Improving coverage and quality of selected priority nutrition-specific interventions in the first 1000 days of life to prevent childhood undernutrition

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Statement of originality

I certify, to the best of my knowledge, that the intellectual content of this thesis is the product of my work. All the assistance received in preparing this thesis and sources have been acknowledged. I also declare that this thesis or any part of this has not been submitted for any degree or other purposes.

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Abstract

The prevalence of childhood undernutrition stays high in low and middle-income countries (LMICs). It is not a problem that originates and is specific to childhood alone—the first 1000 days of a child's life, starting from conception to nine months of foetal life, followed by 24 months after birth, is the most "critical period" considering the pathogenesis and causes of childhood undernutrition. Effective interventions to address the nutritional needs of mother-child dyads during this crucial period are well established. Researchers and global leaders of public health nutrition have recommended priority nutrition-specific interventions which address the immediate drivers of child undernutrition. However, the success of these interventions in improving child nutrition depends on their reach and coverage with optimum quality. Global guidelines recommend implementing these interventions for universal coverage, especially in high undernutrition burden settings. Yet, research, programme, and accountability tracking data suggest several gaps in the quality and coverage of these nutrition interventions. Therefore, the remaining priority agenda in the nutrition programming landscape is to identify how best to deliver these interventions with optimum quality and achieve universal coverage.

This thesis explores how to improve the quality and coverage of selected preventive nutrition-specific interventions during the first 1000 days of life in Bangladesh as a case study for LMICs. The chosen interventions were IFA supplementation during pregnancy, anaemia assessment, IFA distribution, weight gain monitoring and nutrition education at antenatal care (ANC), and promotion of breastfeeding and dietary diversity among infants. The research in this thesis employed quantitative methods to attain the objectives. It analysed data collected in cross-sectional health facility assessments and observations of nutrition service provision at antenatal care contacts (**Chapter 3**) to explore the quality of nutrition services provided at ANC and supply side and client level factors influencing the quality service provision. Then, following Anderson's Behavioural Model of health care-seeking, this research explored the factors influencing the user adherence-adjusted effective coverage of antenatal IFA supplementation using data from a household survey of women who had a recent birth (**Chapter 4**). The research also used data from a cluster randomised controlled trial (CRCT) to explore the effect of digital job aid supported nutrition education intervention delivered by community health workers in improving initial and exclusive breastfeeding practices up to six months and dietary diversity among 6-23 months old children (**Chapter 5 and 6**). Statistical analyses for this research included multiple regression models with sampling adjustments for household survey data and multi-level regression models with clustering adjustments for quality of nutrition service assessment data and CRCT data to estimate the associations and intervention effects.

Chapter 3 of the thesis identified that the quality of nutrition services provided at ANC, the formal contact for pregnant women to receive nutrition services, was low. Only 15% of pregnant women who attended ANC at public health facilities received all four nutrition services including weight measurement, anaemia assessment, nutrition counselling, and IFA supplement. Better readiness of health facilities and knowledge of health care providers improved the quality of nutrition service provision (adjusted incidence rate ratio aIRR: 1.23, 95% confidence interval (CI): 1.08,1.39 and aIRR 1.04; 95% CI: 1.01,1.08, respectively). However, previous training on nutrition and existing external supervision did not improve the service quality. Healthcare providers interacting well with pregnant women by explaining the progress of the pregnancy and allowing the women to ask questions were more likely to provide better quality nutrition services (aIRR 1.14; 95% CI: 1.04,1.26). The use of visual aids or ANC card during consultation showed a promising impact on quality nutrition service provision (aIRR 1.18; 95% CI: 1.11,1.27).

In **Chapter 4**, data analysis from a household survey of 2572 rural Bangladeshi women who had a birth outcome in the last six months showed poor (6%) user adherence-adjusted coverage of consuming ≥180 IFA supplements during pregnancy. Receiving a higher number of ANC visits, first ANC ≤4 gestational months in pregnancy, advice on IFA, and free IFA improved the mean number of IFA tablets consumed. User-adherence adjusted coverage of IFA supplementation was linearly associated with the number of ANC visits among women who started ANC ≤4 gestational months (adjusted risk ratio, aRR 1.46; 95% CI: 1.32, 1.62), however, it showed no statistically significant association among women who received the first ANC ≥5 gestational months (aRR 1.24; 95% CI: 0.94, 1.34). Scenario-based projection analysis suggested receiving ≥8 ANC visits, starting ANC ≤4 gestational months, and receiving advice on IFA is likely to improve user adherence-adjusted coverage of antenatal IFA supplementation to 56%.

Results from the CRCT (**Chapter 5**) demonstrated that a digital job aid supported face-to-face nutrition counselling and practical demonstration provided by community health workers during pregnancy and in the postpartum period reduced the provision of prelacteal feeds by half (RR 0.54; 95% CI: 0.39,0.79) and improved exclusive breastfeeding by 1.22-fold (95% CI: 1.12,1.33) at five months of child's age. The job aid-supported counselling intervention prevented the introduction of complementary food before six months and sustained exclusive breastfeeding practices. From the same CRCT, **Chapter 6** showed that electronic job aid supported age-appropriate complementary feeding counselling improved dietary diversity among 6-23 months old infants (mean difference in dietary diversity score, 0.09, 95% CI: 0.02, 0.16). The intervention significantly improved the consumption of animal-sourced protein, such as flesh food, among children up to 15 months of age (odds ratio, OR 1.36, 95% CI: 1.02,1.83). The research also showed that the effect of job aid-supported nutrition counselling was modified (interaction p-value

<0.05) by the age of children and household food security. The intervention did not increase dietary diversity and animal protein intake among children from food-secure and severely food-insecure households. However, the effect of the nutrition counselling intervention on children's dietary diversity was not modified by their receiving lipid-based nutrient supplements.

The findings of the thesis have important policy and programmatic relevance for improving the quality and coverage of priority nutrition-specific interventions in LMICs. This thesis demonstrates the importance of improving health facility readiness, healthcare providers' skills for better provider-client communication, ensuring consistent guidelines, adopting useful job aids, and reforming the healthcare providers' training and supportive supervision to ensure nutrition services are delivered in better quality. This research also emphasised the critical significance of starting ANC in early gestational months and ensuing eight or more visits, provision of IFA tablets in adequate quantity at ANC contacts, and counselling women on IFA to improve user adherence-adjusted effective coverage of antenatal IFA supplementation. Based on the promising finding from the CRCT, this research recommends adopting electronic job aid-supported nutrition counselling in community-based programmes to improve the coverage of nutrition education intervention and age-appropriate infant and young child feeding practices among children up to two years of age. Lastly, the research acknowledges its limitation of inadequate exploration of the quality of nutrition services at the fast-growing private sector facilities and measurement of composite coverage of nutrition-specific interventions during the first 1000 days of life due to lack of follow-up data and recommends this as a priority future research agenda.

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Authorship attribution statement

This thesis presents the research undertaken during my Doctor of Philosophy candidature under the supervision of Professor Michael John Dibley, Professor Camille Raynes-Greenow, and Associate Professor Patrick Kelly at the Sydney School of Public Health, the University of Sydney.

This thesis consists of four results chapters (Chapters 3-6), all are published in peer-reviewed scientific journals. I am both the lead (first) and corresponding author of all four published journal articles. The studies from which data were used for this thesis were implemented in collaboration between the research team at icddr,b, and other partners. Contributions of other co-authors are specified in the author contribution section at the end of each paper. Finally, I am the author of this thesis.

The first result chapter (**Chapter 3**) of this thesis is published as Billah SM, Ali NB, Khan AN, Raynes-Greenow C, Kelly PJ, Siraj MS, Askari S, Menon P, Arifeen SE, Dibley MJ, Nguyen PH. Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh. PloS one. 2022;17(1):e0262867.
I co-conceptualised and designed the study and identified the data collection methods, coordinated study implementation, conducted data analysis and interpretations, prepared visual illustrations, drafted the manuscript, and addressed reviewers' comments for final submission.

Chapter 4 of this thesis is published as Billah SM, Raynes-Greenow C, Ali NB, Karim F, Lotus SU, Azad R, Sari M, Mustaphi P, Maniruzzaman M, Rahman SM, Dibley MJ, Kelly PJ, Arifeen SE. Iron and Folic Acid Supplementation in Pregnancy: Findings from the Baseline Assessment of a Maternal Nutrition Service Programme in Bangladesh**.** Nutrients. 2022;14(15):3114.
I conceptualised and designed the study, developed the data collection tools, led the study implementation, conducted the data analysis, prepared the first draft and finalised the manuscript, and responded to reviewers' comments for publication.

Chapter 5 of this thesis is published as Billah SM, Ferdous TE, Siddique AB, Raynes-Greenow C, Kelly P, Choudhury N, Ahmed T, Gillespie S, Hoddinott J, Haider R, Menon P, Arifeen SE, Dibley MJ. The effect of electronic job aid assisted one-to-one counselling to support exclusive breastfeeding among 0–5-month-old infants in rural Bangladesh**.** Maternal & Child Nutrition. 2022 May 19:e133
I co-conceptualised and led the randomised controlled trial, prepared the data collection tools, conducted the literature review, analysed data, and drafted the manuscript. I also addressed the reviewers' comments on the manuscript.

Chapter 6 of this thesis is published as Billah SM, Ferdous TE, Kelly P, Raynes-Greenow C, Siddique AB, Choudhury N, Ahmed T, Gillespie S, Hoddinott J, Menon P, Dibley MJ, Arifeen SE. Effect of nutrition counselling with a digital job aid on child dietary diversity: Analysis of secondary outcomes from a cluster randomised controlled trial in rural Bangladesh. Maternal & Child Nutrition. 2022;18(1):e13267
I co-conceptualised and led the randomised controlled trial, prepared the data collection tools, conducted the literature review and data analysis, and wrote the draft manuscript. I also responded to the reviewers' comments for publication.

Sk Masum Billah
Date: 9 January 2023

As supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statements above are correct.

Professor Michael John Dibley
Date: 13 January 2023

Ethics approval

Ethical clearance for the data included in **Chapter 3** was obtained from the Ethical Review Committee of icddr,b in Bangladesh for the study entitled "Evaluation of GoB, UNICEF, CIFF initiative to facilitate and accelerate implementation of the Bangladesh National Nutrition Services" (Protocol # PR-15107).

Ethical clearance for the data used in **Chapter 4** were obtained from the Ethical Review Committee of icddr,b in Bangladesh for the study entitled "Demonstration programme to improve maternal nutrition service delivery including multiple micronutrient supplementation (MMS) through public health ANC platforms: A community based cluster randomized control trial" (Protocol # PR-19124). The study was registered at ClinicalTrials.gov; identifier: NCT04559711

Ethical clearance for the randomized controlled trial data used in **Chapter 5** and **Chapter 6** were obtained from the Ethical Review Committee of icddr,b in Bangladesh for the study entitled "A community-based cluster randomized controlled trial to evaluate the effectiveness of different bundles of nutrition-specific interventions in improving mean height-for-age Z score among children at 24 months of age in rural Bangladesh" (Protocol # PR-14124). The study was registered at ClinicalTrials.gov; identifier: NCT02768181

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Tables and Figures

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Abbreviations

ANC	Antenatal Care
aIRR	Adjusted Incidence Rate Ratio
aOR	Adjusted Odds Ratio
aRR	Adjusted Risk Ratio/Relative Risk
BDHS	Bangladesh Demographic and Health Survey
CHW	Community Health Workers
CI	Confidence Interval
CRCT	cluster randomised controlled trial
IYCF	Infant and Young Child Feeding
IFA	Iron and Folic Acid
GMP	Growth Monitoring and Promotion
IMCI	Integrated Management of Childhood Illness
LBW	Low Birth Weight
LNS	Lipid-based Nutrient Supplementation
LMIC	Low and Middle-Income Countries
MICS	Multiple Indicator Cluster Survey
MMS	Multiple Micronutrient Supplementation
NNS	National Nutrition Services
NPAN	National Plan of Action for Nutrition
NPAN2	Second National Plan of Action for Nutrition
ORS	Oral Rehydration Solution
PNC	Postnatal Care
RR	Risk Ratio/Relative Risk
SDG	Sustainable Development Goals
SGA	Small for Gestational Age
WFP	World Food Programme
WHO	World Health Organization
UNICEF	United Nations Children Fund
UNIMMAP	United Nations International Multiple Micronutrient Antenatal Preparation
USAID	United States Agency for International Development

Chapter 1: Introduction and overview

1.1 Rationale

Over the last two decades, global strategic partnerships such as the Millennium Development Goals, followed by the Sustainable Development Goals (SDG), have resulted in substantial progress in ending poverty and hunger and improving health indicators. Yet, undernutrition in early childhood remains 'unfinished business' in the public health agenda in low- and middle-income countries (LMICs)[1]. Childhood undernutrition refers to nutritional deficiency among children measured in three main forms: low height-for-age or stunting, low weight for height or wasting, and low weight-for-age or underweight[2]. In addition, 'hidden hunger', or micronutrient deficiency, is a critical but invisible form of undernutrition among children with several adverse consequences[3]. Low birth weight and small for gestational age are also considered important forms of childhood undernutrition[1].

Globally, the prevalence of childhood undernutrition remains high[4]. The latest estimate reported that approximately 149 million children (22% of all children globally) are chronically malnourished, shorter for their age, or stunted, and 45 million (7%) are acutely malnourished, too thin for their height, or wasted[4]. About 5% of children suffer from an undernutrition double burden and are at a 5-fold risk of dying prematurely, and this double burden has appeared as a growing concern in recent years[1]. Geographically, a vast majority (~80%) of malnutrition-related under-five deaths, and stunted and wasted children, are in LMICs in South Asia and Africa[4, 5]. Moreover, the reduction of childhood undernutrition has been slower than expected[6]. Stronger efforts and faster declines are necessary to achieve the undernutrition reduction targets of the World Health Assembly by 2025 and the SDGs by 2030[4, 7]. Only one in four countries is on track to achieve the SDG targets on childhood nutrition[4]. At the current pace, the world is likely to fall short of reducing the approximately 27 million stunted children to achieve the World Health Assembly target[6]. Childhood undernutrition trends also demonstrate disparity in improvements between countries and socio-economic backgrounds[4]. Although middle-income countries have made considerable improvements in addressing childhood stunting, low-income countries have made limited progress[1]. Further, stunting prevalence in low-income countries declined faster in higher economic groups and widened the rich-poor gap[8]. Moreover, the COVID-19 pandemic is feared to have exacerbated childhood undernutrition in all forms in the short and long term. The pandemic increased food insecurity and income loss[9]. It disrupted the delivery of nutrition-specific and sensitive interventions, especially in LMICs where there is limited economic and social protection and less resilient health systems[7, 10].

Child undernutrition is not a problem that originates and is specific to childhood alone[11, 12]. Evidence on the intergenerational cycle of child undernutrition has evolved in the last century[11, 13, 14]. The foundation for growth and development in childhood and adolescence is rooted in the first 1000 days, beginning at conception[11, 15]. A child's physical, psychosocial, and cognitive development is critical in this early phase than in any other period and hence is an ideal period to intervene, and is considered as the most important "window of opportunity" [16, 17]. Conversely, approximately two-thirds of the stunted under-two children in LMICs became stunted within the first six months of age[1]. The faster growth velocity in the first two years of life demands higher nutrition requirements in this period than in older childhood[16, 18]. Moreover, children are more susceptible to infection in infancy and early childhood[19]. Further details on pathways to nutrition faltering in pregnancy and the first two years after birth are described in the literature review (section 2.1.3).

The vulnerability of undernutrition and the risk of irreversible loss during the transitioning phase of the first 1000 days of life warrants investment in nutrition interventions[17]. This period is also considered the "most responsive" to interventions addressing child undernutrition[14]. The estimated monetary gain ranges from $4-$35 for a dollar spent on proven nutrition interventions in this period[20]. Investing in nutrition at this foundational stage of life has an "astonishing return on investment" which is likely to substantially impact a country's economic development[21]. The latest review of the evidence of maternal and child nutrition progress also reemphasised the importance of the first 1000 days to address child undernutrition[22].

Evidence on causes of child undernutrition and effective interventions to address them have substantially evolved in recent decades[15, 23-25]. Nutrition-specific interventions, also known as direct nutrition interventions, address the immediate causes of child undernutrition by improving infant feeding, caregiving, preventing childhood illnesses and managing acute undernutrition[15, 23]. In the 2013 Lancet series on maternal and child nutrition, Bhutta and colleagues (2013) reviewed the evidence of effectiveness of nutrition-specific interventions on mortality and undernutrition reduction and identified the top ten interventions to be delivered in the first 1000 days of life[24]. Keats et. al. (2021) updated the list of direct nutrition interventions based on new evidence since 2013[25]. Further details on the effectiveness of the nutrition-specific interventions are described in Chapter 2 (section 2.1.4).

The desired gains of nutrition-specific interventions in reducing child undernutrition to achieve the global nutrition target rely on high population coverage and the quality of the interventions received by the target groups[22, 24, 26]. However, most of the LMICs have much lower than the desired universal coverage of nutrition-specific interventions[26]. These coverage gaps are further exacerbated by widespread between and within country inequalities[7, 22, 27]. Furthermore, the actual impact of health and nutrition interventions on a population depends on their effective coverage which involves quality and compliance to interventions in addition to their crude contact coverage[28, 29]. In LMICs, the quality of nutrition services delivered at facility and community-based contacts are often suboptimal resulting in a substantially lower impact of the interventions than that from standard interventions in an efficacious environment[30]. Similarly, missed opportunities of not delivering critical nutrition-specific interventions with optimum quality at important health service contacts such as antenatal and post-natal care also affects their coverage at population level[28, 31].

In Bangladesh, despite achieving one of the fastest declines in the last decade, childhood undernutrition remains a public health problem with high geographic and socio-economic inequalities[4, 32, 33]. With the current pace of child undernutrition reduction, it is unlikely Bangladesh will achieve the SDG targets[4]. The improvements in child nutrition in the past decade are mostly attributable to the interventions, programmes and policies outside the health sector[32]. More detailed descriptions of the coverage and quality gaps in priority nutrition-specific interventions in LMICs and in Bangladesh are provided in sections 2.1.6 and 2.2.5, respectively. Without addressing the coverage and quality gaps in nutrition-specific interventions, LMICs like Bangladesh are unlikely to achieve the national and global nutrition targets in time.

The interventions selected for this thesis include iron and folic acid (IFA) supplementation during pregnancy, anaemia assessment, IFA distribution, weight gain monitoring and nutrition education at antenatal care, and promotion of breastfeeding and dietary diversity among infants. The rationale for selecting these interventions include: 1) they are part of the eight top priority preventive nutrition-specific interventions in the first 1000 days of life[24]; 2) they are included in the existing National Nutrition Services Operation plan of the 4th Health Population Nutrition Sector Programme[34] 3) they are recommended for all mother-child dyads by the second National Plan of Actions for Nutrition and National Operation Plan[35] and 4) coverage of these interventions have suboptimal in LMICs such as Bangladesh (please see sections 2.1.6 and 2.2.5). Given that antenatal care is the first opportunity to receive these critical preventive nutrition interventions in pregnancy, the quality of service provided during this contact is vital to ensure effective coverage.

1.2 Research aims and objectives

This thesis aims to identify ways to improve the coverage and quality of selected priority nutrition-specific interventions delivered during the first 1000 days of life to prevent childhood undernutrition. This thesis had the following specific objectives:

1. To identify the quality of nutrition services provided at ANC contact at health facilities and the health systems (supply side) and client-level factors influencing the quality of nutrition service provision,
2. To explore the coverage of IFA supplementation in pregnancy and the factors influencing user adherence-adjusted effective coverage of antenatal IFA supplementation,

3. To assess the effect of an electronic job aid-supported breastfeeding counselling and practical demonstration by community health workers on improving coverage of nutrition education, initial breastfeeding, and exclusive breastfeeding practices up to six months of age,
4. To assess the effect of a nutrition education intervention delivered by community health workers using a digital job aid on improving dietary diversity among 6-23 month old children.

1.3 Methodological and analytical approach

In this thesis, I have used quantitative research methods to achieve the four objectives, aiming to improve the coverage and quality of selected nutrition-specific interventions in a low-income setting, in Bangladesh. Quantitative data used to address the objectives of this thesis came from multiple sources. Each of the results chapters (Chapters 3-6) includes a detailed description of the research design, data collection methods, and analysis techniques; these chapters are all published.

In brief, for the first two research chapters (**Chapters 3 and 4**), I used data collected from a cross-sectional health facility evaluation and a population-based household survey, respectively. Assessments of the readiness of health facilities to provide nutrition services, interviews with health care providers, direct observations of the antenatal care consultation, and exit interviews with clients (pregnant women) were conducted at selected public health facilities in 21 districts (out of 64) of Bangladesh (**Chapter 3**). Integrating the data from all sources, I conducted descriptive and multi-level mixed model analysis to explore the quality of antenatal nutrition services, the supply side factors (health facility readiness and providers characteristics) and the pregnant women client level characteristics influencing the quality nutrition service provision (from direct observation) at ANC contacts. I used the data from a cross-sectional household survey implemented in a northern and a southern district of Bangladesh to explore the coverage of IFA supplementation in pregnancy (**Chapter 4**). I conducted a descriptive falter-point analysis to identify the gaps between coverage of health systems contacts, receiving and consuming IFA in any quantity, and the recommended adequate dose of ≥180 tablets during pregnancy. Employing Andersen's Behavioural Model of health care utilisation I conducted multi-stage cluster sampling adjusted linear and logistic regression analysis to explore factors influencing the number of IFA tablets received and user adherence-adjusted effective coverage of IFA supplementation (consuming ≥180 tablets) during pregnancy, respectively[36].

Chapter 5 and **Chapter 6** present the data from a cluster-randomised controlled trial implemented in a north-eastern rural district of Bangladesh. I explored the effect of nutrition counselling by community health workers using a digital job-aid tool on infant feeding practices such as initial breastfeeding, exclusive breastfeeding up to six months, and dietary diversity among 6-23 months old children. For estimating the effect of nutrition counselling and practical demonstration on initial and exclusive breastfeeding I used multi-level Poisson regression models adjusting for clustering and repeat measurements (when relevant) (**Chapter 5**). I analysed the effect of infant feeding counselling on improving dietary diversity (number of food groups consumed) and individual food groups at different time points between 6 to 23 months of children's age using multi-level linear regression and multi-level logistic regression models, respectively (**Chapter 6**). I also conducted necessary sensitivity and sub-group analyses to explore the variations of the counselling intervention's effect on breastfeeding and dietary diversity. A detailed description of the trial design, interventions, data collection methods, questionnaires used for assessing participants' background characteristics, household food insecurity, maternal and newborn health careseeking and child feeding practices have been published in trial protocol paper included in the **Appendix B**.

