific form of nutritional disorder was reported by approximately 3·26 % of the total children analysed.

The associations between nutritional disorders and the ECDI, as well as its individual domains, are presented in Table 2. The likelihoods of positive ECDI were found 18 %

https://doi.org/10.1017/S1368980024000521 Published online by Cambridge University Press

Table 1 Descriptive statistics of children, and exposure and outcome variables, *n* 9455

Demographics of children	%	95 % CI
Age (in moths)		
24–36	50·3	49·1–51·6
37–48	49·7	48·4–50·9
Sex		
Male	49·8	49·0–50·7
Female	50·2	49·4–51·0
Attendance in early childhood education		
No	82·0	80·9–83·0
Yes	18·0	17·0–19·1
Place of residence		
Urban	20·1	19·0–21·3
Rural	79·9	78·8–81·0
Place of region		
Barishal	5·6	5·2–6·0
Chattogram	23·5	22·3–24·6
Dhaka	22·4	21·3–23·6
Khulna	9·4	8·9–10·0
Mymensingh	8·1	7·3–8·9
Rajshahi	11·4	10·7–12·1
Rangpur	10·3	9·6–10·9
Sylhet	9·4	8·5–10·4
Wealth index		
Poorest	25·0	23·7–26·5
Second	20·8	19·8–22·0
Middle	18·2	17·3–19·3
Fourth	18·0	16·9–19·1
Richest	17·9	16·7–19·1
Children mother's education		
Pre-primary education	16·7	15·6–17·9
Primary education	26·7	25·5–27·9
Secondary education	45·2	43·9–46·6
Higher education	11·4	10·6–12·2
Mother's functional difficulties		
Has functional difficulties	3·6	1·5–4·5
Has no functional difficulties	96·4	95·9–96·8
Children who are not developmentally tracked for indicated domains		
Literacy-numeracy	71·21	70·11–72·29
Physical	13·08	11·30–16·80
Socio-emotional	27·29	71·62–73·77
Learning	8·61	8·01–9·26
Early child development index	25·27	24·28–26·28
Nutritional status		
Stunting	28·15	27·06–29·27
Wasting	9·65	8·97–10·38
Underweight	24·45	23·44–25·48
Children with any of the three forms of nutritional disorder	38·09	36·96–39·24
Children with all three forms of nutritional disorder	3·26	2·87–3·71
Children with none of the three nutritional disorders	61·91	60·77–63·07

Note. CI: confidence interval.

(OR, 0·82, 95 % CI, 0·74–0·93) and 11 % (0·89, 95 % CI, 0·80–0·99) lower among stunted and underweighted children, respectively, compared to their non-stunted and normal-weighted counterparts. Children with none of the nutritional disorders showed a 1·12 times higher likelihood of a positive ECDI compared to children with any of the nutritional disorders. The study also found that the likelihoods of stunted, underweighted, and children with any of the three forms of nutritional disorders were 57 % (aOR, 0·43, 95 % CI, 0·33–0·56), 44 % (aOR, 0·56, 95 % CI, 0·43–0·73), and 46 % (aOR, 0·54, 95 % CI, 0·42–0·67) lower, respectively, to be developmentally tracked in the literacy-numeracy domain. Children with none of the nutritional disorders were more likely to be developmentally tracked in the literacy-numeracy domain compared to their counterparts with at least one of the three nutritional disorders.

Additionally, we conducted five different models to examine the socio-demographic factors associated with the ECDI and its four domains. The results of each model are presented in Table 3. Children aged 4 years were 120–153 % more likely to report a positive ECDI and its domains, except for the socio-emotional domain, where higher age was associated with a 16 % protective as compared to children in the lower age range of 24–36 months. Female children (aOR, 0·91, 95 % CI, 0·82–0·99) and children whose mothers faced functional difficulties (aOR, 0·97, 95 % CI, 0·58–0·99) were less likely to report a positive ECDI compared to the male children. Furthermore, children in the Chattogram (aOR, 0·55, 95 % CI, 0·43–0·69), Dhaka (aOR, 0·41, 95 % CI, 0·32–0·51), Khulna (aOR, 0·65, 95 % CI, 0·51–0·83), Mymensingh (aOR, 0·46, 0·34–0·62), and Rangpur (aOR, 0·44, 95 % CI, 0·34–0·56) divisions had lower likelihood to report a positive ECDI compared to children residing in the Barishal division. We also observed a gradient association between the ECDI and the wealth quintile of the children's mothers, with increasing odds ranging from 1·23 to 1·45 for the second to richest quintile compared to respondents in lower wealth quintiles. Similar associations were found between each of the four domains of the ECDI and the socio-demographic factors included in the models.

Discussion

The primary objective of this study was to examine the associations between adverse nutritional disorders and the ECDI and its specific domains in Bangladesh. The findings revealed a significantly high prevalence of childhood nutritional disorders, with over 38 % of the children reporting at least one form of such disorder. Furthermore, nearly one-quarter of the children were not found to be on track in terms of their developmental progress as assessed by the ECDI, and a substantial 71 % of children did not meet the expected levels in the literacy-numeracy domain. Notably, children with nutritional disorders were more likely to exhibit poor ECDI scores and lower performance in their individual domains. These associations remained significant even after adjusting for a range of factors related to children, their mothers, households, and the community. These findings underscore the coexistence of nutritional disorders and impaired child development in Bangladesh, highlighting the long-term challenges faced by the country. Therefore, in order to achieve Sustainable Development Goals 1 and 3, which

https://doi.org/10.1017/S1368980024000521 Published online by Cambridge University Press

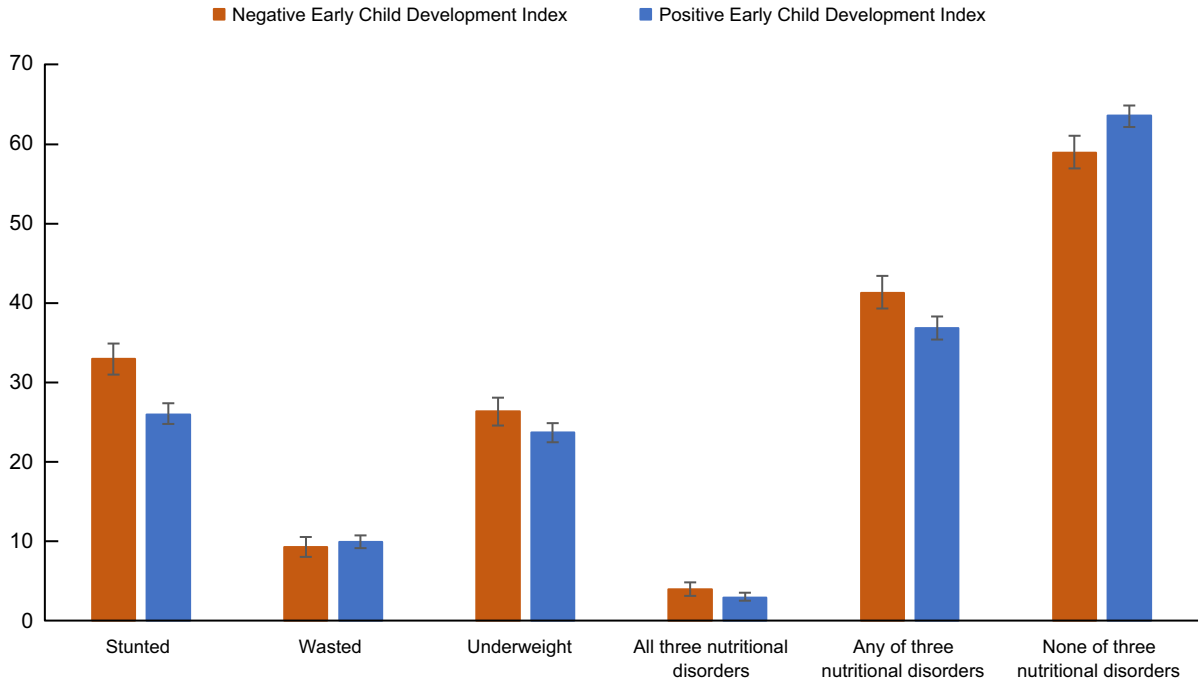

Fig. 2 Estimates of early child development index by child adverse nutritional outcomes

prioritise early childhood development and health for all, it is imperative to address the developmental needs of children affected by nutritional disorders in Bangladesh.

The poor performance of children with nutritional disorders in the ECDI and its domains can be attributed to several interconnected factors. Insufficient intake of essential nutrients, such as proteins, vitamins, and minerals, leads to inadequate nourishment, hindering the optimal functioning of the developing brain and body, and compromising overall growth and development[25–27]. This can result in stunted growth, compromised physical growth, impaired cognitive abilities, and delayed language development[28,29].