1.4 Thesis outline

This thesis is comprised of seven chapters and two appendices. **Chapter 1** provides the overall rationale of the research, aims and specific objectives, methods, and the thesis outline. **Chapter 2** describes the background and context of the research in Bangladesh. The results section of the thesis consists of four chapters (**Chapters 3-6**), all published in peer-reviewed journals, addressing the four specific objectives of the thesis (Table 1.1). Supplementary published data and information are provided at the end of each results chapter.

Table 1.1 List of published papers addressing the four objectives of the thesis

Chapters (Objectives)	Published Papers
Chapter 3 (Objective 1)	Billah SM, Ali NB, Khan AN, Raynes-Greenow C, Kelly PJ, Siraj MS, Askari S, Menon P, Arifeen SE, Dibley MJ, Nguyen PH. **Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh**. PloS one. 2022;17(1):e0262867[37]
Chapter 4 (Objective 2)	Billah SM, Raynes-Greenow C, Ali NB, Karim F, Lotus SU, Azad R, Sari M, Mustaphi P, Maniruzzaman M, Rahman SM, Dibley MJ, Kelly PJ, Arifeen SE. **Iron and Folic Acid Supplementation in Pregnancy: Findings from the Baseline Assessment of a Maternal Nutrition Service Programme in Bangladesh.** Nutrients. 2022;14(15):3114[38]
Chapter 5 (Objective 3)	Billah SM, Ferdous TE, Siddique AB, Raynes-Greenow C, Kelly P, Choudhury N, Ahmed T, Gillespie S, Hoddinott J, Haider R, Menon P, Arifeen SE, Dibley MJ. **The effect of electronic job aid assisted one-to-one counselling to support exclusive breastfeeding among 0–5-month-old infants in rural Bangladesh.** Maternal & Child Nutrition. 2022 May 19:e133[39]
Chapter 6 (Objective 4)	Billah SM, Ferdous TE, Kelly P, Raynes-Greenow C, Siddique AB, Choudhury N, Ahmed T, Gillespie S, Hoddinott J, Menon P, Dibley MJ, Arifeen SE. **Effect of nutrition counselling with a digital job aid on child dietary diversity: Analysis**

	of secondary outcomes from a cluster randomised controlled trial in rural Bangladesh. Maternal & Child Nutrition. 2022;18(1):e13267[40]

The first two results chapters of the thesis (**Chapters 3 and 4**) focus on improving the quality of nutrition service delivery in pregnancy and coverage of antenatal IFA supplementation. **Chapter 3** (Paper 1) presents the quality of four nutrition services such as weight assessment, anaemia screening, nutrition counselling, and IFA supplements provided at antenatal care contacts[37]. Following the Donabedian framework for evaluating the quality of care, it also identifies the health facility readiness, health care provider's characteristics, process of care attributes and client's socio-demographic and obstetrics characteristics influencing the quality nutrition services provided at ANC. The findings highlight important areas to intervene in for improving the quality of nutrition service provision at ANC. **Chapter 4** (Paper 2) delved into identifying the population-level coverage of IFA supplementation in pregnancy[38]. It explored the gaps between receiving ANC and receiving and consuming an adequate dose of IFA. The falter point analysis demonstrates the current service gaps in the effective coverage cascade for antenatal IFA supplementation. The study also identified the programmatically modifiable factors for increasing the user adherence-adjusted effective coverage of antenatal IFA supplementation.

Chapter 5 and Chapter 6 of the thesis explored the benefits of nutrition education intervention supported by a digital job aid to improve breastfeeding and age-appropriate complementary feeding practices (dietary diversity) among children up to 2 years of age. Based on a randomised control trial **Chapter 5** (Paper 3) examined the effect of digital job aid-supported nutrition education counselling provided antenatally and during the first six after birth on improving initial breastfeeding and sustaining exclusive breastfeeding up to six months of child age[39]. Similarly, **Chapter 6** (Paper 4), assessed the effect of age-appropriate complementary feeding counselling delivered by community health workers using a digital job aid to improve dietary diversity among 6-23 months old children[40]. It also provides important inputs to nutrition education programs to consider the modifying effect of household food insecurity on achieving the benefits of the nutrition education intervention on children's dietary diversity. The concluding chapter of the thesis (**Chapter 7**) includes a wrap up discussion on summary findings, study limitations and areas for future research, and finally the policy and programmatic recommendations based on the findings. **Appendix A** includes abstracts of other papers I published during the PhD and are related to the thesis topic. Among them, a method-focused paper presented the experience of establishing an electronic health registry for pregnancy registration and follow-up of mother-child dyads which demonstrates the opportunity of adopting digital job aid tools into community-based platforms for delivering nutrition-specific interventions to a large population. **Appendix B** presents the cluster randomised controlled trial protocol paper involving electronic job aid supported nutrition counselling interventions and assessing the impact on infant feeding practice as a secondary outcome. **Appendix C** includes responses to reviewers' comments for the published papers included in the results chapters. **Appendix D** includes relevant sections of the data collection instruments and questionnaires used for results chapters 3-6.

1.5 References

1. Victora CG, Christian P, Vidaletti LP, Gatica-Domínguez G, Menon P, Black RE. Revisiting maternal and child undernutrition in low-income and middle-income countries: variable progress towards an unfinished agenda. The Lancet. 2021.
2. Shetty P. Malnutrition and undernutrition. Medicine. 2006;34(12):524-9.
3. Grebmer KV, Saltzman A, Birol E, Wiesman D, Prasai N, Yin S, et al. Synopsis: 2014 global hunger index: The challenge of hidden hunger. Bonn, Washington, D.C. and Dublin: International Food Policy Research Institute, Concern Worldwide and Welthungerhilfe; 2014. Report No.: 0896298558.
4. United Nations Children's Fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and Trends in Child Malnutrition: Key Findings of the 2021 Edition of the Joint Child Malnutrition Estimates. Geneva: World Health Organization; 2021. Report No.: 9240025251.
5. Institute for Health Metrics and Evaluation (IHME). GBD Compare Seattle, WA: IHME, University of Washington; 2015 [Available from: http://vizhub.healthdata.org/gbd-compare.
6. Micha R, Mannar V, Afshin A, Allemandi L, Baker P, Battersby J, et al. 2020 Global nutrition report: action on equity to end malnutrition. Bristol, UK: Development Initiatives; 2020. Report No.: 1916445276.
7. Development Initiatives. 2021 Global Nutrition Report: The state of global nutrition. Bristol, UK: Development Initiatives; 2021.
8. da Silva ICM, França GV, Barros AJ, Amouzou A, Krasevec J, Victora CG. Socioeconomic inequalities persist despite declining stunting prevalence in low-and middle-income countries. The Journal of nutrition. 2018;148(2):254-8.
9. FAO, IFAD, UNICEF, WFP, WHO. The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable. Rome: FAO; 2022.
10. Headey D, Heidkamp R, Osendarp S, Ruel M, Scott N, Black R, et al. Impacts of COVID-19 on childhood malnutrition and nutrition-related mortality. The Lancet. 2020;396(10250):519-21.
11. Allen LH, Gillespie SR. What works? A review of the efficacy and effectiveness of nutrition interventions. Asian Development Bank; 2001.
12. Christian P, Lee SE, Donahue Angel M, Adair LS, Arifeen SE, Ashorn P, et al. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low-and middle-income countries. International Journal of Epidemiology. 2013;42(5):1340-55.
13. Martorell R, Zongrone A. Intergenerational influences on child growth and undernutrition. Paediatric Perinatal Epidemiology. 2012;26:302-14.
14. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries. Paediatrics and International Child Health. 2014;34(4):250-65.
15. Smith LC, Haddad L. Reducing child undernutrition: past drivers and priorities for the post-MDG era. World Development. 2015;68:180-204.
16. Martorell R. Improved nutrition in the first 1000 days and adult human capital and health. American Journal of Human Biology. 2017;29(2):e22952.
17. FHI Solutions LLC. 1000 Days [Available from: https://thousanddays.org/.
18. Dewey KG. The challenge of meeting nutrient needs of infants and young children during the period of complementary feeding: an evolutionary perspective. The Journal of Nutrition. 2013;143(12):2050-4.
19. Walker CLF, Rudan I, Liu L, Nair H, Theodoratou E, Bhutta ZA, et al. Global burden of childhood pneumonia and diarrhoea. 2013;381(9875):1405-16.
20. Shekar M, Kakietek J, Eberwein JD, Walters D. An investment framework for nutrition: reaching the global targets for stunting, anemia, breastfeeding, and wasting: World Bank Publications; 2017.
21. Hoddinott J. The economic cost of malnutrition. The Road to Good Nutrition. Washington DC, USA: Karger Publishers; 2013. p. 64-73.
22. Heidkamp RA, Piwoz E, Gillespie S, Keats EC, D'Alimonte MR, Menon P, et al. Mobilising evidence, data, and resources to achieve global maternal and child undernutrition targets and the Sustainable Development Goals: an agenda for action. The Lancet. 2021;397(10282):1400-18.

23. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, Onis MD, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. The lancet. 2013;382(9890):427-51.

24. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? The Lancet. 2013;382(9890):452-77.

25. Keats EC, Das JK, Salam RA, Lassi ZS, Imdad A, Black RE, et al. Effective interventions to address maternal and child malnutrition: an update of the evidence. The Lancet Child Adolescent Health. 2021.

26. Scott N, Delport D, Hainsworth S, Pearson R, Morgan C, Huang S, et al. Ending malnutrition in all its forms requires scaling up proven nutrition interventions and much more: a 129-country analysis. BMC Medicine. 2020;18(1):1-19.

27. Bhutta ZA. How will the next 'Decade of Nutrition' be different from the past one? Nature Reviews Gastroenterology Hepatology. 2016;13(8):441-2.

28. Amouzou A, Leslie HH, Ram M, Fox M, Jiwani SS, Requejo J, et al. Advances in the measurement of coverage for RMNCH and nutrition: from contact to effective coverage. BMJ Global Health. 2019;4(Suppl 4):e001297.

29. Marsh AD, Muzigaba M, Diaz T, Requejo J, Jackson D, Chou D, et al. Effective coverage measurement in maternal, newborn, child, and adolescent health and nutrition: progress, future prospects, and implications for quality health systems. The Lancet Global Health. 2020;8(5):e730-e6.

30. Nguyen PH, Frongillo EA, Sanghvi T, Kim SS, Alayon S, Tran LM, et al. Importance of coverage and quality for impact of nutrition interventions delivered through an existing health programme in Bangladesh. Maternal & Child Nutrition. 2018;14(4):e12613.

31. Sanghvi T, Nguyen PH, Tharaney M, Ghosh S, Escobar-Alegria J, Mahmud Z, et al. Gaps in the implementation and uptake of maternal nutrition interventions in antenatal care services in Bangladesh, Burkina Faso, Ethiopia and India. Maternal & Child Nutrition. 2022;18(2):e13293.

32. Headey D, Hoddinott J, Ali D, Tesfaye R, Dereje M. The other Asian enigma: explaining the rapid reduction of undernutrition in Bangladesh. World Development. 2015;66:749-61.

33. Bangladesh Bureau of Statistics (BBS), UNICEF Bangladesh. Progotir Pathey, Bangladesh Multiple Indicator Cluster Survey 2019, Survey Findings Report. Dhaka, Bangladesh: Bangladesh Bureau of Statistics (BBS); 2019.

34. Government of People’s Republic of Bangladesh. 4th Health, Population and Nutrition Sector Programme (4th HPNSP), Operational Plan, National Nutrition Service (NNS) Dhaka: Institute of Public Health Nutrition, Directorate General of Health Service, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh; 2017.

35. Ministry of Health and Family Welfare. Second National Plan of Action for Nutrition (2016-2025). Dhaka: Government of People's Republic of Bangladesh; 2017.

36. Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? Journal of Health Social Behavior. 1995:1-10.

37. Billah SM, Ali NB, Khan ANS, Raynes-Greenow C, Kelly PJ, Siraj MS, et al. Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh. PloS one. 2022;17(1):e0262867.

38. Billah SM, Raynes-Greenow C, Ali NB, Karim F, Lotus SU, Azad R, et al. Iron and Folic Acid Supplementation in Pregnancy: Findings from the Baseline Assessment of a Maternal Nutrition Service Programme in Bangladesh. Nutrients. 2022;14(15):3114.

39. Billah SM, Ferdous TE, Siddique AB, Raynes-Greenow C, Kelly P, Choudhury N, et al. The effect of electronic job aid assisted one-to-one counselling to support exclusive breastfeeding among 0–5-month-old infants in rural Bangladesh. Maternal & Child Nutrition. 2022:e13377.

40. Billah SM, Ferdous TE, Kelly PJk, Greenow CR, Siddique AB, Choudhury N, et al. Effect of nutrition counselling with a digital job aid on child dietary diversity: Analysis of secondary outcomes from a cluster randomised controlled trial in rural Bangladesh. Maternal & Child Nutrition. 2021(e13267).

Chapter 2: Research background and context

2.1 Research background and literature review

2.1.1 Short- and long-term consequences of childhood undernutrition

Childhood undernutrition results in several short and long-term consequences in childhood and adult life. Approximately 2.7 million children in LMICs die before their fifth birthday due to causes directly and indirectly associated with malnutrition which constitutes more than half of the total deaths in this age group[1]. Undernutrition interacts with infectious diseases in a vicious cycle and predisposes children to be more susceptible to childhood illnesses[2, 3]. Nutrition deficiency, growth faltering, and micronutrient malnutrition in early life are also predictive of delayed physical development in adolescence and poor nutritional status in adulthood[4]. Chronic undernutrition in childhood is linked with impaired intellectual and functional development, leading to lower academic performance, all of which restrains children from thriving to their full potential in adulthood, and perpetuates lifelong economic loss to the individual, community, and nation, especially in LMICs[5-8]. A recent study reported that acute malnutrition in childhood also compromises human capital in adult life[9].

Moreover, growing evidence suggests the long-term effects of childhood undernutrition in LMICs on multifaceted chronic diseases in adulthood[4, 5, 10]. Children born with low birth weight are more susceptible to non-communicable diseases such as cardiometabolic disease, coronary heart disease, hypertension, metabolic syndrome and type-2 diabetes in adulthood[10, 11]. Similarly, chronic and acute malnutrition and micronutrient deficiencies in childhood also result in several chronic diseases, such as hypertension, metabolic disorders, obesity, cancer, immune deficiency, dyslipidaemia, and diabetes in later life[4, 5, 7, 12].

2.1.2 Determinants of childhood undernutrition

Childhood malnutrition results from a complex interplay of multiple causes[13]. The framework for explaining the interrelationships between different causes of child malnutrition (including undernutrition) evolved empirically from the framework proposed by United Nations Children Fund (UNICEF) in the early 1990s[14]. Later the framework was adapted by Black et al. in the Lancet Series on Maternal and Child Undernutrition, World Health Organization (WHO), and other studies as the guiding principle for analysing the determinants of childhood undernutrition and setting priorities[15-18]. The framework identified the causes of undernutrition in three levels - immediate, underlying, and basic causes (Figure 2-1). Furthermore, recent "real world" evaluations with evidence synthesis on the patterns and changes in childhood undernutrition has complemented the evidence on the key basic, underlying and immediate drivers for linear growth faltering reduction in high performing "exemplar" countries[19, 20].

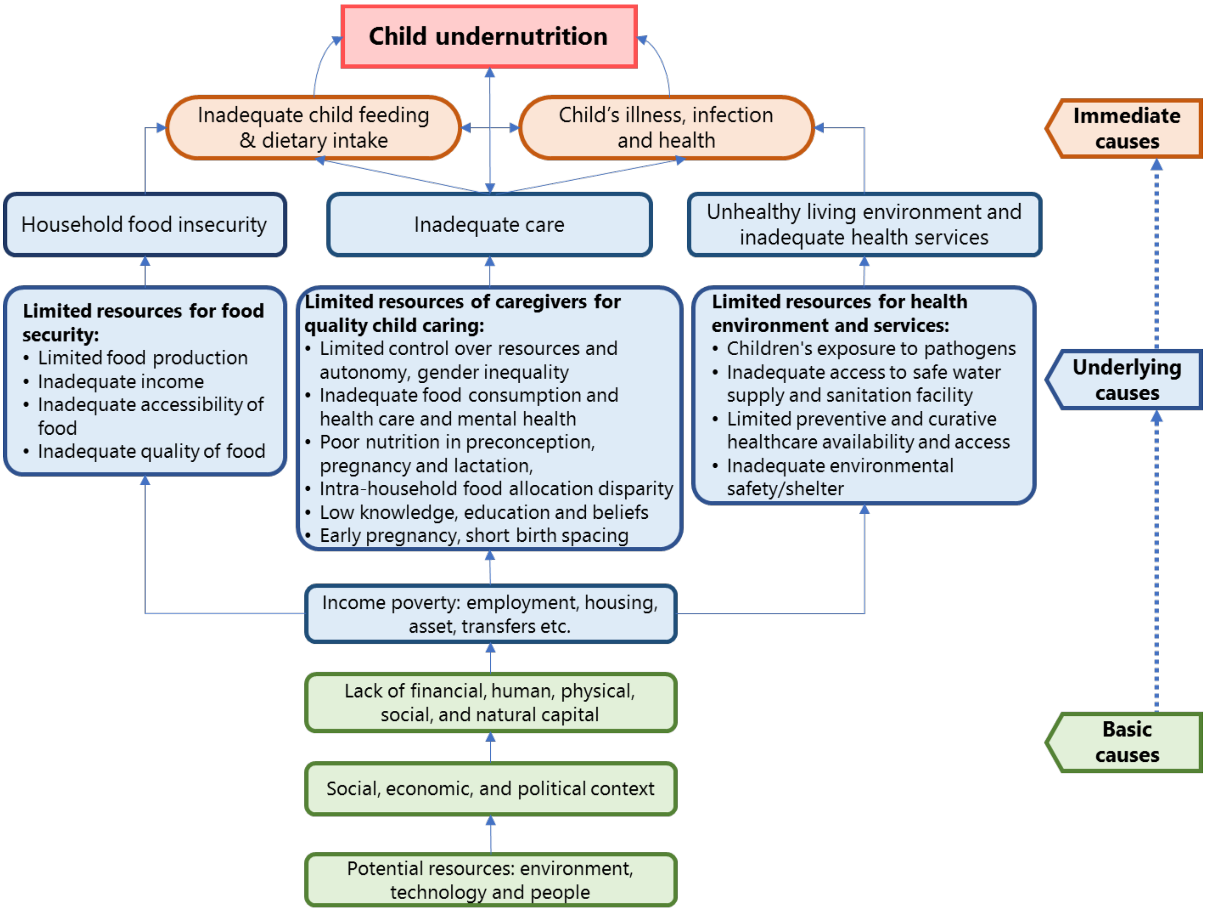


Figure 2-1 Determinants of child undernutrition.
Adapted from the framework by Black 2008 and Smith 2015[15, 16]

<u>Immediate determinants for childhood undernutrition</u> include inadequate breastfeeding practice, dietary intake, childhood illness and health status. Research has demonstrated suboptimal breastfeeding, complementary feeding, poor diet quality, low intake of animal source protein and essential micronutrient-rich foods in LMICs with high socio-economic inequality and its impact on child growth and development[13, 21-27]. Research has also established the intertwined cyclic relationship between inadequate feeding and childhood infections. Inadequate dietary intake leads to poor growth, lowered immunity, and mucosal damage, which results in more frequent and severe illnesses, and subsequently reduced appetite, nutrient loss, and malabsorption of nutrients which again leads to inadequate intake[2, 28]. A recent extension of the malnutrition-infection vicious cycle added pathways of interaction between a child's subclinical infection, poor absorption of nutrients due to enteric dysfunction, gut permeability, metabolic dysregulation, lowered immunity, and inadequate dietary intake[29]. Evidence from the "exemplar" countries with rapid reduction of child's shorter height-for-age also demonstrated a "modest" contribution by maternal obstetric and nutrition factors such as improvements in birth spacing and reduction of parity due to improved family planning practices and

mother's height[19]. Improvements birthweight, age-appropriate breastfeeding and reduction of diarrhoeal illness also were associated with stunting declines over time in several LMICs[19, 30, 31].

Underlying causes of child undernutrition include household food insecurity, inadequate care for children, unhealthy living conditions, and inadequate health care access[16]. All these underlying causes are related to income and poverty, which influence household food insecurity by limiting the production, availability, access, and utilisation of nutritious food. This restricts proper nourishment and negatively affects a child's growth, development, and productivity in adult life, which in turn leads to more impoverishment[32-35].

A women's limited control over household resources, gender disparity in intrahousehold food allocation, inadequate food consumption, poor nutrition during preconception, pregnancy and lactation, early pregnancy, and short pregnancy interval affect nutrition in the utero, child feeding practices, and child's nutrition status[36-40]. Similarly, low women's education, nutritional knowledge and beliefs, physical and mental health also influence the quality of child caring, feeding, support, and healthcare seeking, which are also dependent on household income[16, 32, 40, 41]. The housing condition and environment where the children live, lack of safe water, overcrowding, poor sanitation facilities and practices, inadequate availability, access, and utilisation of preventive and curative healthcare services, quality of service, safety, and protection for children result in recurrent and chronic childhood illnesses, poor health and eventually lead to child undernutrition[42-48]. Regression decomposition analyses of data from LMICs achieving an exemplary reduction of child undernutrition reported improved sanitary practices, increased coverage of antepartum, at birth and post-partum care from medically trained providers, vaccination coverage substantially contributed to the reduction of child's linear growth faltering across countries[19, 49]. Similarly, in several LMICs, improved access to safe water and hygiene practices showed a modest effect in linear growth improvements through reduction of childhood diarrhoea and preventing enteric dysfunction[19, 49, 50].

Basic causes of child undernutrition include gaps in broader social, economic, governance, policy, leadership, public accountability, health and nutrition financing, development investments and support system which influence child undernutrition through poverty and underlying causes[16]. Improvements in households' socioeconomic status and parental education drove the strongest attributable effect to child's linear growth improvements in several top performing LMICs[19, 20, 49].

2.1.3 Intergenerational cycle of undernutrition and importance of the 1000 days of life

Undernutrition is carried through generations in multifaceted interlinked epigenetic, metabolic, and physiological pathways and is influenced by socioeconomic and environmental factors throughout the life cycle[51, 52]. Pooled data analysis from multiple prospective and cross-sectional studies suggest that short maternal stature and low body-mass index are associated with growth faltering in children[53-55]. Child undernutrition has been associated with undernutrition of the mother when she was born[56, 57]. Undernutrition of mothers in early life results in suboptimal growth in childhood and adolescence, depleted health and nutrition status, micronutrient stores, metabolic dysfunction, physical and economic capital in adulthood and poor nutritional status when she is pregnant[51, 52, 58]. Nutritional faltering throughout the life course of mothers, inadequate dietary intake and care, and a non-conducive environment during pregnancy have a 'cumulative effect' on impaired foetal growth, low birth weight, resulting in impaired growth and development of the offspring throughout their life course, and subsequent continuation of the undernutrition life cycle[59]. Addressing undernutrition through the life-cycle approach has identified the critical windows of opportunity for nutritional interventions such as periconceptional period, first 1000 days of life (-9 to 24 months after birth) and catch-up growths between 24-48 months and during adolescence[60]. Maternal nutrition deficiency in the preconception such as anaemia, thinness and short stature result in intrauterine growth faltering, smaller birth size and low birth weight[36, 60]. Periconceptional deficit of important micronutrients such as folic acid, and vitamins increases the risk of birth defects, placental growth faltering, and adverse perinatal outcomes[61, 62]. Preconception care with appropriate nutrition interventions is crucial to address the undernutrition before pregnancy and subsequently associated risk on foetal health as careseeking for antenatal services is often delayed and of inadequate quality [63-65].

The first 1000 days of a child's life, from conception through to 24 months after birth, is the most "critical period" considering the pathogenesis, causes and consequences of childhood undernutrition[55, 66-68]. Pooled data analyses from LMICs showing the child growth trajectories by age, known as "Victroa Curve", reported that most linear growth faltering in childhood occurs within the first two years of life[27, 69]. In pregnancy, maternal nutritional deficit and/or inadequate dietary intake affects hormonal adaptation and epigenetic regulation, restricts foetal growth and development, and results in preterm birth, small for gestational age, and low birth weight[52, 70-73]. Studies have also reported foetal growth restriction and preterm birth origins of child undernutrition and suggested that one-fifth of the linear growth faltering among children is due to uterine causes[27, 74-76]. Studies from LMICs suggested approximately 1.5-5 times increases in acute and chronic undernutrition among children due to low birth weight[74, 77]. Similarly, the latest evidence from a multi-country study reported that shorter birth length was the largest risk factor for shorter length-for-age among toddlers, reinforcing the impact of nutrition in foetal life[78].

The first six months after birth is critical to a child's growth trajectory, as the growth velocity is the highest during this period[79]. A growth faltering trajectory analysis from cohort data in LMICs suggested that at least 40% of stunning in the first two years of life occurs within the first six months after birth[27].

Insufficient exclusive breastfeeding up to the first six months results in inadequate nutritional intake, immature immune function, higher susceptibility to infections, and restricted physical growth and cognitive development[21, 80-82]. Moreover, relative nutritional requirements are much higher in infancy than in older childhood to keep pace with the faster growth and development in this period [25, 83]. Inadequate complementary feeding with delayed start, poor dietary diversity and meal frequency, increasing use of easily available but low-nutritious foods, and early cessation of breastfeeding also result in poor growth and gaps in critical micronutrients during the ages between 6-24 months in LMICs[13, 25, 27, 84-90]. Recurrent and chronic infections like pneumonia, sepsis and diarrhoea, subclinical infection and environmental enteric dysfunction are also prevalent in infancy due to underdeveloped immune function, nutritional (two-way relationship) and environmental risk factors causing poor absorption of nutrients and exacerbating the risk of undernutrition in the first two years of life in LMICs[52, 83, 91]. Evidence suggests that young children aged below two years suffer more from infectious diseases like diarrhoea and acute respiratory infections than older children[92]. Disruption of the microbiome and gut microbiota assembly in the first 1000 days of life due to poor diet, infant formula feeding, and other health service and environmental risk factors also increase growth delay in infancy and childhood[52, 93-95]. Furthermore, catch-up growth from the nutritional deficit that occurred in the first few months of life is often unattainable at a later age[96, 97].

Although the first 1000 days of life is the most crucial "window of opportunity" to ensure optimal growth, the necessity and opportunity for undernutrition correction do not end here[60]. Longitudinal data analysis from several LMICs demonstrated a large catch-up growth of length among children between 2-4 years of age, also known as "a period of stability"[60, 98]. However, this growth catch-up relies on food security, child feeding practices and dietary intake, childhood infections and epigenetic factors[60]. Previous literature suggested this growth catch-up was due to the improved immune system and reduced growth restricting infectious disease morbidity in mid-childhood[60]. Therefore, sustained coverage of contextually tailored interventions to address these immediate and underlying determinants are necessary to ensure catch-up growth in mid-childhood. Adolescence is another important window of opportunity to address child undernutrition[60]. Analyses of longitudinal data demonstrated a dip in linear growth in the pubertal phase, both for boys and girls, followed by a catch-up in adulthood[60]. In adolescence, the needs for macro and micronutrients are high to maintain the fast physiological and cognitive transitions[99-101]. Adolescent girls are more susceptible to being anaemic due to the reduction of iron stores[102]. In LMICs, early marriage and teenage pregnancy are common[65]. Adolescent pregnancy increases the nutrition needs to meet the existing requirement for the adolescent girl herself and additional requirements for the foetus[100, 103]. Therefore, ensuring adequate nourishment in adolescence is not only crucial for adolescent girls but also for breaking the intergenerational undernutrition cycle[100].

2.1.4 Effective nutrition interventions for addressing child undernutrition: a framework-based approach

Evidence on effective interventions to address child undernutrition and its consequences has evolved over the last three decades. Studies have also established the effectiveness of these interventions in different population and contextual settings, especially in LMICs[24]. To date, the three Lancet series on Maternal and Child Nutrition in 2008, 2013, and 2021 had the most comprehensive review, collation, corroboration, and systematic presentation of effective and scalable interventions to address undernutrition among mothers and children[24, 104, 105]. The recent (2020) comprehensive analysis of the observational data and evidence synthesis identified the key direct and indirect drivers for rapid declines of childhood stunting in “exemplar countries”[20].

In the 2013 Lancet nutrition series, Black et al.[55] proposed a conceptual framework for interventions and actions to address the three levels of causes of child undernutrition and the detrimental effects throughout the life course (please see sections 2.1.2). The framework organised effective interventions into ‘nutrition-specific’ and ‘nutrition-sensitive’ and the actions to create an ‘enabling environment’ domains. Nutrition-specific interventions include diet and micronutrient supplementation (or micronutrient fortification) in preconception and pregnancy, breastfeeding and Infant and Young Child Feeding (IYCF) promotion, diet and micronutrient supplementation to children, screening and management of acute malnutrition, prevention and management of common childhood illness, and targeted nutrition interventions in emergency humanitarian response settings[55]. These nutrition-specific interventions address child undernutrition by improving breastfeeding, feeding and caregiving, adequate intake of nutrient-rich food, and preventing the incidence and detrimental impact of childhood illness, especially infections[24, 55].

Priority nutrition-sensitive interventions included in the framework are aimed at improving agriculture and food security, cash transfers and social safety nets, empowering women, increasing attendance in formal education, provision and utilisation of preventive and curative health services, pregnancy and family planning, safe water and sanitation facilities, and child development and protection interventions[55]. The nutrition-sensitive interventions target the underlying causes of child undernutrition, including household food insecurity, access to knowledge and resources at the individual (caregivers), household and community level for improved child feeding and caregiving, access to essential healthcare, and safe and secure environment for children[41, 55].

The third type of intervention in the framework focuses on creating an enabling environment[55] and aims to improve readiness, access, reach, utilisation, and coverage of nutrition-specific and sensitive interventions. Actions such as well-designed evaluations of interventions and their delivery and advocacy strategies, multi-sectoral coordination, building comprehensive planning and activities for multisectoral nutrition, promoting governance, regulations, and supportive legislations, creating informed and skilled leadership, nutrition financing, and resource mobilisation address overarching social, political and economic contextual determinants of undernutrition[55, 106].

In the 2021 Lancet series, Keates et al. revised the framework and updated the list of effective interventions and actions to improve maternal and child nutrition, and classified them into five categories- i) direct health-sector nutrition interventions, ii) indirect health-sector interventions influencing nutrition, iii) interventions in non-health (other) sectors directly influencing nutrition, iv) non-health sectoral interventions/actions indirectly affecting nutrition, and v) cross-cutting strategies influencing nutrition interventions[105]. Nutrition-specific interventions in the 2013 framework were classified under direct nutrition interventions in health sectors and non-health sectors[55, 105]. Indirect nutritional interventions and cross-cutting strategies encompass nutrition-sensitive interventions and actions to create an enabling environment. The revised framework also considered macro-level social, political, economic, and environmental factors influencing the implementation and effectiveness of direct and indirect nutrition interventions. Analysis of key drivers for undernutrition declines in the "exemplar countries" reported a similar contribution of health and non-health sector interventions and recommended a remapping of nutrition interventions based on their contribution in direct and indirect effect pathway [20].

The change in "Victora curves", showing the child's linear growth by age, over time from exemplar countries suggested distinctive patterns of contributions of nutrition interventions [107], The analysis demonstrated that improvements in maternal nutrition and coverage of health care interventions during pregnancy resulted in longer length at birth in some countries[107]. Increased exclusive breastfeeding rates contributed to the reduction in shorter length-for-age in the first six months after birth in all countries included in the analysis[107]. But improvements in length-for-age between 6-23 months were contributed by combination of different factors such as improved infant feeding practices, reduction of household food insecurity, prevention and management of childhood illnesses and better access to safe water and improved sanitation facilities over time[107].

2.1.5 Priority nutrition-specific interventions during the first 1000 days of life

Over the last two decades, enormous efforts have been made to identify and prioritise effective nutrition-specific interventions. As discussed, Bhutta et al. (2013) conducted a comprehensive review of evidence on existing nutrition-specific interventions and modelled their effect on child mortality and undernutrition to identify the relative priority among the interventions[24]. A set of 10 most effective nutrition-specific interventions and the cost of their scale-up in LMICs were identified. These included eight preventive interventions, including maternal balanced food (energy-protein), multiple micronutrients and calcium supplementation in pregnancy, preconception and pregnancy iron and folic acid supplementation, promotion of breastfeeding and complementary feeding, preventive zinc and vitamin A supplementation for children and two curative interventions- management of severe and moderate acute malnutrition among children[24].

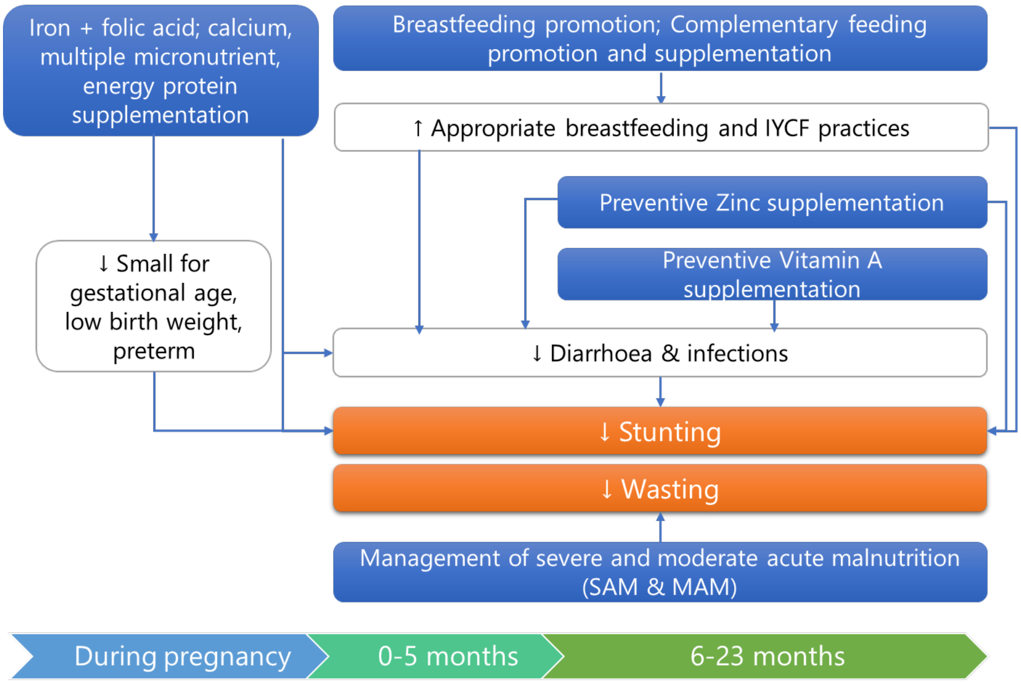


Figure 2-2 Priority nutrition-specific interventions during the first 1000 days of life and their linkages with reducing child undernutrition.
[Adapted from Bhutta et al. 2013 and Keats et al. (2021)[24, 105]]

The modelled estimates suggested that this set of nutrition specific/direct interventions, when implemented at 90% population coverage, could reduce 20% of stunting, ~ 60% of severe wasting, 15% of mortality among children aged less than five years in LMICs with high burden of undernutrition[24]. All of these ten interventions are to be delivered mainly in the first 1000 days of life and have a direct effect on preventing child undernutrition (Figure 2-2). Since 2013, evidence of their effectiveness was further strengthened by primary studies, systematic reviews, and evidence synthesis from multiple LMIC settings[105]. Updated evidence on the effectiveness of theses priority interventions is provided in the following section.

Iron and folic acid supplementation in pregnancy

Several studies have established the benefits of antenatal iron and folic acid (IFA) supplementation in LMICs in addressing maternal anaemia and preventing low birth weight[105, 108, 109]. An updated systematic review and meta-analysis reported a 12% protective effect (RR 0.88, 95% CI: 0.78, 0.99) of IFA supplementation in pregnancy on low birth weight[109]. Although the updated meta-analysis did not find an overall effect of antenatal IFA supplementation on preterm birth, an earlier Cochrane review found a 49% protective effect (RR 0.51, 95% CI: 0.29, 0.91) on very preterm births[108, 109]. Although there is an adverse effect of iron supplementation on malaria, a recent mediation analysis from a longitudinal study found that the protective relationship of iron deficiency on low birth weight was not largely mediated through preventing malaria and suggested antenatal IFA supplementation in malaria-endemic regions[110, 111]. Evidence of the long-term effect of antenatal IFA on child nutrition is also emerging. Our recent pooled analysis from South Asian countries also demonstrated the positive impact of antenatal IFA supplementation on linear growth among children aged less than two years[112]. However, starting IFA supplementation early in pregnancy is important to achieve its multiple benefits. Supplementation of folic preconceptionally and in the first few weeks of pregnancy is critical to support neural tube formation and foetal development[113]. Similarly starting iron supplementation early is important to fill the gap in iron stores among women in LMICs where iron deficiency is highly prevalent as well as meeting the extra demand for iron due to increased blood volume during pregnancy and foetal growth in later trimesters[114, 115]. Early introduction of IFA also has beneficial impacts on perinatal health outcomes such as preventing early neonatal mortality[116]. Starting IFA supplementation early in pregnancy is also important to allow mothers to consume the recommended dose. Based on a comprehensive synthesis of the available evidence, the WHO included antenatal supplementation of IFA containing 30-60 mg iron and 0.4 mg folate once daily for at least six months in the antenatal care (ANC) recommendations[117].

Calcium supplementation in pregnancy

Calcium supplementation during pregnancy has shown substantial maternal health benefits, such as preventing eclampsia and severe preeclampsia in LMICs[105, 109]. Meta-analyses also suggest protective effects of calcium supplementation on preterm birth, varying from 20% to 24%, and increase in birth weight, ranging from 56 to 86 gram, but a non-significant reduction of low birth weight prevalence[118-120]. Nonetheless, a definitive and greater effect on the reduction of preterm birth was found for a dose of one gram and above of calcium supplementation among women with higher pre-eclamptic risk[119, 120]. Considering the substantial protective effect of calcium on pre-eclampsia in pregnancy and the correlation with preterm birth, the WHO recommend a daily 1.5-2.0 gram oral calcium supplementation antenatally in settings where a regular diet is grossly calcium-deficient[117].

Multiple Micronutrient Supplementation (MMS) in pregnancy

Multiple Micronutrient Supplementation (MMS) in pregnancy is one of the ten most effective nutrition-specific interventions, especially LMICs, where women often lack adequate stores and intake of different essential vitamins and minerals[24, 55, 121]. Pregnant women in these settings often do not meet the increased demand for these critical micronutrients for themselves and the developing foetus, which increases the risk of adverse pregnancy outcomes and is directly linked with impaired child growth[122]. A recent Cochrane review and meta-analysis based on robust screening and selection criteria suggested that MMS prevented low birth weight by 12% (RR 0.88, 95% CI: 0.85, 0.91) compared with IFA[121]. Although MMS with 13-15 micronutrients did not demonstrate sufficient evidence of an effect on SGA, the United Nations International Multiple Micronutrient Antenatal Preparation (UNIMMAP) with 15 micronutrients had a 9% protective effect (RR 0.91, 95% CI: 0.85, 0.98) on SGA[121]. Other systematic reviews also identified reductions of 12-15% in low birth weight, and 6-7% in SGA by antenatal MMS[109, 123]. The effect was higher among anaemic and underweight women and starting supplementation early in pregnancy[109, 123]. Although antenatal MMS is likely to decrease the incidence of childhood diarrhoea by 16%, evidence of the effect on child growth is limited[109, 124]. Antenatal MMS is also more cost-effective in preventing disability-adjusted life years than IFA in LMICs[125]. Considering the comparative benefits, limited evidence of harm, acceptability, and cost-effectiveness, the WHO antenatal care recommendation suggests supplementation of antenatal MMS, including iron and folic acid, instead of only IFA supplement in LMIC settings for conducting implementation research[126, 127].

Balanced energy protein supplementation and nutrition education in pregnancy

Several studies have identified that a balanced energy-protein supplementation during pregnancy, especially among undernourished women, is an important nutrition-specific intervention to improve foetal growth and birth outcomes[128-130]. Stevens et al. (2015) suggested that the balanced energy protein supplementation addresses the dietary energy intake gap among mothers with chronic malnutrition and often acute malnutrition due to food insecurity in LMICs[131]. The latest systematic review in 2020, included studies from LMICs on a balanced energy-protein supplementation, reported improvements in mean birth weight by 108 gm (95% CI: 69, 146), prevention of low birth weight by 40% (RR 0.60, 95% CI: 0.41, 0.86)[130]. The effect of a balanced energy-protein supplementation in pregnancy on child nutrition is inconclusive due to a lack of sufficient information from randomised trials[131]. However, some evidence from LMICs also demonstrate the intervention's protective effect on stunting, length, and weight in different sub-groups of under-five children[132, 133]. The WHO recommends this intervention in settings where the prevalence of underweight women is ≥20%[117]. Recent evidence suggested that nutrition education interventions on increased protein and energy consumption in pregnancy have proven benefits in lowering low birth weight and preterm births, especially in the undernourished population[128]. The WHO guideline included two relevant recommendations on nutrition education during pregnancy- i) counselling of all pregnant women on a healthy diet in all settings and ii) nutrition education on dietary diversity and consuming extra protein and energy than pre-pregnancy regular diet in settings where ≥ 40% women are underweight[117].

Breastfeeding promotion

Promoting appropriate breastfeeding practices is one of the highest-impact nutrition-specific interventions during infancy and early childhood, which has multiple benefits for children, their mothers, and society as a whole[21, 24, 134]. A joint recommendation by the WHO and UNICEF promotes early initiation (<1 hour after birth) of breastfeeding, exclusive breastfeeding for up to six months, and continued breastfeeding up to at least two years of the child's age[135, 136]. Breastfeeding is considered the first immunisation for children, ensures equal access to nutritional start-up in early life, prevents the risk of infection like diarrhoea and respiratory illness and death, and helps the physical, cognitive and hence the economic potential of the child[21, 134]. A systematic review of studies from LMICs identified that exclusive breastfeeding reduces the risk of dying by eight-fold among children up to six months of age, and continued breastfeeding halves the deaths among children aged 6-23 months compared to non-breastfed children in the same age groups[137]. The effect of breastfeeding on preventing infection-related deaths was related to breastfeeding intensity[137]. The most recent projection suggested that scaling-up breastfeeding to a near-universal coverage would prevent more than 0.8 million child deaths in LMICs[21]. Nutrition education and counselling interventions commenced during pregnancy and continued postnatally were found effective to improve breastfeeding knowledge and skills, breastfeeding initiation, exclusive breastfeeding up to 6 months, and continued breastfeeding up to 2 years of child's age[138-140]. The latest systemic review of studies from LMICs reported that mothers receiving nutrition education interventions were 1.2 times more likely (95% CI: 1.12, 1.28) to initiate breastfeeding within 1 hour of birth, 1.53 times more likely (95% CI: 1.47, 1.58) to adhere exclusive breastfeeding up to six months of child's age[141]. Another meta-analysis reported 15% and 22% increase in continued breastfeeding up to 2 years by nutrition education interventions delivered at health services and community settings, respectively[138]. However, the direct effect of breastfeeding promotion on improvements in child growth indicators was not evident[21, 27, 105, 141]. Nutrition education interventions had the highest effect when nutrition counselling and educational interventions were implemented simultaneously through health service, community and mass or social media platforms[138].

Age-appropriate complementary feeding promotion

Age-appropriate complementary feeding with adequate dietary diversity and meal frequency is essential for infants' survival, thriving, and development[24, 105, 142]. The WHO and UNICEF recommend starting nutritionally-balanced complementary feeding at six months of child's age[136, 142]. Feeding infants aged six months or older with diversified food improves consumption of essential nutrients and micronutrients[25, 143]. Nutrition education or behaviour change counselling of caregivers of infants and young children has been the most studied and effective intervention for improving complementary feeding practices[142]. Research has identified nutrition education promoting appropriate weaning practices provided at the facility and community-based settings were effective in improving caregivers' knowledge, and skills of complementary feeding[139, 144-146]. Nutrition education reduced early weaning, and improved dietary diversity, meal frequency, minimum acceptable diet, intake of specific food groups, animal-sourced protein, energy, and nutrient-dense food[139, 144, 147, 148]. Although the type, content, and platforms for delivering infant feeding counselling vary widely, well-designed, intensive and practical skill-focused nutrition counselling were effective in improving complementary feeding practices[142, 147, 149]. However, the effect of nutrition education on complementary feeding practice is modified by caregivers' affordability and household food security[121, 150, 151]. Although nutrition counselling was mostly found effective in improving complementary feeding practices in food secure settings, some recent studies demonstrated improved intake of specific food groups in food insecure settings[149, 152, 153]. Recent systematic reviews of evidence from LMICs identified positive effects of nutrition counselling on height, weight and linear growth (length-for-age) among 6-23 months old infants in food secure settings but no definitive effect in food-insecure populations[130, 154].