Additionally, nutritional disorders can cause reduced energy levels, making it challenging for children to actively engage in learning activities and explore their environment[30]. Moreover, these disorders can weaken the immune system, making children more vulnerable to infections and illnesses, which further impairs their overall development and well-being[12,18,30]. This, in turn, can disrupt regular attendance in early childhood education programmes and limit opportunities for social interaction and learning[16].

Furthermore, the limited availability of nutritious food and a stimulating home environment contributes to the limited cognitive stimulation experienced by children with nutritional disorders[31]. Cognitive stimulation, which includes exposure to language, books, and stimulating activities, plays a vital role in developing cognitive skills, problem-solving abilities, and attention span[32,33]. Moreover, children with nutritional disorders often face social-emotional challenges, such as low self-esteem and emotional instability, which can influence their socio-emotional well-being and interactions with peers and caregivers, further affecting their overall development[34].

Addressing these interconnected factors requires comprehensive interventions. Strategies should focus on improving access to nutritious food, promoting optimal feeding practices, providing early childhood education programmes that foster cognitive and socio-emotional development, and creating supportive environments that stimulate learning and positive social interactions[35,36]. By addressing these factors, it is possible to improve the ECDI outcomes of children with nutritional disorders and promote their overall optimal development.

This study possesses several strengths and a few limitations. It is noteworthy that this is the first study conducted in Bangladesh to investigate the association between nutritional disorders and the ECDI, while adjusting for a comprehensive range of factors at the children, individual, household, and community levels. Advanced statistical models were employed to analyse the data, considering various model combinations to ensure a thorough examination of the potential associations between child nutritional disorders and ECDI outcomes. As a result, the findings of this study are robust and hold significant implications for the development of national-level policies and programmes. However, it is important to acknowledge the major limitation of this study, which is the utilisation of cross-sectional data. Consequently, the findings can only establish correlations rather than causal relationships. Additionally, it is important to recognise that the data reported in this study are based on self-reports, which introduces the possibility of recall bias. Nonetheless,

https://doi.org/10.1017/S1368980024000521 Published online by Cambridge University Press

Table 2 Results of multilevel logistic regression analysis assessing the associations of early childhood development index and its domains with adverse nutritional outcomes

Nutritional disorders	Literacy-numeracy domain	95 % CI	Physical domain	95 % CI	Socio-emotional domain	95 % CI	Learning domain	95 % CI	Early child development index	95 % CI
Stunting	0·43**	0·33–0·56	0·87	0·44–1·73	1·04	0·92–1·16	0·85	0·71–1·02	0·82**	0·74–0·93
Wasting	1·14	0·82–1·59	0·80	0·30–2·13	0·99	0·84–1·18	1·11	0·83–1·47	1·08	0·91–1·28
Underweight	0·56**	0·43–0·73	0·72	0·37–1·40	1·03	0·92–1·16	0·94	0·78–1·14	0·94	0·84–1·06
Children with any of the three forms of nutritional disorder	0·54*	0·42–0·67	0·89	0·47–1·69	1·02	0·91–1·13	0·91	0·77–1·08	0·89**	0·80–0·99
Children with all three forms of nutritional disorder	0·71	0·40–1·27	0·64	0·16–2·59	1·00	0·76–1·32	0·75	0·50–1·12	0·83	0·63–1·08
Children with none of the three nutritional disorders	1·87**	1·49–2·35	0·99	0·81–1·19	0·97	0·87–1·08	1·12	0·94–1·33	1·12**	1·01–1·24

Note: Negative response in each nutritional disorder is considered as reference category; Values inside the parentheses represent 95 % CI.
**$P < 0.05$.
*$P < 0.01$.

any potential bias of this nature is likely to be random, and the primary exposure and outcome variables are based on real-time data. Furthermore, it is essential to acknowledge that there are other factors, such as food intake, that can influence both nutritional disorders and early childhood development. However, due to the lack of relevant data in the survey, these factors were not considered in the model. Despite these limitations, this study provides valuable insights into the association between nutritional disorders and ECDI outcomes.