Micronutrient supplementation for children

Evidence on the effectiveness of different micronutrient supplementation among children has increased in the last decade[105]. Direct supplementation of micronutrients to children has been tested in three forms- i) single micronutrients, ii) MMS and iii) lipid-based nutrient supplementation (LNS) with multiple micronutrients[155]. Among single nutrient supplements, several studies have tested the effectiveness of Vitamin-A supplementation for children, and this is now recommended for children aged 6-59 months in high-deficient settings[156, 157]. A 2022 Cochrane review identified a positive effect of Vitamin-A supplementation on child mortality, diarrhoeal illness, measles, night blindness, and an evidence gap on its impact on child growth outcomes[157]. Provision of iron supplements alone or in combination with other micronutrients among children prevented anaemia in all age subgroups but iron-only supplement had no effect on child growth indicators[105, 158]. Preventive zinc supplementation among children showed mixed results for nutrition and mortality outcomes. Preventive zinc supplementation had positive effects on a child's weight and height, especially in the nutritionally deficient subgroup, but not on stunting and wasting, however, the effect was more pronounced beyond two years of age[105, 158, 159]. Although there have been mixed findings, a recent meta-analysis of studies mostly from LMICs with either preventive or therapeutic zinc supplementation (for diarrhoea) identified 16% reduction (RR 0.84, 95% CI: 0.74, 0.96) in child mortality[160]. Studies testing the efficacy of different forms of MMS demonstrated improvements in children's height, length-for-age z-score, and prevention of childhood anaemia, however, did not reduce stunting and wasting[105, 158]. In contrast, LNS was effective in improving child growth outcomes [105, 158, 161].

Management of acute malnutrition

In several LMICs, severe acute malnutrition is highly prevalent among children, however, if not identified early, remains untreated, and results in premature death and long-term adverse consequences[162]. The WHO guideline suggested acutely malnourished children with medical complications and impaired appetite should only be treated at inpatient facilities and recommended outpatient or community-based acute malnutrition management for children without clinical illness and no appetite issues[163]. Further, in a joint WHO, World Food Programme (WFP), and UNICEF statement, the process of community-based screening of acute malnutrition and recommendations for treating the uncomplicated severe acute malnutrition cases in the community- known as Community-based Management of Acute Malnutrition was recommended[164]. Several studies have tested diverse facility and community-based treatment strategies for moderate and severe acute malnutrition and have reported varying levels of their effectiveness on recovery and mortality rates[105, 165].

2.1.6 Coverage of preventive nutrition-specific interventions in LMICs

Adequate coverage of priority nutrition interventions is essential to achieving global nutrition targets. Based on their modelled projections Bhutta et al. (2013) demonstrated that a 20% reduction of linear growth faltering among children can only be achieved if the 10 priority interventions can be scaled at 90% coverage in high undernutrition burden LMICs[24]. Despite the substantial data gap in nutrition coverage, varying coverage and progress of nutrition-specific interventions were observed in LMICs[149, 166-168]. Further, large within-country inequity in nutrition intervention coverage also makes several geographical pockets and disadvantaged populations more vulnerable to undernutrition[169-171].

Coverage of antenatal IFA supplementation has been low and progressing slowly. Based on the data available from national surveys approximately only one-third of the women in 17 LMICs consumed 90+ IFA tablets during their most recent pregnancy in the last five years[149]. Estimated global coverage of IFA supplementation was lower in LMICs[172]. Based on the latest available national estimates, IFA coverage also varies widely across LMICs (Figure 2-3). Coverage of WHO recommended adequate dose of consuming 180+ tables is much lower and achieving 90% coverage is unlikely with existing efforts[173].

Geographic inequity and missed opportunities between health service platform contact, low coverage of any IFA, and inadequate dose are frequently reported in the literature[168, 173].

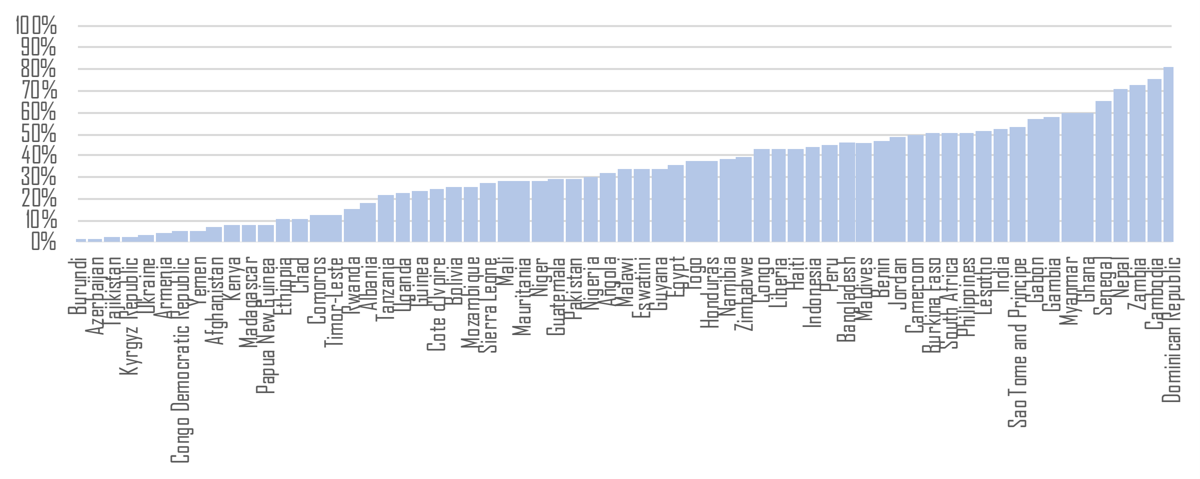


Figure 2-3 Percentage of women with a birth in the past five years who took iron tablets or syrup for 90+ days in LMICs (latest available data point).

Source: ICF, 2015. The DHS Program STATcompiler. Funded by USAID. https://www.statcompiler.com. August 16, 2022

Coverage of calcium intake by pregnant women is similar to IFA, and has been lower than the recommended daily intake in most of the LMICs with high calcium deficiency among women[174, 175]. Although the recent WHO guideline recommends blanket calcium supplementation during pregnancy in counties where diet in calcium-deficient, implementation of the intervention and coverage have been constrained by the dosing schedule of consuming multiple tablets daily and the current preference for time spacing between calcium and iron consumption[117, 176-178]. Although acceptance of MMS was high among pregnant women, coverage data at the population level is limited as scale-up of MMS delivery is not yet recommended[127]. Moreover, implementation research on the distribution of MMS through ANC contacts and market-based delivery channels are also ongoing[179, 180].

Balanced energy protein supplementation during pregnancy is recommended only in populations with high under-nutrition prevalence among women[117]. There remains limited population-level implementation and coverage data on balanced energy protein supplementation, and this intervention is resource intensive and may require substantial logistical investment which may impede its coverage in LMICs[117, 149, 181]. Sharing the supplements with other household members, especially in food insecure households, the supplement's taste, smell, and contextual factors may also limit acceptance, coverage, compliance, and intended benefits[182-184]. Further, there is a paucity of national-level data on coverage of nutrition education interventions promoting the consumption of an adequate and balanced energy protein diet in pregnancy[149].

Globally, appropriate infant feeding practices including early initiation of breastfeeding after birth and exclusive breastfeeding of children up to six months of age, continued breastfeeding for up to two years, and adequate complementary feeding from 6 months onwards have been low and progressing slowly[105]. According to the latest progress tracking from 96 countries, 44% of children aged less than six months were exclusively breastfed which is lower than the 50% target, and only 35 countries are likely to achieve this target by 2025[171, 185]. The latest estimates from LMICs reported that just over half (52%) of mothers initiated breastfeeding within one hour of birth and only 56% continued breastfeeding up to two years of the child's age[185]. Cross-country variations in breastfeeding practices remain high (Figure 2-4), and suggest that universal coverages of age-appropriate breastfeeding practices will be even more challenging to achieve in the near future[186]. Although breastfeeding is among the few health behaviours better practised in low-income settings, declines in breastfeeding practices were observed in the urban population, especially among highly educated mothers[21, 187]. Recent studies also identified a negative association between increasing trend of caesarean births and early breastfeeding initiation and exclusive breastfeeding up to six months in LMICs[188, 189]. Breastfeeding practices are influenced by a whole variety of individual knowledge, skills, self-efficacy, interpersonal support, community level socio-cultural acceptance and belief, health systems intervention and contextual policy level factors[190-192].

Improvements in age-appropriate complementary feeding practices have been slow and vary widely across countries and geographic regions in LMICs[88, 193, 194]. The latest pooled analysis of data from 101 countries reported only 16% children aged 6-23 months were fed a minimum acceptable diet[88]. Although coverage of age-appropriate minimum meal frequency was relatively higher (52%), consumption of minimum dietary diversity of feeding 4+ (out of a maximum 7) food groups was low (29%) [88]. A cross-country comparison demonstrates low dietary diversity mainly results in low coverage of appropriate IYCF practices among 6-23 months old infants (Figure 2-5). Inappropriate timing of introduction to complementary food, higher dependency on staples, and low intake of animal-sourced protein, fruits, and vegetables remain the main gaps in complementary feeding practices[195]. Similar to breastfeeding, knowledge, perception, cultural norms and customs, socio-economic status, household food security, food systems, health system, and community support influence complementary feeding practices [88].

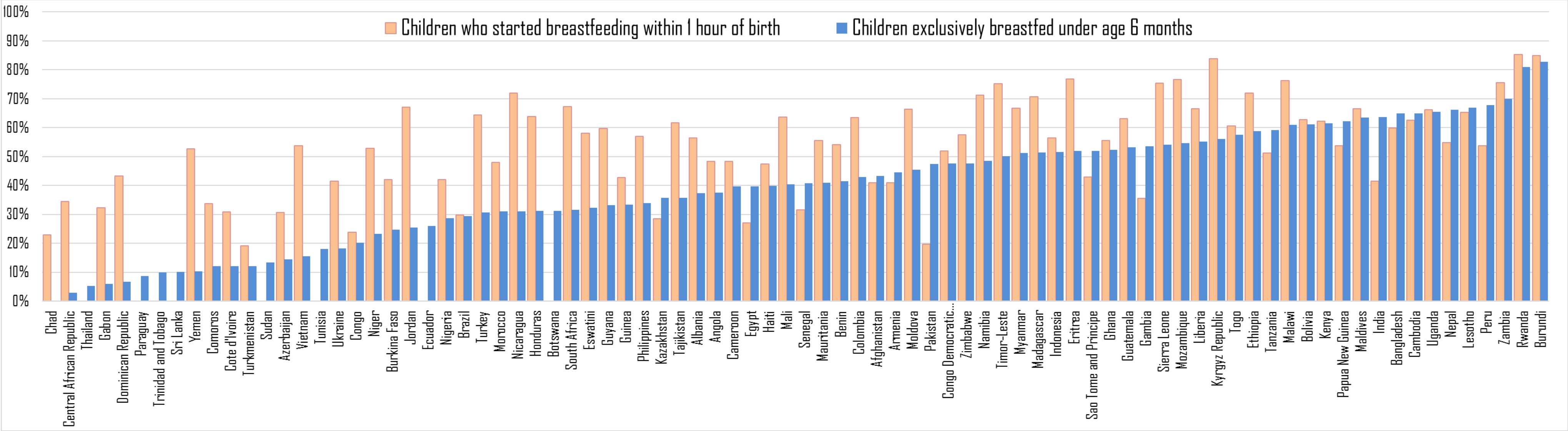


Figure 2-4 Initiation of breastfeeding within 1 hour of birth and exclusive breastfeeding among 0-5 months old children in 84 LMICS (latest available data point). Initiation of breastfeeding missing in 8 countries. Data Source: ICF, 2015. The DHS Program STATcompiler. Funded by USAID. https://www.statcompiler.com. August 23, 2022

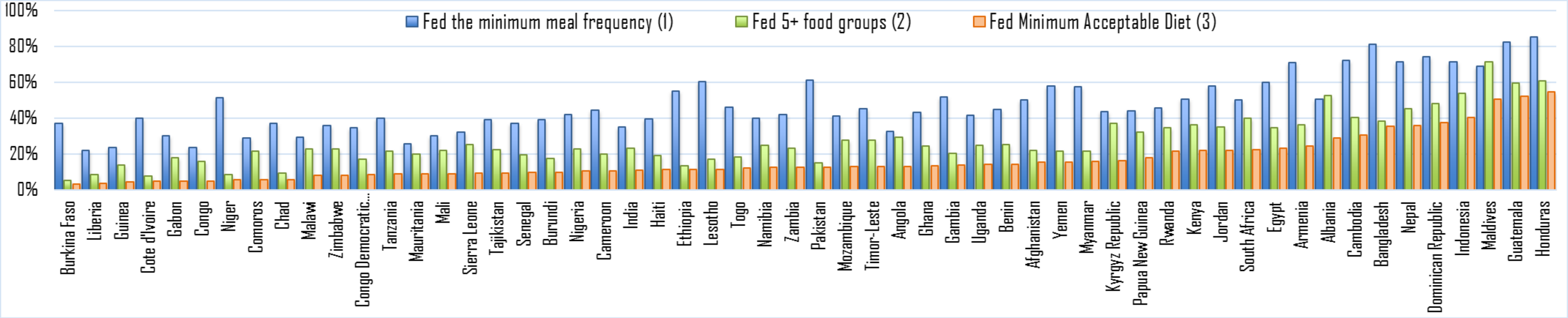


Figure 2-5 IYCF practices among 6-23 months old children in 54 LMICs.

1. Minimum Meal frequency (MMF): fed 2+ solids or semi solids to 6-8 months and 3+ solids or semi solids to 9-23 months old breastfed infants or 4+ solids or semi solids or milk to 6-23 months old non-breastfed infants; 2. Minimum Dietary Diversity (MDD): consumed 5+ food groups (out of 8); 3. Minimum Acceptable Diet (MAD): MMF and MDD for breastfed children, MDD excluding dairy (4 out of 6 groups) and MMF and 2+ more milk fed to non-breastfed children. Data Source: ICF, 2015. The DHS Program STATcompiler. Funded by USAID. https://www.statcompiler.com. August 23, 2022.

Among the preventive micronutrient supplementations, vitamin A supplement is provided to 6-59 months old children in 80+ LMICs mostly delivered at nationwide campaigns often through other child health events such as the oral polio immunization campaign[196]. Although the coverage of yearly double-dose supplementation of vitamin A (one in six months) reached the target of 80% in early 2000, the coverage declined substantially in the last decade, especially after 2016 to <65%[196, 197]. A model based estimate reported even a lower coverage (43%) of vitamin A in LMICs[172]. Recently, the relevance and effectiveness of mass-scale vitamin A supplementation was debated[198]. But, there is a considerable data gap on the current prevalence of vitamin A deficiency in LMICs, and large disparities in between and within-country vitamin A coverage persist in high-priority countries[196, 198]. Although the therapeutic use of zinc supplements for the treatment of childhood diarrhoea has been adopted by all LMICs, its coverage remains low[199, 200]. Lage cross-country variations were also reported in coverage of zinc supplementation and the gap between oral rehydration solution and zinc in childhood diarrhoea due to challenges in consistent supply, availability in the local market, delivery modalities, and awareness and acceptance of zinc[199, 201]. Routine preventive zinc supplementation and small quantity lipid-based nutrient supplementation is still not recommended. Moreover, very few countries have implemented large-scale preventive zinc supplementation for children as the most amenable and effective strategy for mass scale-up, how this is done in LMICs is yet to be determined[149, 202, 203]. Similarly, guidance, feasibility and side-effects of population-level lipid-based nutrient supplementation on complementary feeding is yet to be explored[149].

Data on direct measurement of coverage of nutrition interventions such as nutrition counselling at antenatal and postnatal care at health facilities and during home visits by frontline health workers are scarce in many LMICs[149]. Periodic national demographic health surveys collect some information on receiving messages on breastfeeding at antepartum and immediate postpartum health care contacts yet data on coverage and timing of complementary feeding counselling are not available[167]. An analysis of breastfeeding counselling data available from 33 countries demonstrated a wide variation in coverage of receiving breastfeeding counselling at the postnatal care contacts within two days of birth (6% to 96%) and in nearly half of the countries ≥50% mothers did not receive this nutrition intervention (Figure 2-6). Improving breastfeeding and age-appropriate complementary feeding practices also necessitates mothers/caregivers receiving multiple and consistent nutrition education during pregnancy and in the first two years after birth[204, 205]. However, limited information is available from LMICs to compare coverage on the continuum of nutrition education during pregnancy and in the postpartum period.

Figure 2-6 Among the livebirths in last two years mothers received breastfeeding counselling at the post-natal care contact within two days of birth in LMICs.

Data Source: ICF, 2015. The DHS Program STATcompiler. Funded by USAID. https://www.statcompiler.com. August 23, 2022

2.1.7 Effective coverage and quality of nutrition interventions

Previous estimates of the combined effect of priority nutrition-specific interventions on reducing child mortality and stunting considered a hypothetical 90% coverage of those interventions[24]. However, researchers and programme managers argue that only contact coverage of receiving the interventions is unlikely to translate their desired effect, documented in efficacious settings, to population-level impact[206, 207]. Effective coverage measurement integrates quality of the intervention delivery, in addition to the target population reach, into the intervention coverage measure so that the actual likely effect of the intervention can be estimated[208, 209]. Definition, extent, and approaches to measure effective coverage of health and nutrition interventions have evolved over the last two decades. Changes have included composite measures of different elements of the impact pathway logic model such as inputs, processes, output, and impact-based intervention coverage assessments[207, 210]. Recently, the Effective Coverage Think Tank Group updated the cascade-based framework of effective coverage measures of health and nutrition interventions, originally proposed by Amouzou et. al.[207, 208]. Expanding from the conventional crude contact coverage of an intervention, the framework measures the quality of services-adjusted coverage, user-adjusted coverage that includes compliance with the intervention into account if relevant, and outcome-adjusted coverage, factoring in the efficacy of the intervention for a specific outcome[208].

The endpoint of the effective-coverage measure from this cascade-based model depends on the type of intervention, target audience, and relevant data availability[208]. However, for preventive nutrition-specific interventions, input, quality, and user adherence-adjusted coverages were widely used as effective coverage measures[210, 211]. Examples of effective coverage measures of nutrition interventions have shown poorer coverage than contact coverage[210]. For example, an analysis of data from 72 LMICs demonstrated gaps between receiving ANC contacts and IFA supplements in any quantity except for a few countries (Figure 2-7). A larger reduction in coverage was often reported between the contact and quality-adjusted coverage[212]. A pooled analysis of data from LMICs reported that only half (~35%) of the women receiving 4+ ANC visits during pregnancy (~68%) consumed 90+ IFA tablets during pregnancy (half of the recommended dose)[149]. Researchers have also argued that the gaps between the contact coverage and quality-adjusted effective coverage and the inequity in effective coverage could be underestimated when using health facility based data as it fails to represent the nuances of provider practice variations and differences in recipient's characteristics[213]. The importance of developing and implementing appropriate effective coverage measures to track the progress of health and nutrition interventions is increasingly recognised by academia, program managers and policy makers[208].

Most of the priority nutrition-specific interventions suggested in the 2013 Lancet series are delivered mainly through the facility and community-based health service contacts[149]. In the last decade, rapid paradigm shifts of integrating nutrition interventions into health systems and promoting nutrition services at health systems contacts were observed in LMICs, supported by global initiatives such as Scaling Up Nutrition and Universal Health Coverage[214]. Integration of nutrition-specific interventions into the health systems instead of delivering through the timebound parallel programme is expected to have higher reach, coverage, utilisation, efficiency, and sustainability[215, 216]. Nutrition-specific interventions are delivered during ANC visit, facility birth, postnatal care, scheduled visits, (such as immunizations, child health days and growth monitoring and promotion), and sick child management contacts[168]. Therefore, the quality of services remains at the core of achieving effective coverage. A study from a low-income setting demonstrated that improving intervention coverage with quality is likely to double the impact of nutrition interventions than that of improving the coverage alone[217].

Inadequate readiness and quality of nutrition services at important health systems contacts, especially in the first two years of life explain the slow progress in nutrition intervention coverage in LMICs. Over the last two decades, coverage of 4+ ANC visits, skilled attendance at birth, post-natal care from medically trained providers, and care-seeking for childhood illnesses have increased substantially in LMICs[218, 219]. However, effective coverage of nutrition intervention depends on the consistent contact and quality of services provided at those critical health care contacts[207, 220]. In LMICs, the quality of the nutrition service at these health service contacts is often substandard, and the structural and process level gaps hamper the quality of service[216, 221]. For instance, antenatal IFA and calcium supplementation coverage are influenced by supply chain disruptions, their availability, providers' knowledge, preference, and distribution of supplements at antenatal care contacts[149, 222-224]. Similarly, the provision and coverage of zinc supplements with ORS for the treatment of childhood diarrhoea depends on zinc availability and the provider's awareness of the interventions. These barriers were also likely to affect the coverage of recently recommended antenatal MMS[149]. Maternal weight gain monitoring and nutrition counselling were often suboptimal at routine ANC contacts resulting in poor coverage of these interventions[221, 224]. Moreover, harnessing the effect of preventive nutrition interventions such as nutrition education and nutrient supplementation during pregnancy requires multiple contacts with the trained service providers delivering quality services. Substandard quality of care is likely to reduce the demand for and utilisation of services and affect the intervention coverage[225, 226].

Different approaches to nutrition education interventions such as one-to-one, group-based, and phone counselling have shown variable success in improving breastfeeding practices[227, 228]. However, inadequate counselling, demonstration of breastfeeding techniques and problem-solving at antenatal and postnatal care contacts and social norms result in noncompliance to age-appropriate breastfeeding of infants[224, 229]. Gaps in the implementation of health facility-based breastfeeding promotion initiatives have also resulted in such initiatives failing to achieve the desired impact[192]. An analysis of country-level data from 29 LMICs demonstrated poor healthcare providers' performance in observing breastfeeding at postnatal care in most countries (Figure 2-8). Similarly, nutrition counselling on complementary feeding in postnatal care and child health contacts is often suboptimal[230].

Previous literature suggests that the success of nutrition-specific interventions such as education programs promoting IYCF practices depends on a wide range of supply-side political and legislative environments, health system readiness, integration of technological innovations, and socio-cultural contextualisation of the interventions[192]. Healthcare providers often lack knowledge, skills, and confidence in delivering nutrition interventions[231, 232]. Moreover, the integration of preventive interventions such as growth monitoring, and nutrition education into curative health service platforms may lead healthcare providers to deprioritise these interventions while managing multiple health service responsibilities[233]. Evidence suggests that applying a job aid for healthcare providers is beneficial in ensuring provider skill adherence and improving the quality of service[234]. However, examples from LMICs on integrating digital support tools to enhance provider competence and the delivery of nutrition interventions are sparse[231, 235, 236]. Achieving the maximal benefit of improving the reach and coverage of nutrition-specific interventions delivered through health systems depends on a well-functioning integration of nutrition services into the health systems with optimum quality[215]. Moreover, the composite coverage of priority interventions is often much lower than their individual coverage. A recent study identified that only a few South-Asian mother-infant dyads received all of the eight nutrition-specific interventions delivered in pregnancy and early childhood[169].