Conclusion

The results indicated a considerably elevated occurrence of nutritional disorders among children, as more than 38 % of them reported experiencing at least one form of such disorder. Additionally, a significant proportion, approximately 25 %, of the children did not demonstrate appropriate developmental progress according to the ECDI assessment. Moreover, a noteworthy majority of 71 % of children fell short of the expected proficiency levels in the literacy-numeracy domain. Children with nutritional disorders represented a higher probability of presenting with subpar scores on the ECDI and performing poorly in specific domains. Improving access to nutritious food, promoting optimal feeding practices, providing early childhood education programmes that foster cognitive and socio-emotional development, and creating supportive environments that stimulate learning and positive social interactions are important.

Acknowledgements

Data used in this study were collected from the UNICEF MICS Archive. We would like to thank the UNICEF for granting permission to use the data.

Availability of data and materials

The data utilised in this study were originally collected by UNICEF. The data were securely stored in their repository in a deidentified format to ensure privacy and were made accessible to researchers for conducting research. Our team obtained access to this data by submitting a research proposal. Researchers who are interested can request access to the data by submitting their own relevant research proposal.

Financial support

This study is conducted without any financial support from any sources.

Public Health Nutrition
https://doi.org/10.1017/S1368980024000521 Published online by Cambridge University Press

Table 3 Adjusted OR of the associations between major demographic variables and early childhood development index

			Early childhood development index's domains							
	Early childhood development index	95 % CI	Literacy-numeracy	95 % CI	Physical	95 % CI	Socio-emotional	95 % CI	Learning	95 % CI
Age of the children (in months)										
24–36 (rc)	1·00		1·00		1·00		1·00		1·00	
37–48	1·41**	1·27–1·56	3·33**	2·94–3·76	1·20**	1·01–1·45	0·84**	0·76–0·93	1·53**	1·30–1·80
Sex of the children										
Male (rc)	1·00		1·00		1·00		1·00		1·00	
Female	0·91**	0·82–0·99	1·13*	1·02–1·26	0·89	0·74–1·06	0·75	1·68–0·83	1·14	0·98–1·33
Early childhood education programme attendance										
Yes (rc)	1·00		1·00		1·00		1·00		1·00	
No	2·08**	1·79–2·42	3·64**	3·16–4·19	1·81**	1·34–2·45	1·03	0·90–1·18	1·56	1·23–1·98
Mother's education										
Pre-primary or none (rc)	1·00		1·00		1·00		1·00		1·00	
Primary	1·04	0·88–1·23	1·34**	1·08–1·68	0·94	0·71–1·24	0·96	0·81–1·15	1·04	0·80–1·34
Secondary	1·33**	1·13–1·57	2·36**	1·91–2·92	1·22	0·93–1·60	0·91	0·77–1·08	1·24	0·97–1·60
≥Higher secondary	1·46**	1·18–1·81	3·88**	3·01–5·00	1·51**	1·00–2·89	0·83	0·67–1·04	1·14	0·82–1·60
Mother's functional difficulties										
Yes	1·00		1·00		1·00		1·00		1·00	
No	0·77	0·53–1·14	1·18	0·78–1·80	0·67	0·30–1·49	0·49**	0·31–0·76	1·14	0·65–2·00
Area of residence										
Urban	1·00		1·00		1·00		1·00		1·00	
Rural	1·05	0·90–1·23	1·03	0·88–1·21	1·03	0·76–1·38	1·03	0·88–1·20	1·16	0·90–1·48
Child resided region										
Barishal (rc)	1·00		1·00		1·00		1·00		1·00	
Chattogram	0·55**	0·43–0·69	0·69**	0·55–0·88	0·71	0·47–1·07	0·54**	0·43–0·69	0·80	0·58–1·12
Dhaka	0·41**	0·32–0·51	0·69**	0·54–0·88	0·69	0·46–1·03	0·32**	0·25–0·40	1·28	0·91–1·80
Khulna	0·65**	0·51–0·83	0·52**	0·41–0·68	1·82**	1·08–3·05	0·72**	0·56–0·92	1·45**	1·00–2·10
Mymenshing	0·46**	0·34–0·62	0·88	0·64–1·21	0·31**	0·20–0·49	0·32**	0·23–0·44	0·95	0·62–1·47
Rajshahi	0·87	0·67–1·12	0·52*	0·39–0·67	1·13	0·70–1·81	1·04	0·81–1·35	1·46	0·99–2·15
Rangpur	0·44**	0·34–0·56	0·76	0·58–1·01	0·66	0·43–1·02	0·31*	0·24–0·40	1·46**	1·01–2·12
Sylhet	0·87	0·64–1·19	0·55**	0·41–0·73	0·34**	0·22–0·53	1·83**	1·33–2·53	0·62**	0·41–0·92
Wealth quintile										
Poorest (rc)	1·00		1·00		1·00		1·00		1·00	
Second	1·23**	1·07–1·42	1·39**	1·16–1·67	1·30**	1·01–1·66	1·03	0·89–1·19	1·04	0·84–1·29
Middle	1·38**	1·18–1·62	1·74**	1·44–2·10	1·40**	1·06–1·84	1·01	0·87–1·19	1·34**	1·05–1·72
Fourth	1·39**	1·17–1·65	1·90**	1·57–2·30	1·16	0·87–1·55	1·09	0·92–1·30	1·49**	1·12–1·96
Richest	1·47**	1·20–1·80	2·61**	2·10–3·26	1·62**	1·11–2·36	0·95	0·77–1·16	1·81**	1·30–2·53