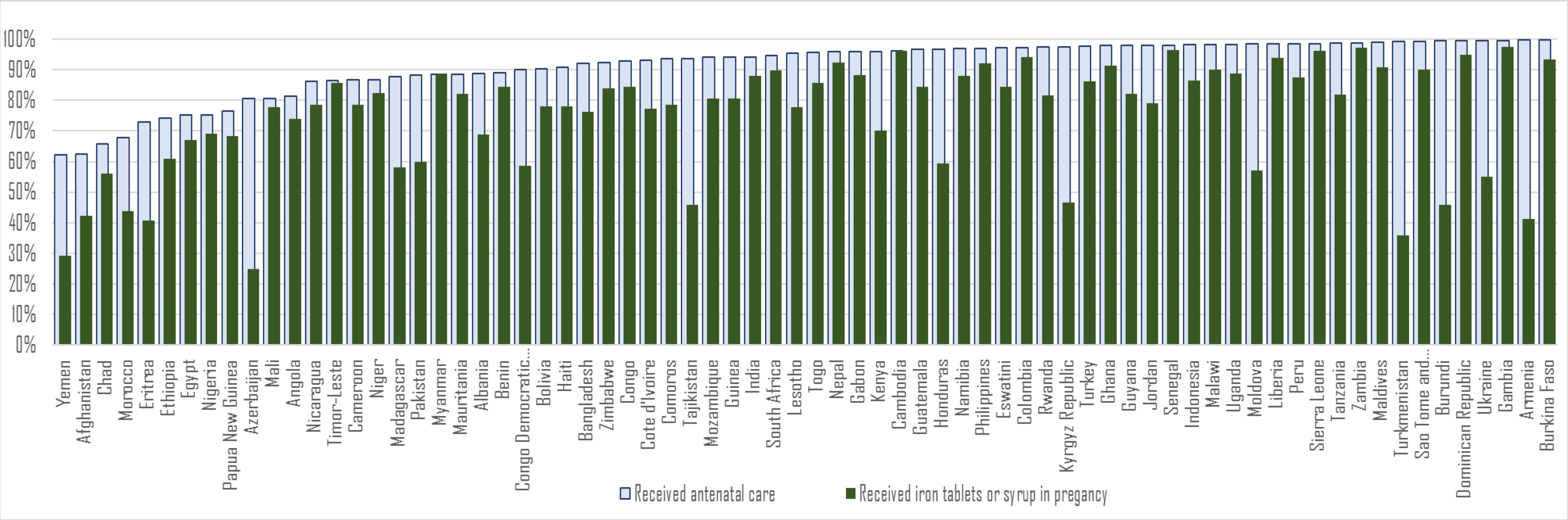


Figure 2-7 Women received antenatal care and iron tablets or syrup during pregnancy.
Data Source: ICF, 2015. The DHS Program STATcompiler. Funded by USAID. https://www.statcompiler.com. August 30, 2022

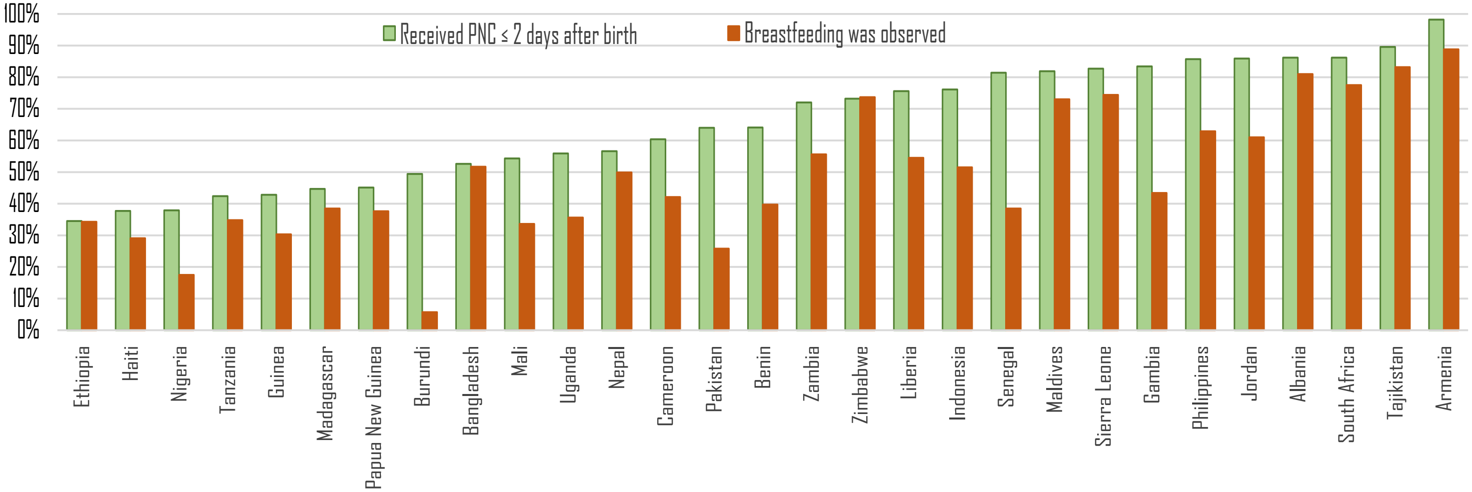


Figure 2-8 Among the recent livebirths the newborn received postnatal care and breastfeeding was observed within 2 days of birth.
Data Source: ICF, 2015. The DHS Program STATcompiler. Funded by USAID. https://www.statcompiler.com. September 3, 2022

2.2 Study context – Bangladesh country profile

2.2.1 Location, geography, and climate

The People's Republic of Bangladesh is a Ganges and Brahmaputra riverine floodplain delta that constitutes most of the Bengal Basin[237, 238]. The country is situated in the northeast of South Asia and the northern end of the Bay of Bengal (Figure 2-9)[238]. The country has approximately 147 thousand square kilometres of landmass with a non-uniform and dynamic coastline on the south; surrounded by land boundaries mostly with three states of India and a short land and water border with Myanmar[239, 240]. The topology of Bangladesh is mostly occupied by several types of floodplain lowlands but has an uplifted block of tracts and terraces and a strip of hills constituting approximately 20% of the total land area[240]. Hundreds of rivers, canals, and tributaries crisscrossing the country are the natural lifelines. At the same time, the country's location at downstream of major Himalayan rivers and flat low laying topology makes it vulnerable to flooding and riverbank erosion[241]. The country also has some habited coastal islands, river islands, known as *Chars,* in the four mains river systems and north-eastern estuarine marshes[240]. The Sundarbans, the world's largest mangrove forest, is located at the southwestern opening to the Bay of Bengal[240].

Figure 2-9 Location of Bangladesh in South Asia

The Tropic of Cancer bisects Bangladesh. Consequently, the country experiences a sub-tropical monsoonal climatic pattern. Summer lasts from mid-March to mid-June with encroaching heat, temperatures ranging from 21-38 degree centigrade with frequent rains, occasional storms, and tropical cyclones in a 2-3 year cycle[239, 242]. The monsoonal months last from mid-June to mid-October and are extremely humid, warm, and very wet. Due to the difference in atmospheric heat, the cooler offshore of the Bay of Bengal pushes moist clouds into hot inland and causes torrential rains[241]. More than 80% of the total yearly average rainfall of >1500 millimetres, seasonal inundation, and periodic flooding occur during the monsoon[239]. The north-eastern regions experience the highest rainfall[241]. The dry winter extends from October to March and is relatively cooler, with temperatures ranging from 11-20 degree centigrade, and has infrequent precipitation due to the inland to sea bound wind direction[241, 242].

2.2.2 Governance structure, demographic and household characteristics, and economy

Bangladesh achieved independence and was established as a sovereign country in 1971. The Prime Minister is the leader of the parliament and the head of the Government[239]. The current local government structure, originating from the colonial era, has eight administrative divisions (Figure 2-10), 64 districts and 490 sub-districts (known as *upazila*), and 4553 unions[239]. Each of these levels has a local administration and a local government institution from district to union level[243]. City corporations and municipalities (known as *pourashava*) are the local government institutions in urban areas[239, 243].

Figure 2-10 Eight administrative divisions of Bangladesh

Bangladesh is home to ~165 million people and has one of the world's highest population densities, on average 1119 people living in each square kilometre[244]. The population in the country is currently growing at a rate of 1.22% per annum[244]. Dhaka division has the highest number of people while the Barishal division has the lowest. Of the total population, 49.5% are female and 68.5% reside in rural areas[244]. The country is gradually reaching the replacement level fertility; the latest estimates reporting a total fertility rate of 2.3 children for every woman, and 2 and 2.3 in urban and rural areas, respectively[245]. Consequently, adolescents (10-19 years) are the largest proportion (~20%) in the population age distribution and 9% in each of the 5-9 years and <5-year age groups[244]. The average size of households has reduced from 4.4 in 2011 to 4 in 2022[244]. Most of the Bangladeshis are Bengalis and Bangla is the spoken and official language; only 1% of people of ethnic minority groups speak other languages[242]. Islam is the predominant religion (91%) in the country and 8% follow Hinduism[244].

Over the years, Bangladesh has shown remarkable progress in improving the literacy rate and is gradually reducing the male-female gap in literacy. Currently, 75% of the total population, 77% of men, and 73% of women can read and write[244]. The highest literacy rate is in the Dhaka division (78%) and the lowest in Rangpur (72%)[244]. Approximately 97% of the households have access to a safe drinking water source (piped water supply or borewells) and 98% have electricity connection from the national grid[244]. The country is also gradually improving access to improved sanitation; 78% of households have an improved toilet; however, some disparity in access to improved sanitation exists between urban and rural areas and across the divisions[244].

Bangladesh has a fast-progressing economy and is on track to graduate to a middle-income country[246]. In 2021, the country's gross domestic product per capita was US$2503, and in 2022 the forecasted growth rate is 7.2%[247]. The Bangladeshi economy is predominantly agriculture dependent. However, the demographic dividend of a large young workforce, gradual involvement of women in formal employment, the expansion of the export-oriented ready-made garment industry, rapid digitalization, and consistent inflow of remittance by approximately 10 million migrant workers and robust private sector are fuelling the country's high-pace economic growth in recent years[246, 248, 249]. Currently, approximately 72% and 37% of adults use mobile phones and the internet, respectively[244]. These improvements have contributed to emerging the country from a so-called "bottomless basket" at independence in 1971 to a ''poverty reduction model''[250, 251]. The proportion of people living below the national poverty line fell to 21% in 2019[252].

2.2.3 Overview of child nutrition in Bangladesh

Since the start of the millennium, Bangladesh has achieved tremendous progress in child health and nutrition. Bangladesh is among the few countries achieving the highest long-term decline in child undernutrition such as stunting and underweight over the last two decades[253, 254]. Yet, the prevalence of child undernutrition remains high in the country. The latest national survey reported that 28% of all Bangladeshi children aged below five years are stunted, 9% are severely stunted, 10% are wasted and 23% remain lower than the standard weight for their age(Figure 2-11) [255].

A 2021 secondary analysis of national survey data also revealed that 19% of under-five children suffer from multiple forms of undernutrition[256]. According to the latest joint UN estimate, Bangladesh has a 'very high' stunting and 'medium' wasting prevalence amounting to approximately 4.33 million under-five children being stunted and 1.4 million being wasted[257]. Furthermore, the current inadequate annual rate of reduction of child undernutrition resulting in the country being 'off track' to achieve Sustainable Development Goal targets for child nutrition indicators by 2030[257]. Deficiency of essential micronutrients is also prevalent among Bangladeshi children. More than 50% of the children have multiple micronutrient deficiency, approximately 50% have vitamin A deficiency, about one-third (31%) are zinc deficient and approximately 15% have some form of iron deficiency[258].

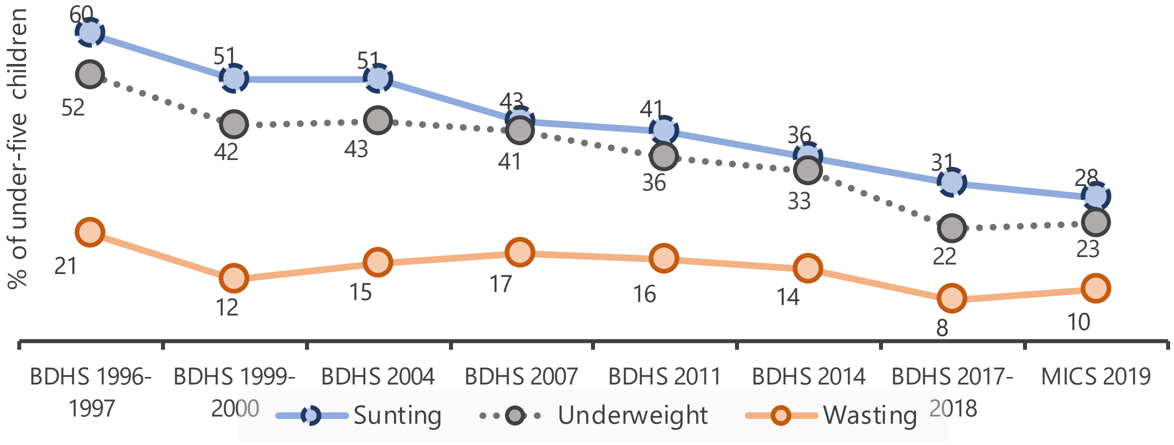


Figure 2-11 Trend of undernutrition (stunting, underweight and wasting) prevalence among under-five children
Data source: Bangladesh Demographic and Health Survey (BDHS) 2017-18[245] and Multiple Indicator Cluster Survey (MICS) 2019[255]

Bangladesh's achievement in the progress towards reducing child undernutrition is dampened by the widespread inequalities across regions, wealth, and education. Prevalence of childhood stunting widely vary across geographic regions (Figure 2-12). Sylhet division has the highest prevalence of childhood undernutrition indicators, while Khulna division has the lowest stunting prevalence, and Dhaka division has the lowest prevalence of child wasting[255]. Under-five children in the poorest wealth quintile had 16, 18, and 4 percentage points higher prevalence of underweight, stunting, and wasting compared to the prevalence among children from the richest wealth quintile (Figure 2-13). Similarly, children living in the urban area and whose mothers have a secondary or higher education have a lower prevalence of undernutrition compared to children from rural areas whose mothers have little or no education.

Childhood undernutrition in Bangladesh is associated with several immediate, underlying, and basic causes[14, 15, 259]. Among the immediate drivers, better infant feeding practices such as dietary diversity were associated with lower stunting, and exclusive breastfeeding for up to six months was protective against wasting among Bangladeshi children[260]. However, age-appropriate infant and young child feeding practices and diet quality remained suboptimal. The latest national survey reported a downward trend of early initiation of breastfeeding and this practice is strongly and negatively associated with caesarean section births in Bangladesh[245, 255, 261, 262].

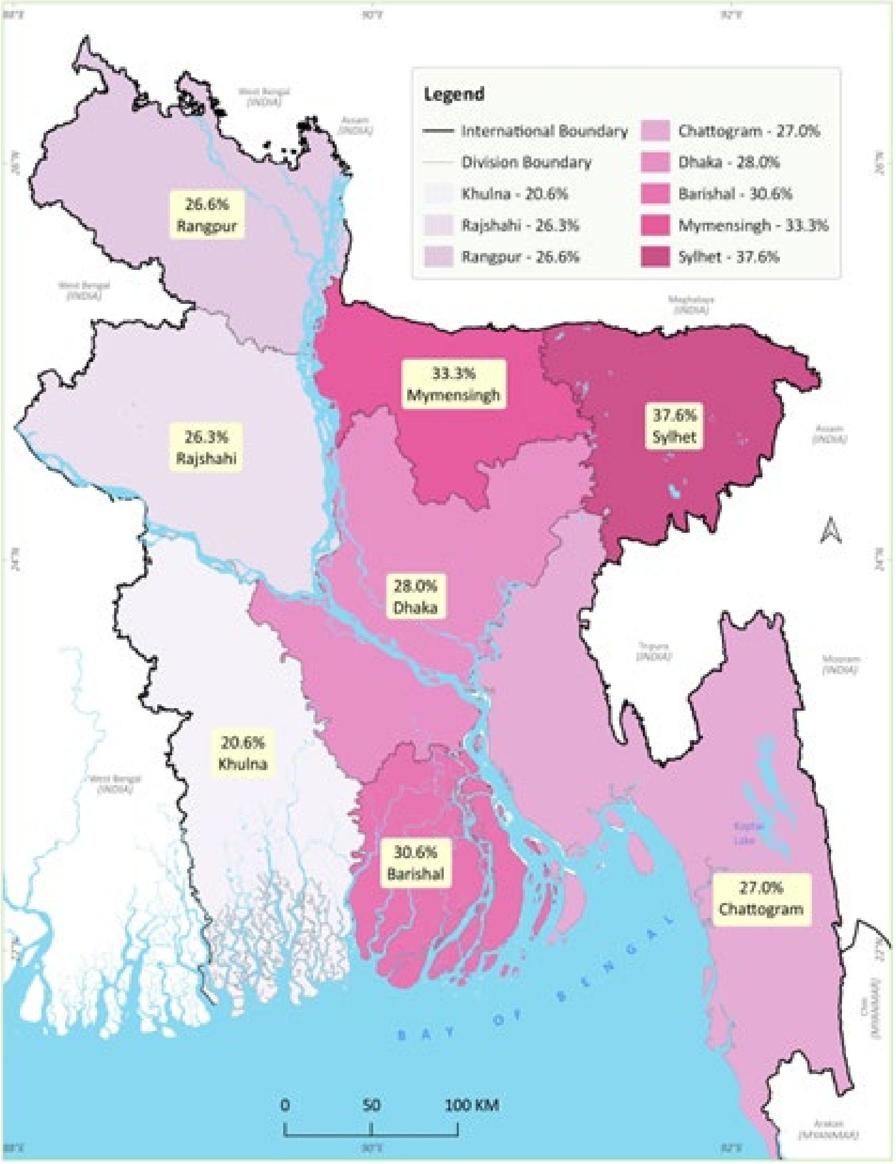


Figure 2-12 Geographic inequality in under-five stunting, Data source: MICS 2019

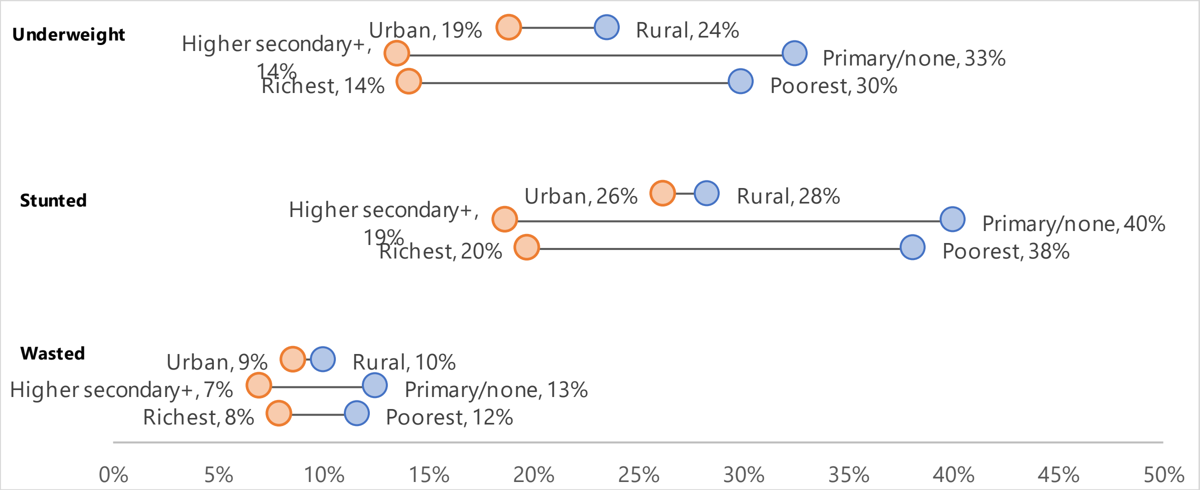


Figure 2-13 Inequalities of childhood undernutrition by area, wealth status, and maternal education. (Data source: MICS 2019)

The exclusive breastfeeding rate has shown no improvements in almost a decade, children's dietary diversity has been the lowest performing complementary feeding indicator and diet quality such as consumption of animal-sourced protein has been inadequate[245, 255, 263, 264]. Insufficient quantity of food intake and poor dietary diversity also result in inadequate intake of essential micronutrients[90, 265]. The coverage gaps of infant and young child feeding practices are described further in section 2.2.5. In Bangladesh, children also suffer from frequent infections such as fever, respiratory illness, diarrhoea, and malaria (in some endemic pockets) which increase child undernutrition[266]. The latest national survey reported that in the last two decades about a quarter of under-five children suffered from fever, 7% from diarrhoea, and 2% from respiratory infections[255]. A study also demonstrated a cyclical relationship between enteric infections, intestinal barrier dysfunction, and undernutrition among Bangladeshi children[267].

Among the underlying causes, household food insecurity increases the risk of childhood undernutrition in Bangladesh[268]. Approximately 57% of the population experience some level and one-fifth (21%) experience a moderate to severe form of household food insecurity[269]. Wide seasonal and geographic variations of household food insecurity were also documented; April-June are the most food insecure months and the northwest region has the highest prevalence of food insecurity[269, 270]. In Bangladesh, multifaceted adverse effects of climate change, extreme weather events, household income, cropping cycle, seasonal income loss, temporary migration for employment, education, involvement in non-farm activities, and emergency situations such as the COVID-19 pandemic influence household food insecurity[270-273]. Unhealthy living conditions including poor sanitation and hygiene practices, and food insecurity also entail a combined effect on childhood infections and undernutrition[274, 275]. Acute undernutrition such as childhood wasting are highly influenced by seasonal food insecurity and economic shocks[276, 277]. The spatial distribution demonstrates an overlapping pattern of higher wasting and pockets of higher food insecurity which may explain the slow progress in wasting reduction[278, 279]. Also, coverage of screening and management of wasting through existing healthcare contacts has been suboptimal in Bangladesh[210].

Undernutrition of mothers is also an important risk factor for child undernutrition in Bangladesh. The national survey data reported a slowly declining trend of maternal short stature but a faster increasing trend of overweight and obesity[280]. About 13% of women are still of short stature, 19% are too thin (body mass index<18.5), and 43% of pregnant women are anaemic which increases the risk of short body length for gestational age, preterm birth, low birth weight and child undernutrition [245, 266, 281-283]. The 2017-18 BDHS reported 16% of children were born with low birth weight[280]. However, the BDHS estimate of low birth weight should be interpreted with caution because the birth weight was reported for less than half (45%) of the births[280]. Nearly 50% babies born at home are often not weighed after birth[284]. Furthermore, child marriage (60%), teenage pregnancy (24%), unplanned pregnancy (26%), and inadequate birth spacing (11% of births <24 months) are high and associated with low birth weight and childhood undernutrition in Bangladesh[245, 255, 285-288]. Similarly, gender norms and women's limited control over household decision-making, and inadequate diet and healthcare seeking during pregnancy negatively influence low birth weight and childhood undernutrition in Bangladesh[265, 284, 289-291]. Critical micronutrients such as iron, zinc, vitamin D, folate, vitamin B12, and vitamin A are deficient among women and the deficiency is often greater among pregnant and lactating women[90, 265, 292, 293]. A lack of knowledge of the constitution of a balanced diet and the nutritional quality of different foods, misconceptions, cultural and societal norms, and family beliefs are often negatively associated with inadequate maternal dietary practices and child-feeding behaviours[291, 294-296]. Care-seeking for antenatal and post-partum preventive health and nutrition services from trained healthcare providers is inadequate (please see section 2.2.5)[245]. Households' economic status also has contributed to a multifaceted direct and indirect effect on these underlying clauses of childhood undernutrition[259, 265, 270, 290, 297-299].

2.2.4 Nutrition-specific interventions and service delivery platforms in Bangladesh

Selection and delivery of nutrition-specific interventions for addressing maternal and child undernutrition in Bangladesh has evolved through major programme shifts over the last three decades under the leadership of the Ministry of Health and Family Welfare. Agreeing on the resolution from the International Conference on Nutrition in 1992, the Government of Bangladesh prepared the first National Plan of Action for Nutrition (NPAN) in 1997 involving 13 ministries and two departments to improve the nutritional status of the country's people[300]. The first NPAN underpinned several nutrition-specific interventions such as the promotion of breastfeeding and complementary feeding, addressing micronutrient deficiencies, improving diet and healthy lifestyles, and nutrition promotion through education and advocacy[300]. Aligning with the goals of NPAN, the Bangladesh National Nutrition Project 1995-2002 was the country's first government nutrition programme that was implemented in 59 out then 464 sub-districts, with nutrition services provided mainly by nongovernment organisation partners[233, 301]. The program included three key nutrition-specific interventions such as growth monitoring and promotion of children, supplementary feeding of malnourished pregnant women, lactating mothers, and 6-24-month-old children and micronutrient supplementation, nutrition education on maternal nutrition, infant and young child feeding and nutrition of adolescents delivered through community-based activities[301, 302]. The interventions were geographically expanded to 173 sub-districts by the subsequent National Nutrition Programme between 2006 and 2011 and were included in the national Health, Nutrition, and Population, Sector Program 2005-2011 operation plans[233, 301].

Considering the mixed results of the Bangladesh Integrated Nutrition Project[301], low geographic and population coverage of the National Nutrition Programme, and limited functional link between the NGO service delivery and public health systems, the Government of Bangladesh undertook a structural change in nutrition programming. The country introduced a 'nutrition mainstreaming and integrated approach' in the 3rd Health, Population, and Nutrition Sector Development Programme 2011-2016[303]. The sector program shifted the delivery of key nutrition-specific interventions through the health systems platforms instead of vertical programme implementation and intervention delivery by nongovernment organisations[233, 303]. The National Nutrition Services operation plan of the 3rd sector programme prioritised ANC and integrated management of childhood illness (IMCI) contacts and some national campaigns such as vitamin A campaigns for delivering key nutrition-specific interventions routinely to mothers and children[233, 303]. The National Nutrition Policy 2015 and then the Second National Plan of Action for Nutrition (NPAN2) 2016-2025 to operationalise the nutrition policy mandated strengthening implementation of nutrition-specific interventions following a life-cycle approach[304, 305]. In line with the strategies of the nutrition policy and NPAN2, the 4th Health, Nutrition and Population Sector Programme 2017-2022 continued the nutrition-specific interventions included in the 3rd sector programme but with some additions on delivery platforms, human resource capacity building, monitoring and information system and an extra emphasis in two underperforming divisions i.e., Sylhet and Chattogram[306]. Current nutrition specific interventions and their delivery platforms in the public health systems are summarized in Table 2.1.

In the addition to government nutrition services delivered through health systems platforms, several nongovernment organisations continue delivering nutrition-specific interventions through community-based programmes. These programmes are often delivered by community healthcare providers and include nutrition education promoting maternal nutritional, distribution of essential micronutrients such as iron and folic acid (IFA), calcium supplements, multiple micronutrient powers for children, child growth monitoring and nutrition education for mothers and family members on age-appropriate infant feeding practices, and provision of nutrition supplements in food insure population[307-315]. However, most of these nongovernment organization-supported programmes are only implemented in selected geographic locations.

Table 2.1 Existing nutrition-specific interventions during the first 1000 days of life, target groups and delivery platforms

Intervention	Target group/timing	Activities and delivery platforms
Nutrition education on maternal nutrition and dietary practices Maternal weight gain monitoring in pregnancy	Pregnant women and lactating mothers up to 2 years of child's age	- Maternal nutrition counselling during antenatal care and post-natal care visits and weight gain monitoring (weight assessment) during ANC at district, sub-district, and union-level health facilities and community clinics - Maternal nutrition counselling during home visits by frontline health and family planning workers
Antenatal and postpartum IFA supplementation	Pregnant women, and postpartum women in the first three months after birth	- Antenatal and post-natal care visits at district, sub-district, and union-level health facilities and community clinics
Calcium supplementation	Pregnant women	- ANC visits at district, sub-district, and union-level health facilities and community clinics
Social and Behaviour Change Communication (SBCC) to promote and support Infant and Young Child Feeding (IYCF) practices including: - Initiation of breastfeeding within 1 hour of birth - Exclusive breastfeeding up to six months - Continued breastfeeding up to 2 years - Age-appropriate complementary feeding Social mobilization and campaign on IYCF	Pregnant women, lactating women up to 2 years of child's age Secondary target groups: Husbands and family members, healthcare providers, social gatekeepers, religious and opinion leaders, employers, and community members	- Nutrition counselling during ANC, PNC, IMCI and Nutrition service contacts at district, sub-district, and union-level health facilities and community clinics - Nutrition counselling during home visits by frontline health and family planning workers - Mass media campaigns and observation of special events, community dialogue for community awareness - Support breastfeeding at the workplace
Zinc supplementation (with ORS) for the management of childhood diarrhoea	Under-five children (up to 2 years for this research) with diarrhoeal illness	- Distribute and counsel for consuming zinc (with ORS) at IMCI and Nutrition service contacts at district, sub-district, and union-level health facilities and community clinics

Intervention	Target group/timing	Activities and delivery platforms
		- SBCC during domiciliary visits by frontline health and family planning workers
Growth Monitoring and Promotion (GMP)	Under-five children (up to 2 years for this research)	- Provides GMP card and assesses growth at the first health facility contact for the child such as postnatal check-up, immunization (recently added), or illness care-seeking (IMCI and Nutrition) and counsels caregiver for periodic visits to the health facility for growth monitoring and promotion
Vitamin A supplementation	6-59 months old children	- National campaign for vitamin A supplementation once every six months - Mass media campaign and mobile messaging, counselling at IMCI visits for food-based consumption
Management of moderate and severe acute malnutrition	Under-five children	- Screening for acute malnutrition during IMCI and Nutrition service contacts at health facilities and domiciliary visits by frontline health and family planning workers - Inpatient management of severe acute malnutrition with the complication at designated health facilities - Community-based management of uncomplicated severe acute malnutrition and moderate acute malnutrition at community-based outpatient services
Multiple Micronutrient Powder supplementation	6-23 months old children (targeted to undernourished children only)	- MNP 5 sachets are provided at IMCI and Nutrition service contacts at district and sub-district level facilities

Source: National Nutrition Services Operational Plan of the 4th HNPSP[306], Saha et. al. 2015[306], and personal communication with Dr. Md Maniruzzaman, Programme Manager, National Nutrition Services. ORS: Oral Rehydration Solution, SBCC: Social and Behaviour Change Communication, GMP: Growth Monitoring and Promotion, IMCI: Integrated Management of Childhood Illness, MNP: Multiple Micronutrient Power

2.2.5 Coverage and quality of nutrition-specific interventions in Bangladesh

Despite mainstreaming of nutrition service delivery into health systems and multifaceted health systems strengthening efforts made in recent years[314, 316-318], coverage of nutrition-specific interventions and contacts with their delivery platforms remains low in Bangladesh[210]. The country's achievements in reducing childhood undernutrition in the past decade are largely attributed to nutrition-sensitive drivers such as economic development, increased parental education, fertility reduction, and improvements in sanitation[254, 259]. Inadequate coverage, wide geographic and socioeconomic inequalities, and often poor quality interventions result in a lower contribution of nutrition-specific interventions to improvements in child nutrition and an overall slower-than-required decline of undernutrition[259]. In Bangladesh, several nutrition-specific intervention indicators remain far below the national 2025 targets (Figure 2-14)[305].

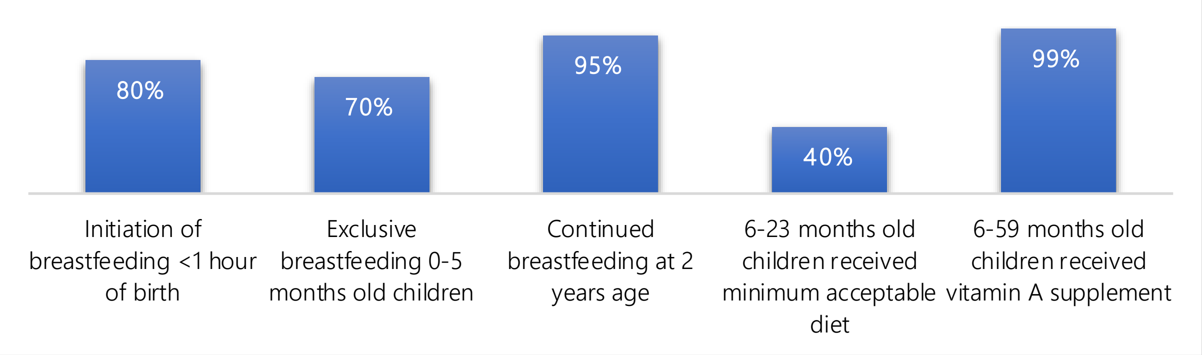


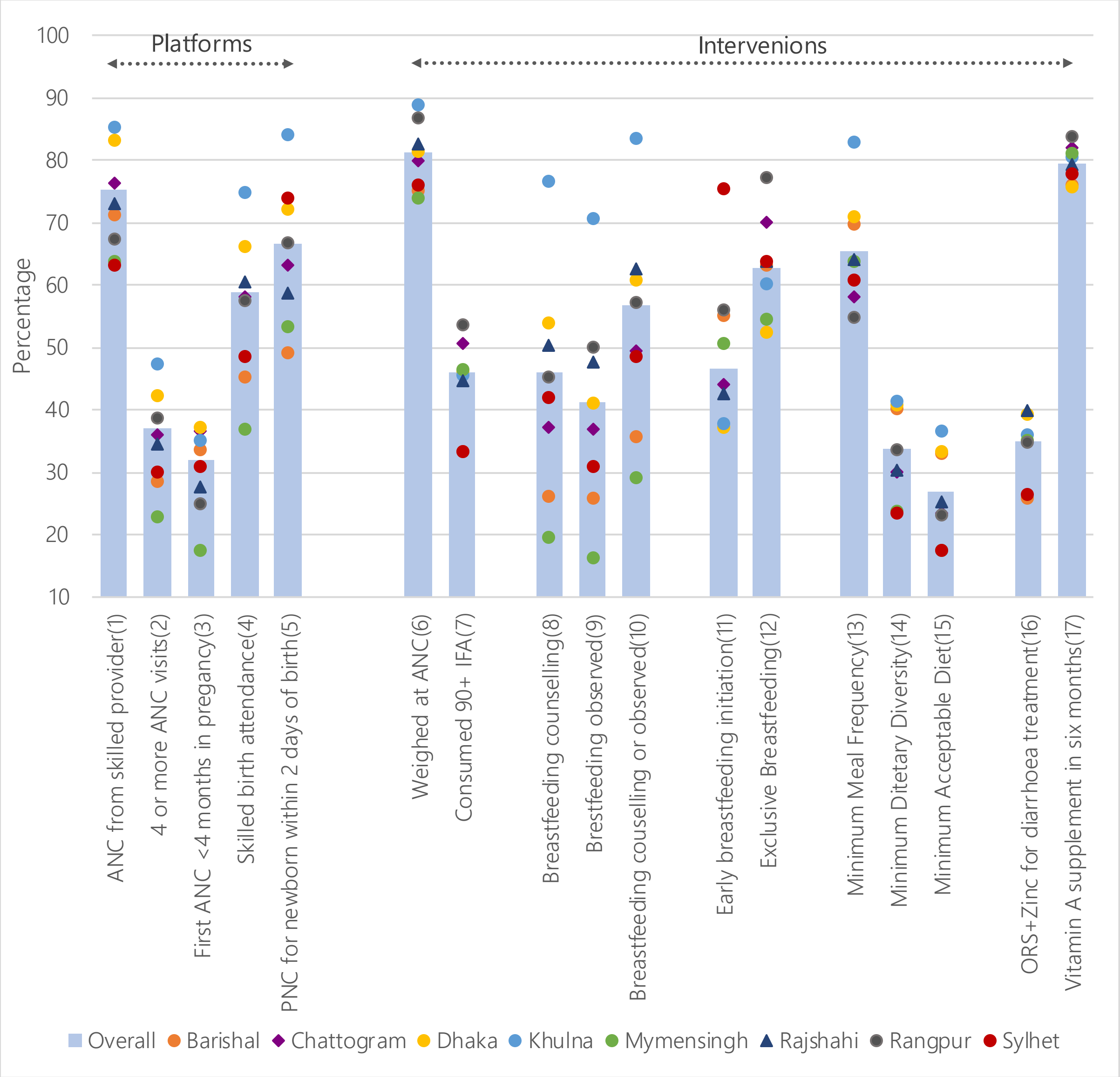
Figure 2-14 Targets of the Second National Action Plan for Nutrition on selected nutrition-specific intervention indicators by 2025[305]

Coverage of contacts with the main platforms for delivering nutrition-specific interventions is often low and varies widely across the regions (Figure 2-15). In Bangladesh, although three-quarters (75%) of pregnant women attend ANC at least once from a skilled care provider, only 37% receive four or more contacts during pregnancy and less than a third (32%) initiate ANC in the first trimester of pregnancy. Starting ANC early in pregnancy and attending regularly are critical for receiving nutrition interventions during pregnancy such as weight gain monitoring, nutrition counselling, and essential micronutrient supplementation[294]. Of all live births, 59% are attended by skilled healthcare providers and two-thirds (67%) of the newborns receive post-natal care (PNC) from a healthcare provider within 2 days of birth. However, skilled birth attendance and PNC coverage varied widely across divisions; the Khulna division had the highest coverage and Mymensingh was the lowest performing.

In Bangladesh, although approximately 82% of women are weighed at least once in pregnancy, only 46% of women consumed IFA supplements for 90 or more days during pregnancy (Figure 2-15). Sylhet and Barisal division has much lower coverage of half of the recommended dose of 90+ IFA (33%) than other divisions. Against the 67% coverage of PNC for newborns, 56% of mothers receive either breastfeeding counselling or breastfeeding observation by a healthcare provider, suggesting a coverage and quality gap between the contact with the nutrition service platform and the provision of nutrition service. Coverage of postnatal breastfeeding counselling or observation varies widely, ranging from 29% to 84% in Mymensingh and Khulna divisions, respectively. Coverage of early initiation of breastfeeding (within 1 hour of birth) is much lower (47%) than the 2017-18 survey estimate (60%) and the second national action plan target (80%)[245, 305]. In contrast to the trend of nearly all other indicators, the Sylhet division has the highest early breastfeeding initiation coverage (76%), while Khulna and Dhaka divisions have the lowest coverage of the early start of breastfeeding (37-38%). Data on population-level coverage of age-appropriate infant feeding counselling is not available from the national surveys. An analysis of service utilization data demonstrated that caregivers of 61% of children under two years of age attending community clinics in six divisions except for Sylhet and Chattogram received nutrition counselling[318]. However, population-level coverage of nutrition counselling on infant feeding could be much lower as visits to health facilities are made mainly for childhood illness, and treatment is sought from a formal source for 46%, 57%, and 30% of children suffering from respiratory illness, fever and diarrhoea, respectively[255].

For IYCF practices, approximately two-thirds (63%) of children below six months of age are exclusively breastfed and two-thirds (66%) of 6-23 months old children are fed with the recommended minimum meal frequency (Figure 2-15). Only 34% of children aged 6-23 months receive recommend minimum dietary diversity of at least 5 out of 8 food groups resulting in 27% consuming a minimum acceptable diet. Complementary feeding coverage is relatively better in the Khulna division and worst in Sylhet. One-third of the children under-five (35%) suffering from diarrhoea receive both the recommended oral rehydration solution and zinc supplements. Although the vitamin A campaign is implemented throughout the country every six months, approximately only 79% children aged 6-59 months received vitamin A supplements in the last six months which is a 20-percentage point difference to achieve the national action plan target of 99% by 2025. No direct national estimate of coverage of growth monitoring and promotion of children is available and this service is mainly provided at childhood illness management contacts[210, 233]. Care-seeking for childhood illness related to growth monitoring and promotion has low coverage, only a third of under-five children (35%) are taken to a facility for growth monitoring and the coverage varies between 30% to 39% across divisions[210].

Observation-based data on the quality of nutrition-specific interventions, such as the quality of nutrition assessment and counselling during pregnancy, nutrition education on infant feeding and growth monitoring, and screening of acute malnutrition are also scarce. However, some previous Bangladeshi studies revealed that nutrition interventions delivered during ANC, PNC and child health service contacts, and screening and management of acute malnutrition have inadequate readiness and are of suboptimal quality[210, 221, 224, 233, 319]. The importance of improving both coverage and quality of nutrition interventions to achieve the maternal and child nutrition targets has also been emphasised[210, 217, 221].



ANC: Antenatal care, IFA: Iron and Folic Acid, ORS: Oral Rehydration Solution; Denominator for 1-5 and 8-10: 15-49 years old women with a livebirth in the last two years[255]; Denominator for 6-7: 15-49 years old women with a livebirth in the last three years [245]; Denominator for 11: Most recent liveborn children in the last two years to 15-49 years old women[255]; Denominator for 12: children aged 0-5 months[255]; Denominator for 13-15: children aged 6-23 months[255]; Denominator for 16: under-five children[255]; Denominator for 17: children aged 6-59 months[245]; 1)ANC at least one ANC from skilled provider[255]; 8-9)mother of the livebirth received breastfeeding counselling, being observed or both[255]; 11) breastfeeding initiation within one hour of birth[255]; 13) currently breastfed children aged 6-8 months received solid/semisolids/soft food ≥twice and children aged 9-23 months received ≥three time, non-breastfed 6-23 months old children received ≥four times[255]; 14) received at least any five out of eight food groups[255]; 15)6-23 months old children-breastfed: minimum dietary diversity + minimum meal frequency, non-breastfed: minimum dietary diversity + minimum meal frequency + ≥ twice milk feeding[255]; Data Source: for 1-5, 8-10, 11-16 Multiple Indicator Cluster Survey (MICS) 2019[255], for 6-7 and 17, Bangladesh Demographic and Health Survey (BDHS) 2017-18[245]

Figure 2-15 Coverage of nutrition service delivery platforms and nutrition-specific interventions, overall and by divisions

2.3 References

1. Institute for Health Metrics and Evaluation (IHME). GBD Compare Seattle, WA: IHME, University of Washington; 2015 [Available from: http://vizhub.healthdata.org/gbd-compare.
2. Katona P, Katona-Apte J. The interaction between nutrition and infection. Clinical Infectious Diseases. 2008;46(10):1582-8.
3. Schaible UE, Kaufmann SHE. Malnutrition and infection: complex mechanisms and global impacts. PLoS medicine. 2007;4(5):e115.
4. Lassi Z, Moin A, Bhutta Z. Nutrition in middle childhood and adolescence. In: Bundy DAP, Silva Nd, Horton S, Jamison DT, Patton GC, editors. Disease Control Priorities : Child Adolescent Health Development. Washington DC.: The World Bank; 2017. p. 1896.
5. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. The lancet. 2008;371(9609):340-57.
6. Hoddinott J. The economic cost of malnutrition. The Road to Good Nutrition. Washington DC, USA: Karger Publishers; 2013. p. 64-73.
7. Martins VJ, Toledo Florêncio TM, Grillo LP, Do Carmo P Franco M, Martins PA, Clemente APG, et al. Long-lasting effects of undernutrition. International journal of environmental research and public health. 2011;8(6):1817-46.
8. Leroy JL, Frongillo EA. Perspective: what does stunting really mean? A critical review of the evidence. Advances in Nutrition. 2019;10(2):196-204.
9. Mwene-Batu P, Bisimwa G, Ngaboyeka G, Dramaix M, Macq J, Hermans MP, et al. Severe acute malnutrition in childhood, chronic diseases, and human capital in adulthood in the Democratic Republic of Congo: the Lwiro Cohort Study. The American journal of clinical nutrition. 2021;114(1):70-9.
10. Barker DJP. The developmental origins of adult disease. Journal of the American College of Nutrition. 2004;23(sup6):588S-95S.
11. de Mendonça ELSS, de Lima Macêna M, Bueno NB, de Oliveira ACM, Mello CS. Premature birth, low birth weight, small for gestational age and chronic non-communicable diseases in adult life: A systematic review with meta-analysis. Early human development. 2020;149:105154.
12. Sawaya AL, Sesso R, Florêncio TMdMT, Fernandes MT, Martins PA. Association between chronic undernutrition and hypertension. Maternal & Child Nutrition. 2005;1(3):155-63.
13. Ijarotimi OS. Determinants of childhood malnutrition and consequences in developing countries. Current Nutrition Reports. 2013;2(3):129-33.
14. United Nations Children's Fund. Strategy for improved nutrition of children and women in developing countries. New York: UNICEF; 1990.
15. Black RE, Allen LH, Bhutta ZA, Caulfield LE, Onis MD, Ezzati M, et al. Maternal and child undernutrition: global and regional exposures and health consequences. The lancet. 2008;371(9608):243-60.
16. Smith LC, Haddad L. Reducing child undernutrition: past drivers and priorities for the post-MDG era. World Development. 2015;68:180-204.
17. Stewart CP, Iannotti L, Dewey KG, Michaelsen KF, Onyango AWJM. Contextualising complementary feeding in a broader framework for stunting prevention. Maternal & Child Nutrition. 2013;9:27-45.
18. Black MM, Lutter CK, Trude AC. All children surviving and thriving: re-envisioning UNICEF's conceptual framework of malnutrition. The Lancet Global Health. 2020;8(6):e766-e7.
19. Vaivada T, Akseer N, Akseer S, Somaskandan A, Stefopulos M, Bhutta ZA. Stunting in childhood: an overview of global burden, trends, determinants, and drivers of decline. The American journal of clinical nutrition. 2020;112(Supplement_2):777S-91S.
20. Bhutta ZA, Akseer N, Keats EC, Vaivada T, Baker S, Horton SE, et al. How countries can reduce child stunting at scale: lessons from exemplar countries. The American journal of clinical nutrition. 2020;112(Supplement_2):894S-904S.
21. Victora CG, Bahl R, Barros AJ, França GV, Horton S, Krasevec J, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. The Lancet. 2016;387(10017):475-90.