Note: Values inside the parentheses represent 95 % confidence interval; rc: reference category.
**$P < 0.05$.
*$P < 0.01$.

Conflict of interest

The authors declare no conflicts of interest.

Authorship

Khanam SJ designed this study, conducted data analysis, and reported the first draft of this manuscript. Khan MN critically reviewed this manuscript. All authors approve the final version of this manuscript.

Ethics of human subject participation

The current paper was a secondary analysis of publicly available MICS conducted by UNICEF. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the UNICEF. Verbal informed consent was obtained from all subjects/patients. Verbal consent was witnessed and formally recorded.

References

1. Council NR (2000) *From Neurons to Neighborhoods: The Science of Early Childhood Development*. Washington (DC): National Academies Press (US).
2. Boyce WT (2014) The lifelong effects of early childhood adversity and toxic stress. *Pediatr Dent* **36**, 102–108.
3. Nelson CA, Bhutta ZA, Harris NB *et al.* (2020) Adversity in childhood is linked to mental and physical health throughout life. *Bmj* **371**, m3048.
4. Metzler M, Merrick MT, Klevens J *et al.* (2017) Adverse childhood experiences and life opportunities: shifting the narrative. *Children Youth Serv Rev* **72**, 141–149.
5. Winichagoon P & Margetts BM (2017) The double burden of malnutrition in low-and middle-income countries. *Energy Balance Obesity* **52**, 1–14.
6. UNICEF W, The World Bank (2021) *Levels and Trends in Child Malnutrition: UNICEF/WHO/The World Bank Group Joint Child Malnutrition Estimates: Key Findings of the 2021 Edition*. Geneva, Switzerland: WHO.
7. WHO (2017) *Global Targets 2025 to Improve Maternal, Infant and Young Children Nutrition*. Geneva, Switzarland: World Health Organization.
8. Popkin BM, Corvalan C & Grummer-Strawn LM (2020) Dynamics of the double burden of malnutrition and the changing nutrition reality. *Lancet* **395**, 65–74.
9. Ssentongo P, Lewcun J, Ssentongo A *et al.* (2020) Association of undernutrition and neonatal, infant and under-5 mortality: evidence from 62 low-income and middle-income countries. *Curr Dev Nutr* **4**, 911–911.
10. Wolde T & Belachew T (2019) Chronic undernutrition (stunting) is detrimental to academic performance among primary schools of adolescent children: a randomized cross sectional survey in Southern Ethiopia. *BMC Res Notes* **12**, 1–6.
11. Alderman H & Fernald L (2017) The nexus between nutrition and early childhood development. *Annu Rev Nutr* **37**, 447–476.
12. Hurley KM, Yousafzai AK & Lopez-Boo F (2016) Early child development and nutrition: a review of the benefits and challenges of implementing integrated interventions. *Adv Nutr* **7**, 357–363.
13. Hasan MN, Babu M, Chowdhury MAB *et al.* (2023) Early childhood developmental status and its associated factors in Bangladesh: a comparison of two consecutive nationally representative surveys. *BMC Public Health* **23**, 1–13.
14. USAID (2021) *Nurturing Care to Improve Early Childhood Development: Bangladesh Country Profile*. Dhaka, Bangaldesh: USAID.
15. Haq I, Hossain M, Zinnia MA *et al.* (2021) Determinants of the early childhood development index among children aged < 5 years in Bangladesh, Costa Rica and Ghana: a comparative study. *Eastern Mediterr Health J* **27**, 1–14.
16. Shrestha ML, Perry KE, Thapa B *et al.* (2022) Malnutrition matters: association of stunting and underweight with early childhood development indicators in Nepal. *Maternal Child Nutr* **18**, e13321.
17. Kakchapati S, KC SP, Giri S *et al.* (2023) Factors associated with early child development in Nepal–a further analysis of multiple indicator cluster survey 2019. *Asian J Social Health Behavior* **6**, 21.
18. El-Kogali S & Krafft C (2015) Global and regional perspectives of early childhood development in the middle east and north. *Afr* 15–47.
19. Bliznashka L, Perumal N, Yousafzai A *et al.* (2022) Diet and development among children aged 36–59 months in low-income countries. *Arch Dis Childhood* **107**, 719–725.
20. Bangladesh Bureau of Statistics (BBS) & UNICEF Bangladesh (2019) *Progotir Pathey, Bangladesh Multiple Indicator Cluster Survey 2019, Survey Findings Report*. Dhaka, Bangladesh: Bangladesh Bureau of Statistics (BBS).
21. Loizillon A, Petrowski N, Britto P *et al.* (2017) *Development of the Early Childhood Development Index in MICS surveys*. New York: MICS Methodological Papers, No. 6, Data and Analytics Section, Division of Data, Research and Policy, UNICEF.
22. De Onis M & Onyango AW (2008) WHO child growth standards. *Lancet* **371**, 204.
23. WHO (2023) *Children Aged 36–59 Months Who are Developmentally on Track in at Least Three of the Following Domains: Literacy-Numeracy, Physical Development, Social-Emotional Development and Learning (%)*. Geneva, Switzarland: World Health Organization.
24. Holodinsky JK, Austin PC & Williamson TS (2020) An introduction to clustered data and multilevel analyses. *Family Pract* **37**, 719–722.
25. Kiani AK, Dhuli K, Donato K *et al.* (2022) Main nutritional deficiencies. *J Preventative Med Hyg* **63**, E93.
26. Barchitta M, Maugeri A, Favara G *et al.* (2019) Nutrition and wound healing: an overview focusing on the beneficial effects of curcumin. *Int J Mol Sci* **20**, 1119.
27. Latham MC (1997) *Human Nutrition in the Developing World*. Rome: Food & Agriculture Organization.
28. Caulfield LE, Richard SA, Rivera JA *et al.* (2006) Stunting, wasting, and micronutrient deficiency disorders. In *Disease Control Priorities in Developing Countries 2nd Edition*. New York: Oxford University Press.
29. Fraser DR (2004) Vitamin D-deficiency in Asia. *J Steroid Biochem Mol Biol* **89**, 491–495.
30. Choge JK (2020) *Malnutrition: Current Challenges and Future Perspectives*. London, United Kingdom: Intech Open press.
31. Marasinghe E, Chackrewarthy S, Abeysena C *et al.* (2015) Micronutrient status and its relationship with nutritional status in preschool children in urban Sri Lanka. *Asia Pac J Clin Nutr* **24**, 144–151.
32. Drago F, Scharf RJ, Maphula A *et al.* (2020) Psychosocial and environmental determinants of child cognitive development

https://doi.org/10.1017/S1368980024000521 Published online by Cambridge University Press

in rural south africa and tanzania: findings from the mal-ed cohort. *BMC Public Health* **20**, 1–8.
33. Lu C, Black MM & Richter LM (2016) Risk of poor development in young children in low-income and middle-income countries: an estimation and analysis at the global, regional, and country level. *Lancet Global Health* **4**, e916–e922.
34. Livingston EM, Siegel LS & Ribary U (2018) Developmental dyslexia: emotional impact and consequences. *Aust J Learn Difficulties* **23**, 107–135.
35. Tartaglia J, McIntosh M, Jancey J *et al.* (2021) Exploring feeding practices and food literacy in parents with young children from disadvantaged areas. *Int J Environ Res Public Health* **18**, 1496.
36. Zhang L, Ssewanyana D, Martin M-C *et al.* (2021) Supporting child development through parenting interventions in low-to middle-income countries: an updated systematic review. *Front Public Health* **9**, 671988.

Public Health Nutrition

https://doi.org/10.1017/S1368980024000521 Published online by Cambridge University Press