22. Gatica-Domínguez G, Neves PA, Barros AJ, Victora CG. Complementary feeding practices in 80 low-and middle-income countries: prevalence of and socioeconomic inequalities in dietary diversity, meal frequency, and dietary adequacy. The Journal of nutrition. 2021;151(7):1956-64.
23. Heemann M, Kim R, Vollmer S, Subramanian S. Assessment of Undernutrition Among Children in 55 Low-and Middle-Income Countries Using Dietary and Anthropometric Measures. JAMA Network Open. 2021;4(8):e2120627-e.
24. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? The Lancet. 2013;382(9890):452-77.
25. Dewey KG. The challenge of meeting nutrient needs of infants and young children during the period of complementary feeding: an evolutionary perspective. The Journal of Nutrition. 2013;143(12):2050-4.
26. Ferguson E, Chege P, Kimiywe J, Wiesmann D, Hotz C. Zinc, iron and calcium are major limiting nutrients in the complementary diets of rural Kenyan children. Maternal & Child Nutrition. 2015;11:6-20.
27. Victora CG, Christian P, Vidaletti LP, Gatica-Domínguez G, Menon P, Black RE. Revisiting maternal and child undernutrition in low-income and middle-income countries: variable progress towards an unfinished agenda. The Lancet. 2021.
28. Bresnahan KA, Tanumihardjo SA. Undernutrition, the acute phase response to infection, and its effects on micronutrient status indicators. Advances in Nutrition. 2014;5(6):702-11.
29. Walson JL, Berkley JA. The impact of malnutrition on childhood infections. Current opinion in infectious diseases. 2018;31(3):231.
30. Ervin PA, Bubak V. Closing the rural-urban gap in child malnutrition: Evidence from Paraguay, 1997–2012. Economics & Human Biology. 2019;32:1-10.
31. Rannan-Eliya R, Hossain S, Anuranga C, Wickramasinghe R, Jayatissa R, Abeykoon A. Trends and determinants of childhood stunting and underweight in Sri Lanka. Ceylon Medical Journal. 2013;58(1).
32. Siddiqui F, Salam RA, Lassi ZS, Das JK. The intertwined relationship between malnutrition and poverty. Frontiers in Public Health. 2020:453.
33. Peña M, Bacallao J. Malnutrition and poverty. Annual Review of Nutrition. 2002;22(1):241-53.
34. Banerjee A, Duflo E. More than 1 billion people are hungry in the world. Foreign Policy. 2011(186):66-72.
35. Vorster HH. The link between poverty and malnutrition: A South African perspective. Health SA Gesondheid. 2010;15(1).
36. Young MF, Ramakrishnan U. Maternal undernutrition before and during pregnancy and offspring health and development. Annals of Nutrition and Metabolism. 2020;76(3):41-53.
37. Carlson GJ, Kordas K, Murray-Kolb LE. Associations between women's autonomy and child nutritional status: a review of the literature. Maternal & Child Nutrition. 2015;11(4):452-82.
38. Dewey KG, Cohen RJ. Does birth spacing affect maternal or child nutritional status? A systematic literature review. Maternal & Child Nutrition. 2007;3(3):151-73.
39. Rodríguez-Bernal CL, Rebagliato M, Iniguez C, Vioque J, Navarrete-Munoz EM, Murcia M, et al. Diet quality in early pregnancy and its effects on fetal growth outcomes: the Infancia y Medio Ambiente (Childhood and Environment) Mother and Child Cohort Study in Spain. The American Journal of Clinical Nutrition. 2010;91(6):1659-66.
40. Nguyen PH, Scott S, Neupane S, Tran LM, Menon P. Social, biological, and programmatic factors linking adolescent pregnancy and early childhood undernutrition: a path analysis of India's 2016 National Family and Health Survey. The Lancet Child and Adolescent Health. 2019;3(7):463-73.
41. Ruel MT, Alderman H, Maternal Child Nutrition Study Group. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? The Lancet. 2013;382(9891):536-51.
42. Hamel C, Enne J, Omer K, Ayara N, Yarima Y, Cockcroft A, et al. Childhood malnutrition is associated with maternal care during pregnancy and childbirth: a cross-sectional study in Bauchi and Cross River States, Nigeria. Journal of Public Health Research. 2015;4(1).

43. Tette E, Sifah EK, Nartey ET. Factors affecting malnutrition in children and the uptake of interventions to prevent the condition. BMC pediatrics. 2015;15(1):1-11.

44. Clark H, Coll-Seck AM, Banerjee A, Peterson S, Dalglish SL, Ameratunga S, et al. A future for the world's children? A WHO–UNICEF–Lancet Commission. The Lancet. 2020;395(10224):605-58.

45. Shrestha A, Six J, Dahal D, Marks S, Meierhofer R. Association of nutrition, water, sanitation and hygiene practices with children’s nutritional status, intestinal parasitic infections and diarrhoea in rural Nepal: a cross-sectional study. BMC public health. 2020;20(1):1-21.

46. Schmidt CW. Beyond malnutrition: the role of sanitation in stunted growth. Environmental Health Perspective. 2014.

47. Tusting LS, Gething PW, Gibson HS, Greenwood B, Knudsen J, Lindsay SW, et al. Housing and child health in sub-Saharan Africa: A cross-sectional analysis. PLoS medicine. 2020;17(3):e1003055.

48. Becquey E, Sombié I, Touré M, Turowska Z, Buttarelli E, Nisbett N. Stories of change in nutrition in Burkina Faso 1992–2018: a micro-level perspective. Food Security. 2022:1-14.

49. Headey D, Hoddinott J, Park S. Accounting for nutritional changes in six success stories: a regression-decomposition approach. Global Food Security. 2017;13:12-20.

50. Pickering AJ, Null C, Winch PJ, Mangwadu G, Arnold BF, Prendergast AJ, et al. The WASH Benefits and SHINE trials: interpretation of WASH intervention effects on linear growth and diarrhoea. The Lancet Global Health. 2019;7(8):e1139-e46.

51. Martorell R, Zongrone A. Intergenerational influences on child growth and undernutrition. Paediatric Perinatal Epidemiology. 2012;26:302-14.

52. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries. Paediatrics and International Child Health. 2014;34(4):250-65.

53. Addo OY, Stein AD, Fall CH, Gigante DP, Guntupalli AM, Horta BL, et al. Maternal height and child growth patterns. The Journal of Pediatrics. 2013;163(2):549-54. e1.

54. Özaltin E, Hill K, Subramanian S. Association of maternal stature with offspring mortality, underweight, and stunting in low-to middle-income countries. JAMA. 2010;303(15):1507-16.

55. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, Onis MD, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. The lancet. 2013;382(9890):427-51.

56. Drake AJ, Walker BR. The intergenerational effects of fetal programming: non-genomic mechanisms for the inheritance of low birth weight and cardiovascular risk. Journal of Endocrinology. 2004;180(1):1-16.

57. Warrington NM, Beaumont RN, Horikoshi M, Day FR, Helgeland Ø, Laurin C, et al. Maternal and fetal genetic effects on birth weight and their relevance to cardio-metabolic risk factors. Nature Genetics. 2019;51(5):804-14.

58. Christian P. Prenatal origins of undernutrition. Emerging Societies-Coexistence of Childhood Malnutrition and Obesity. 63: Karger Publishers; 2009. p. 59-77.

59. Allen LH, Gillespie SR. What works? A review of the efficacy and effectiveness of nutrition interventions. Asian Development Bank; 2001.

60. Prentice AM, Ward KA, Goldberg GR, Jarjou LM, Moore SE, Fulford AJ, et al. Critical windows for nutritional interventions against stunting. The American of Clinical Nutrition. 2013;97(5):911-8.

61. Stephenson J, Heslehurst N, Hall J, Schoenaker DA, Hutchinson J, Cade JE, et al. Before the beginning: nutrition and lifestyle in the preconception period and its importance for future health. The Lancet. 2018;391(10132):1830-41.

62. He Y, Pan A, Hu FB, Ma X. Folic acid supplementation, birth defects, and adverse pregnancy outcomes in Chinese women: a population-based mega-cohort study. The Lancet. 2016;388:S91.

63. Dean S, Rudan I, Althabe F, Webb Girard A, Howson C, Langer A, et al. Setting research priorities for preconception care in low-and middle-income countries: aiming to reduce maternal and child mortality and morbidity. PLoS medicine. 2013;10(9):e1001508.

64. Lassi ZS, Kedzior SG, Tariq W, Jadoon Y, Das JK, Bhutta ZA. Effects of preconception care and periconception interventions on maternal nutritional status and birth outcomes in low-and middle-income countries: a systematic review. Nutrients. 2020;12(3):606.

65. Johnson W, Moore S. Adolescent pregnancy, nutrition, and health outcomes in low-and middle-income countries: what we know and what we don't know. Bjog. 2016;123(10):1589.

66. Bhatia J, Bhutta ZA, Kalhan SC. Maternal and child nutrition: the first 1,000 days: Karger Medical and Scientific Publishers; 2013.

67. Christian P, Mullany LC, Hurley KM, Katz J, Black RE, editors. Nutrition and maternal, neonatal, and child health. Seminars in Perinatology; 2015: Elsevier.

68. FHI Solutions LLC. 1000 Days [Available from: https://thousanddays.org/.

69. Victora CG, De Onis M, Hallal PC, Blössner M, Shrimpton R. Worldwide timing of growth faltering: revisiting implications for interventions. Pediatrics. 2010;125(3):e473-e80.

70. Christian P, Stewart CP. Maternal micronutrient deficiency, fetal development, and the risk of chronic disease. The Journal of Nutrition. 2010;140(3):437-45.

71. Abu-Saad K, Fraser D. Maternal nutrition and birth outcomes. Epidemiologic Reviews. 2010;32(1):5-25.

72. McKay JA, Mathers JC. Diet induced epigenetic changes and their implications for health. Acta Physiologica. 2011;202(2):103-18.

73. World Health Organization, United Nations Children’s Fund (UNICEF). Nurturing care for early childhood development: a framework for helping children survive and thrive to transform health and human potential. Geneva: World Health Organization (WHO); 2018. Report No.: 924151406X.

74. Christian P, Lee SE, Donahue Angel M, Adair LS, Arifeen SE, Ashorn P, et al. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low-and middle-income countries. International Journal of Epidemiology. 2013;42(5):1340-55.

75. De Onis M, Branca F. Childhood stunting: a global perspective. Maternal Child Nutrition. 2016;12:12-26.

76. Huang L, Jiang S, Xu J, Lei X, Zhang J. Associations between prepregnancy body mass index, gestational weight gain and weight catch-up in small-for-gestational-age children. Maternal Child Nutrition. 2022;18(1):e13235.

77. Ntenda PAM. Association of low birth weight with undernutrition in preschool-aged children in Malawi. Nutrition Journal. 2019;18(1):1-15.

78. Krebs NF, Hambidge KM, Westcott JL, Garcés AL, Figueroa L, Tshefu AK, et al. Birth length is the strongest predictor of linear growth status and stunting in the first 2 years of life after a preconception maternal nutrition intervention: the children of the Women First trial. The American Journal of Clinical Nutrition. 2022.

79. Botton J, Heude B, Maccario J, Ducimetière P, Charles M-A, FLVS Study Group. Postnatal weight and height growth velocities at different ages between birth and 5 y and body composition in adolescent boys and girls. The American Journal of Clinical Nutrition. 2008;87(6):1760-8.

80. Khan M, Islam MM. Effect of exclusive breastfeeding on selected adverse health and nutritional outcomes: a nationally representative study. BMC Public Health. 2017;17(1):1-7.

81. Wren-Atilola HM, Solomons NW, Scott ME, Koski KG. Infant Anthropometry and Growth Velocity Before 6 Months are Associated with Breastfeeding Practices and the Presence of Subclinical Mastitis and Maternal Intestinal Protozoa in Indigenous Communities in Guatemala. Current Developments in Nutrition. 2021;5(9):nzab086.

82. Ho NT, Li F, Lee-Sarwar KA, Tun HM, Brown BP, Pannaraj PS, et al. Meta-analysis of effects of exclusive breastfeeding on infant gut microbiota across populations. Nature communications. 2018;9(1):1-13.

83. Martorell R. Improved nutrition in the first 1000 days and adult human capital and health. American Journal of Human Biology. 2017;29(2):e22952.

84. Müller O, Krawinkel M. Malnutrition and health in developing countries. CMAJ. 2005;173(3):279-86.

85. Nigatu D, Azage M, Motbainor A. Effect of exclusive breastfeeding cessation time on childhood morbidity and adverse nutritional outcomes in Ethiopia: analysis of the demographic and health surveys. PLoS One. 2019;14(10):e0223379.

86. Pries AM. Snacks and nutrition during the complementary feeding period: a cross-sectional study among children 12-23 months of age in Kathmandu Valley, Nepal: London School of Hygiene & Tropical Medicine; 2019.

87. Masuke R, Msuya SE, Mahande JM, Diarz EJ, Stray-Pedersen B, Jahanpour O, et al. Effect of inappropriate complementary feeding practices on the nutritional status of children aged 6-24 months in urban Moshi, Northern Tanzania: Cohort study. PloS one. 2021;16(5):e0250562.

88. White JM, Bégin F, Kumapley R, Murray C, Krasevec J. Complementary feeding practices: Current global and regional estimates. Maternal & Child Nutrition. 2017;13:e12505.

89. Pries AM, Filteau S, Ferguson EL. Snack food and beverage consumption and young child nutrition in low-and middle-income countries: A systematic review. Maternal & Child Nutrition. 2019;15:e12729.

90. Arsenault JE, Yakes EA, Islam MM, Hossain MB, Ahmed T, Hotz C, et al. Very low adequacy of micronutrient intakes by young children and women in rural Bangladesh is primarily explained by low food intake and limited diversity. Journal of Nutrition. 2013;143(2):197-203.

91. Checkley W, Buckley G, Gilman RH, Assis AM, Guerrant RL, Morris SS, et al. Multi-country analysis of the effects of diarrhoea on childhood stunting. International Journal of Epidemiology. 2008;37(4):816-30.

92. Walker CLF, Rudan I, Liu L, Nair H, Theodoratou E, Bhutta ZA, et al. Global burden of childhood pneumonia and diarrhoea. 2013;381(9875):1405-16.

93. Robertson RC, Manges AR, Finlay BB, Prendergast AJ. The human microbiome and child growth–first 1000 days and beyond. Trends in Microbiology. 2019;27(2):131-47.

94. Mueller NT, Bakacs E, Combellick J, Grigoryan Z, Dominguez-Bello MG. The infant microbiome development: mom matters. Trends in Molecular Medicine. 2015;21(2):109-17.

95. Smith MI, Yatsunenko T, Manary MJ, Trehan I, Mkakosya R, Cheng J, et al. Gut microbiomes of Malawian twin pairs discordant for kwashiorkor. Science. 2013;339(6119):548-54.

96. Benjamin-Chung J, Mertens A, Colford JM, Hubbard AE, van der Laan MJ, Coyle J, et al. Early childhood linear growth failure in low-and middle-income countries. MedRxiv. 2020.

97. Leroy JL, Frongillo EA, Dewan P, Black MM, Waterland RA. Can children catch up from the consequences of undernourishment? Evidence from child linear growth, developmental epigenetics, and brain and neurocognitive development. Advances in Nutrition. 2020;11(4):1032-41.

98. Stein AD, Wang M, Martorell R, Norris SA, Adair LS, Bas I, et al. Growth patterns in early childhood and final attained stature: data from five birth cohorts from low-and middle-income countries. American Journal of Human Biology. 2010;22(3):353-9.

99. Das JK, Salam RA, Thornburg KL, Prentice AM, Campisi S, Lassi ZS, et al. Nutrition in adolescents: physiology, metabolism, and nutritional needs. Annals of the New York Academy of Sciences. 2017;1393(1):21-33.

100. Arlinghaus KR, Truong C, Johnston CA, Hernandez DC. An intergenerational approach to break the cycle of malnutrition. Current nutrition reports. 2018;7:259-67.

101. Patton GC, Sawyer SM, Santelli JS, Ross DA, Afifi R, Allen NB, et al. Our future: a Lancet commission on adolescent health and wellbeing. The Lancet. 2016;387(10036):2423-78.

102. Mesías M, Seiquer I, Navarro MP. Iron nutrition in adolescence. Critical reviews in food science and nutrition. 2013;53(11):1226-37.

103. De-Regil LM, Harding KB, Roche ML. Preconceptional nutrition interventions for adolescent girls and adult women: Global guidelines and gaps in evidence and policy with emphasis on micronutrients. The Journal of nutrition. 2016;146(7):1461S-70S.

104. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, et al. What works? Interventions for maternal and child undernutrition and survival. The Lancet. 2008;371(9610):417-40.

105. Keats EC, Das JK, Salam RA, Lassi ZS, Imdad A, Black RE, et al. Effective interventions to address maternal and child malnutrition: an update of the evidence. The Lancet Child Adolescent Health. 2021.

106. Gillespie S, Haddad L, Mannar V, Menon P, Nisbett N, Maternal Child Nutrition Study Group. The politics of reducing malnutrition: building commitment and accelerating progress. The Lancet. 2013;382(9891):552-69.

107. Roediger R, Hendrixson DT, Manary MJ. A roadmap to reduce stunting. Oxford University Press; 2020. p. 773S-6S.

108. Peña-Rosas JP, De-Regil LM, Garcia-Casal MN, Dowswell T. Daily oral iron supplementation during pregnancy. Cochrane Database of Systematic Reviews. 2015(7).

109. Oh C, Keats EC, Bhutta ZA. Vitamin and mineral supplementation during pregnancy on maternal, birth, child health and development outcomes in low-and middle-income countries: a systematic review and meta-analysis. Nutrients. 2020;12(2):491.

110. Fowkes FJ, Moore KA, Opi DH, Simpson JA, Langham F, Stanisic DI, et al. Iron deficiency during pregnancy is associated with a reduced risk of adverse birth outcomes in a malaria-endemic area in a longitudinal cohort study. BMC Medicine. 2018;16(1):1-10.

111. Schümann K, Solomons NW. Can iron supplementation be reconciled with benefits and risks in areas hyperendemic for malaria? Food and Nutrition Bulletin. 2013;34(3):349-56.

112. Nisar YB, Aguayo VM, Billah SM, Dibley MJ. Antenatal Iron-Folic Acid Supplementation Is Associated with Improved Linear Growth and Reduced Risk of Stunting or Severe Stunting in South Asian Children Less than Two Years of Age: A Pooled Analysis from Seven Countries. Nutrients. 2020;12(9):2632.

113. Crider KS, Qi YP, Yeung LF, Mai CT, Head Zauche L, Wang A, et al. Folic Acid and the Prevention of Birth Defects: 30 Years of Opportunity and Controversies. Annual Review of Nutrition. 2022;42:423-52.

114. Georgieff MK, Krebs NF, Cusick SE. The benefits and risks of iron supplementation in pregnancy and childhood. Annual review of nutrition. 2019;39:121-46.

115. Fisher AL, Nemeth E. Iron homeostasis during pregnancy. The American journal of clinical nutrition. 2017;106(suppl_6):1567S-74S.

116. Nisar YB, Dibley MJ. Earlier initiation and use of a greater number of iron-folic acid supplements during pregnancy prevents early neonatal deaths in Nepal and Pakistan. PloS one. 2014;9(11):e112446.

117. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva, Switzerland: World Health Organization (WHO); 2016.

118. Imdad A, Bhutta ZA. Effects of calcium supplementation during pregnancy on maternal, fetal and birth outcomes. Paediatric Perinatal Epidemiology. 2012;26:138-52.

119. Buppasiri P, Lumbiganon P, Thinkhamrop J, Ngamjarus C, Laopaiboon M, Medley N. Calcium supplementation (other than for preventing or treating hypertension) for improving pregnancy and infant outcomes. Cochrane Database of Systematic Reviews. 2015(2).

120. Hofmeyr GJ, Lawrie TA, Atallah ÁN, Torloni MR. Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems. Cochrane Database of Systematic Reviews. 2018(10).

121. Keats EC, Haider BA, Tam E, Bhutta ZA. Multiple-micronutrient supplementation for women during pregnancy. Cochrane Database of Systematic Reviews. 2019(3).

122. Berti C, Biesalski H, Gärtner R, Lapillonne A, Pietrzik K, Poston L, et al. Micronutrients in pregnancy: current knowledge and unresolved questions. Clinical Nutrition. 2011;30(6):689-701.

123. Smith ER, Shankar AH, Wu LS, Aboud S, Adu-Afarwuah S, Ali H, et al. Modifiers of the effect of maternal multiple micronutrient supplementation on stillbirth, birth outcomes, and infant mortality: a meta-analysis of individual patient data from 17 randomised trials in low-income and middle-income countries. The Lancet Global Health. 2017;5(11):e1090-e100.

124. Haider BA, Bhutta ZA. Multiple-micronutrient supplementation for women during pregnancy. Cochrane Database of Systematic Reviews. 2017(4).

125. Kashi B, M Godin C, Kurzawa ZA, Verney AM, Busch-Hallen JF, De-Regil LM. Multiple micronutrient supplements are more cost-effective than iron and folic acid: modeling results from 3 high-burden Asian countries. The Journal of Nutrition. 2019;149(7):1222-9.

126. Aguayo VM, Koné D, Bamba SI, Diallo B, Sidibé Y, Traoré D, et al. Acceptability of multiple micronutrient supplements by pregnant and lactating women in Mali. Public Health Nutrition. 2005;8(1):33-7.

127. World Health Organization. WHO Antenatal Care Recommendations for a Positive Pregnancy Experience: Nutritional Interventions Update: Multiple Micronutrient Supplements During Pregnancy. Geneva, Switzerland: World Health Organization (WHO); 2020. Report No.: 9240007784.

128. Ota E, Hori H, Mori R, Tobe-Gai R, Farrar D. Antenatal dietary education and supplementation to increase energy and protein intake. Cochrane Database of Systematic Reviews. 2015(6).

129. Imdad A, Bhutta ZA. Effect of balanced protein energy supplementation during pregnancy on birth outcomes. BMC Public Health. 2011;11(3):1-9.

130. Lassi ZS, Padhani ZA, Rabbani A, Rind F, Salam RA, Das JK, et al. Impact of dietary interventions during pregnancy on maternal, neonatal, and child outcomes in low-and middle-income countries. Nutrients. 2020;12(2):531.

131. Stevens B, Buettner P, Watt K, Clough A, Brimblecombe J, Judd J. The effect of balanced protein energy supplementation in undernourished pregnant women and child physical growth in low-and middle-income countries: A systematic review and meta-analysis. Maternal & Child Nutrition. 2015;11(4):415-32.

132. Khan AI, Kabir I, Ekström E-C, Åsling-Monemi K, Alam DS, Frongillo EA, et al. Effects of prenatal food and micronutrient supplementation on child growth from birth to 54 months of age: a randomized trial in Bangladesh. Nutrition Journal. 2011;10(1):1-11.

133. Kusin JA, Renqvist U, Kardjati S, Houtkooper J. Energy supplementation during pregnancy and postnatal growth. The Lancet. 1992;340(8820):623-6.

134. Hansen K. Breastfeeding: a smart investment in people and in economies. The Lancet. 2016;387(10017):416.

135. World Health Organization. Breastfeeding: Recommendations: World Health organization; [Available from: https://www.who.int/health-topics/breastfeeding#tab=tab_2.

136. World Health Organization. Infant and young child feeding: World Health Organization (WHO); 2021 [Available from: https://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding.

137. Sankar MJ, Sinha B, Chowdhury R, Bhandari N, Taneja S, Martines J, et al. Optimal breastfeeding practices and infant and child mortality: a systematic review and meta-analysis. Acta Paediatrica. 2015;104:3-13.

138. Rollins NC, Bhandari N, Hajeebhoy N, Horton S, Lutter CK, Martines JC, et al. Why invest, and what it will take to improve breastfeeding practices? The Lancet. 2016;387(10017):491-504.

139. Kim SS, Nguyen PH, Tran LM, Sanghvi T, Mahmud Z, Haque MR, et al. Large-scale social and behavior change communication interventions have sustained impacts on infant and young child feeding knowledge and practices: results of a 2-year follow-up study in Bangladesh. The Journal of Nutrition. 2018;148(10):1605-14.

140. Abdulahi M, Fretheim A, Argaw A, Magnus JH. Breastfeeding Education and Support to Improve Early Initiation and Exclusive Breastfeeding Practices and Infant Growth: A Cluster Randomized Controlled Trial from a Rural Ethiopian Setting. Nutrients. 2021;13(4):1204.

141. Lassi ZS, Rind F, Irfan O, Hadi R, Das JK, Bhutta ZA. Impact of infant and young child feeding (iycf) nutrition interventions on breastfeeding practices, growth and mortality in low-and middle-income countries: systematic review. Nutrients. 2020;12(3):722.

142. UNICEF. UNICEF programming guidance: Improving young children's diets during the complementary feeding period. New York: UNICEF; 2020.

143. Kennedy GL, Pedro MR, Seghieri C, Nantel G, Brouwer I. Dietary diversity score is a useful indicator of micronutrient intake in non-breast-feeding Filipino children. The Journal of Nutrition. 2007;137(2):472-7.

144. Arikpo D, Edet ES, Chibuzor MT, Odey F, Caldwell DM. Educational interventions for improving primary caregiver complementary feeding practices for children aged 24 months and under. Cochrane Database of Systematic Reviews. 2018(5).

145. Muluye SD, Lemma TB, Diddana TZ. Effects of nutrition education on improving knowledge and practice of complementary feeding of mothers with 6-to 23-month-old children in daycare centers in

Hawassa Town, Southern Ethiopia: an institution-based randomized control trial. Journal of Nutrition and Metabolism. 2020;2020.

146. Zaman S, Ashraf RN, Martines J. Training in complementary feeding counselling of healthcare workers and its influence on maternal behaviours and child growth: a cluster-randomized controlled trial in Lahore, Pakistan. Journal of Health, Population and Nutrition. 2008;26(2):210.

147. Sanghvi T, Seidel R, Baker J, Jimerson A. Using behavior change approaches to improve complementary feeding practices. Maternal and Child Nutrition. 2017;13:e12406.

148. Nikièma L, Huybregts L, Martin-Prevel Y, Donnen P, Lanou H, Grosemans J, et al. Effectiveness of facility-based personalized maternal nutrition counseling in improving child growth and morbidity up to 18 months: A cluster-randomized controlled trial in rural Burkina Faso. Plos One. 2017;12(5):e0177839.

149. Heidkamp RA, Piwoz E, Gillespie S, Keats EC, D'Alimonte MR, Menon P, et al. Mobilising evidence, data, and resources to achieve global maternal and child undernutrition targets and the Sustainable Development Goals: an agenda for action. The Lancet. 2021;397(10282):1400-18.

150. Aguayo VM. Complementary feeding practices for infants and young children in South Asia. A review of evidence for action post-2015. Maternal and Child Nutrition. 2017;13:e12439.

151. Saleem AF, Mahmud S, Baig-Ansari N, Zaidi AK. Impact of maternal education about complementary feeding on their infants' nutritional outcomes in low-and middle-income households: a community-based randomized interventional study in Karachi, Pakistan. Journal of Health, Population and Nutrition. 2014;32(4):623.

152. Kim SS, Nguyen PH, Yohannes Y, Abebe Y, Tharaney M, Drummond E, et al. Behavior change interventions delivered through interpersonal communication, agricultural activities, community mobilization, and mass media increase complementary feeding practices and reduce child stunting in Ethiopia. The Journal of Nutrition. 2019;149(8):1470-81.

153. Warren AM, Frongillo EA, Nguyen PH, Menon P. Nutrition intervention using behavioral change communication without additional material inputs increased expenditures on key food groups in Bangladesh. The Journal of Nutrition. 2020;150(5):1284-90.

154. Panjwani A, Heidkamp R. Complementary feeding interventions have a small but significant impact on linear and ponderal growth of children in low-and middle-income countries: a systematic review and meta-analysis. The Journal of Nutrition. 2017;147(11):2169S-78S.

155. Keats EC, Imdad A, Das JK, Bhutta ZA. PROTOCOL: Efficacy and effectiveness of micronutrient supplementation and fortification interventions on the health and nutritional status of children under-five in low and middle-income countries: a systematic review. Campbell Systematic Reviews. 2018;14(1):1-36.

156. World Health Organization. vitamin A supplementation in infants and children 6–59 months of age. Geneva: World Health Organization (WHO); 2011.

157. Imdad A, Mayo-Wilson E, Haykal MR, Regan A, Sidhu J, Smith A, et al. Vitamin A supplementation for preventing morbidity and mortality in children from six months to five years of age. Cochrane Database of Systematic Reviews. 2022(3).

158. Tam E, Keats EC, Rind F, Das JK, Bhutta ZA. Micronutrient supplementation and fortification interventions on health and development outcomes among children under-five in low-and middle-income countries: a systematic review and meta-analysis. Nutrients. 2020;12(2):289.

159. Liu E, Pimpin L, Shulkin M, Kranz S, Duggan CP, Mozaffarian D, et al. Effect of zinc supplementation on growth outcomes in children under 5 years of age. Nutrients. 2018;10(3):377.

160. Rouhani P, Rezaei Kelishadi M, Saneei P. Effect of zinc supplementation on mortality in under 5-year children: A systematic review and meta-analysis of randomized clinical trials. European Journal of Nutrition. 2021:1-18.

161. Dewey KG, Wessells KR, Arnold CD, Prado EL, Abbeddou S, Adu-Afarwuah S, et al. Characteristics that modify the effect of small-quantity lipid-based nutrient supplementation on child growth: an individual participant data meta-analysis of randomized controlled trials. The American Journal of Clinical Nutrition. 2021;114(Supplement_1):15S-42S.

162. Lenters L, Wazny K, Bhutta Z. Chapter 11. Management of severe and moderate acute malnutrition in children. Disease Control Priorities: Reproductive, Maternal, Newborn, Child Health. 2. Washington, DC, USA: The World Bank; 2016.

163. World Health Organization. Updates on the management of severe acute malnutrition in infants and children. Geneva: World Health Organization (WHO); 2013.

164. World Health Organization. Community-based management of severe acute malnutrition: a joint statement by the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children's Fund. World Health Organization (WHO); 2007. Report No.: 9280641476.

165. Das JK, Salam RA, Saeed M, Kazmi FA, Bhutta ZA. Effectiveness of interventions for managing acute malnutrition in children under five years of age in low-income and middle-income countries: a systematic review and meta-analysis. Nutrients. 2020;12(1):116.

166. Fritschel H, Carter T, Whitehead J, Marble A. Actions and accountability to accelerate the world's progress on nutrition. Washington, DC: International Food Policy Research Institute; 2014.

167. Gillespie S, Menon P, Heidkamp R, Piwoz E, Rawat R, Munos M, et al. Measuring the coverage of nutrition interventions along the continuum of care: time to act at scale. BMJ Global Health. 2019;4(Suppl 4):e001290.

168. Heidkamp RA, Wilson E, Menon P, Kuo H, Walton S, Gatica-Domínguez G, et al. How can we realise the full potential of health systems for nutrition? BMJ. 2020;368.

169. Nguyen PH, Singh N, Scott S, Neupane S, Jangid M, Walia M, et al. Unequal coverage of nutrition and health interventions for women and children in seven countries. Bulletin of the World Health Organization. 2022;100(1):20.

170. Bhutta ZA. How will the next 'Decade of Nutrition' be different from the past one? Nature Reviews Gastroenterology Hepatology. 2016;13(8):441-2.

171. Development Initiatives. 2021 Global Nutrition Report: The state of global nutrition. Bristol, UK: Development Initiatives; 2021.

172. Scott N, Delport D, Hainsworth S, Pearson R, Morgan C, Huang S, et al. Ending malnutrition in all its forms requires scaling up proven nutrition interventions and much more: a 129-country analysis. BMC Medicine. 2020;18(1):1-19.

173. Sununtnasuk C, D'Agostino A, Fiedler JL. Iron+ folic acid distribution and consumption through antenatal care: identifying barriers across countries. Public Health Nutrition. 2016;19(4):732-42.

174. Kumssa DB, Joy EJ, Ander EL, Watts MJ, Young SD, Walker S, et al. Dietary calcium and zinc deficiency risks are decreasing but remain prevalent. Scientific Reports. 2015;5(1):1-11.

175. Cormick G, Betrán A, Romero I, Lombardo C, Gülmezoglu A, Ciapponi A, et al. Global inequities in dietary calcium intake during pregnancy: a systematic review and meta-analysis. BJOG: An International Journal of Obstetrics Gynaecology. 2019;126(4):444-56.

176. Gomes F, Ashorn P, Askari S, Belizan JM, Boy E, Cormick G, et al. Calcium supplementation for the prevention of hypertensive disorders of pregnancy: current evidence and programmatic considerations. Annals of the New York Academy of Sciences. 2022;1510(1):52-67.

177. Klemm GC, Birhanu Z, Ortolano SE, Kebede Y, Martin SL, Mamo G, et al. Integrating calcium into antenatal iron-folic acid supplementation in Ethiopia: women's experiences, perceptions of acceptability, and strategies to support calcium supplement adherence. Global Health: Science and Practice. 2020;8(3):413-30.

178. World Health Organization. WHO recommendation: calcium supplementation during pregnancy for prevention of pre-eclampsia and its complications. Geneva: World Health Organization (WHO); 2018. Report No.: 9241550457.

179. Healthy Mothers Healthy Babies. Implementation of Multiple Micronutrient Supplementation Washington DC: Micronutrient Forum; [Available from: https://hmhbconsortium.org/mms-implementation/.

180. Hossain M, Sanin KI, Haque MA, Mbuya MN, Ghosh S, Aksari S, et al. Evaluating the impact of a countrywide, market-based roll-out of multiple micronutrient supplementation on low birth weight in

Bangladesh: protocol for a two-arm, quasi-experimental and mixed-methods evaluation study. BMJ open. 2022;12(5):e060230.

181. Perumal N, Blakstad MM, Fink G, Lambiris M, Bliznashka L, Danaei G, et al. Impact of scaling up prenatal nutrition interventions on human capital outcomes in low-and middle-income countries: a modeling analysis. The American Journal of Clinical Nutrition. 2021;114(5):1708-18.

182. Jones L, de Kok B, Moore K, de Pee S, Bedford J, Vanslambrouck K, et al. Acceptability of 12 fortified balanced energy protein supplements-Insights from Burkina Faso. Maternal and Child Nutrition. 2021;17(1):e13067.

183. Lama TP, Khatry SK, Isanaka S, Moore K, Jones L, Bedford J, et al. Acceptability of 11 fortified balanced energy-protein supplements for pregnant women in Nepal. Maternal and Child Nutrition. 2022;18(3):e13336.

184. de Kok B, Moore K, Jones L, Vanslambrouck K, Toe LC, Ouédraogo M, et al. Home consumption of two fortified balanced energy protein supplements by pregnant women in Burkina Faso. Maternal and Child Nutrition. 2021;17(3):e13134.

185. Wu H, Zhao M, Magnussen CG, Xi B. Global prevalence of WHO infant feeding practices in 57 LMICs in 2010–2018 and time trends since 2000 for 44 LMICs. EClinicalMedicine. 2021;37:100971.

186. Cai X, Wardlaw T, Brown DW. Global trends in exclusive breastfeeding. International Breastfeeding Journal. 2012;7(1):1-5.

187. Oakley L, Baker CP, Addanki S, Gupta V, Walia GK, Aggarwal A, et al. Is increasing urbanicity associated with changes in breastfeeding duration in rural India? An analysis of cross-sectional household data from the Andhra Pradesh children and parents study. BMJ open. 2017;7(9):e016331.

188. Raihana S, Alam A, Chad N, Huda TM, Dibley MJ. Delayed Initiation of Breastfeeding and Role of Mode and Place of Childbirth: Evidence from Health Surveys in 58 Low-and Middle-Income Countries (2012–2017). International Journal of Environmental Research and Public Health 2021;18(11):5976.

189. Chen C, Yan Y, Gao X, Xiang S, He Q, Zeng G, et al. Influences of cesarean delivery on breastfeeding practices and duration: a prospective cohort study. Journal of Human Lactation. 2018;34(3):526-34.

190. Kavle JA, LaCroix E, Dau H, Engmann C. Addressing barriers to exclusive breast-feeding in low- and middle-income countries: a systematic review and programmatic implications. Public Health Nutrition. 2017;20(17):3120-34.

191. Snyder K, Hulse E, Dingman H, Cantrell A, Hanson C, Dinkel D. Examining supports and barriers to breastfeeding through a socio-ecological lens: a qualitative study. International Breastfeeding Journal. 2021;16(1):1-8.

192. Pérez-Escamilla R, Curry L, Minhas D, Taylor L, Bradley E. Scaling up of breastfeeding promotion programs in low-and middle-income countries: the "breastfeeding gear" model. Advances in Nutrition. 2012;3(6):790-800.

193. Shaker-Berbari L, Qahoush Tyler V, Akik C, Jamaluddine Z, Ghattas H. Predictors of complementary feeding practices among children aged 6–23 months in five countries in the Middle East and North Africa region. Maternal & Child Nutrition. 2021;17(4):e13223.

194. Na M, Aguayo VM, Arimond M, Dahal P, Lamichhane B, Pokharel R, et al. Trends and predictors of appropriate complementary feeding practices in Nepal: An analysis of national household survey data collected between 2001 and 2014. Maternal & Child Nutrition. 2018;14:e12564.

195. Sirkka O, Abrahamse-Berkeveld M, van der Beek EM. Complementary Feeding Practices Among Young Children in China, India and Indonesia: A Narrative Review. Current Developments in Nutrition. 2022.

196. UNICEF. Coverage at a crossroads: new directions for vitamin A supplementation programmes. New York: UNICEF; 2018.

197. McLean E, Klemm R, Subramaniam H, Greig A. Refocusing vitamin A supplementation programmes to reach the most vulnerable. BMJ Global Health. 2020;5(7):e001997.

198. Wirth JP, Petry N, Tanumihardjo SA, Rogers LM, McLean E, Greig A, et al. Vitamin A supplementation programs and country-level evidence of vitamin A deficiency. Nutrients. 2017;9(3):190.

199. Black RE. Progress in the use of ORS and zinc for the treatment of childhood diarrhea. Journal of Global Health. 2019;9(1).

200. International Vaccine Access Center, Johns Hopkins Bloomberg School of Public Health. Pneumonia & diarrhea progress report 2018 2020 [Available from: https://www.jhsph.edu/ivac/wp-content/uploads/2018/11/Pneumonia-and-Diarrhea-Progress-Report-2018-1.pdf.

201. DEFEATDD, PATH. Use ORS and zinc for a one-two punch against diarhroea 2021 [Available from: https://www.defeatdd.org/blog/use-ors-and-zinc-one-two-punch-against-diarrhea.

202. Gupta S, Brazier A, Lowe N. Zinc deficiency in low-and middle-income countries: prevalence and approaches for mitigation. Journal of Human Nutrition Dietetics. 2020;33(5):624-43.

203. IZiNCG, icddr b, CHORI, JHU, CU. Closing the knowledge gap: Finding the most effective protocol for large-scale preventive zinc intervention programs Oakland, CA, USA: IZiNCG Secretariat; 2018 [Available from: https://www.izincg.org/new-blog-1/which-form-how-much-how-often.

204. Choufani J, Kim SS, Nguyen PH, Heidkamp R, Grummer-Strawn L, Saha KK, et al. Measuring coverage of infant and young child feeding counselling interventions: A framework and empirical considerations for survey question design. Maternal & Child Nutrition. 2020;16(4):e13001.

205. World Health Organization. Guideline: counselling of women to improve breastfeeding practices. Geneva: World Health Organization (WHO); 2018.

206. Shengelia B, Tandon A, Adams OB, Murray CJ. Access, utilization, quality, and effective coverage: an integrated conceptual framework and measurement strategy. Social Science & Medicine. 2005;61(1):97-109.

207. Amouzou A, Leslie HH, Ram M, Fox M, Jiwani SS, Requejo J, et al. Advances in the measurement of coverage for RMNCH and nutrition: from contact to effective coverage. BMJ Global Health. 2019;4(Suppl 4):e001297.

208. Marsh AD, Muzigaba M, Diaz T, Requejo J, Jackson D, Chou D, et al. Effective coverage measurement in maternal, newborn, child, and adolescent health and nutrition: progress, future prospects, and implications for quality health systems. The Lancet Global Health. 2020;8(5):e730-e6.

209. Jannati A, Sadeghi V, Imani A, Saadati M. Effective coverage as a new approach to health system performance assessment: a scoping review. BMC Health Services Research. 2018;18(1):1-13.

210. Nguyen PH, Khương LQ, Pramanik P, Billah SM, Menon P, Piwoz E, et al. Effective coverage of nutrition interventions across the continuum of care in Bangladesh: insights from nationwide cross-sectional household and health facility surveys. BMJ Open. 2021;11(1):e040109.

211. Exley J, Gupta PA, Schellenberg J, Strong KL, Requejo JH, Moller A-B, et al. A rapid systematic review and evidence synthesis of effective coverage measures and cascades for childbirth, newborn and child health in low-and middle-income countries. Journal of Global Health. 2022;12.

212. King S, Heidkamp R, Sheffel A, Xu YY, Munos M. Effective Coverage for Nutrition: Operationalizing Effective Coverage Cascades for Nutrition Interventions Delivered to Pregnant Women and Children. Current Developments in Nutrition. 2020;4(Supplement_2):853-.

213. Exley J, Marchant T. Inequalities in effective coverage measures: are we asking too much of the data? BMJ Global Health. 2022;7(5):e009200.

214. Hogan DR, Stevens GA, Hosseinpoor AR, Boerma T. Monitoring universal health coverage within the Sustainable Development Goals: development and baseline data for an index of essential health services. The Lancet Global Health. 2018;6(2):e152-e68.

215. Salam RA, Das JK, Bhutta ZA. Integrating nutrition into health systems: What the evidence advocates. Maternal & Child Nutrition. 2019;15:e12738.

216. Holschneider S, Subandoro AW, Karjadi E, Provo AM, Herkutanto R, Ayuningtyas P, et al. Improving the Quality of Frontline Nutrition Services in Indonesia's Health Sector. Health, Nutrition and Population Discussion Paper. Washington, DC.: World Bank; 2021.

217. Nguyen PH, Frongillo EA, Sanghvi T, Kim SS, Alayon S, Tran LM, et al. Importance of coverage and quality for impact of nutrition interventions delivered through an existing health programme in Bangladesh. Maternal & Child Nutrition. 2018;14(4):e12613.

218. Tikmani SS, Ali SA, Saleem S, Bann CM, Mwenechanya M, Carlo WA, et al. Trends of antenatal care during pregnancy in low-and middle-income countries: Findings from the global network maternal and newborn health registry. Seminars in perinatology. 2019;43(5):297-307.

219. Rahman M, Taniguchi H, Nsashiyi RS, Islam R, Mahmud SR, Rahman S, et al. Trend and projection of skilled birth attendants and institutional delivery coverage for adolescents in 54 low-and middle-income countries, 2000–2030. BMC Medicine. 2022;20(1):1-11.

220. Subramanian L, Murthy S, Bogam P, Yan SD, Delaney MM, Goodwin CD, et al. Just-in-time postnatal education programmes to improve newborn care practices: needs and opportunities in low-resource settings. BMJ Global Health. 2020;5(7):e002660.

221. Billah SM, Saha KK, Khan ANS, Chowdhury AH, Garnett SP, Arifeen SE, et al. Quality of nutrition services in primary health care facilities: Implications for integrating nutrition into the health system in Bangladesh. PloS one. 2017;12(5):e0178121-e.

222. Siekmans K, Roche M, Kung'u JK, Desrochers RE, De-Regil LMJM, nutrition c. Barriers and enablers for iron folic acid (IFA) supplementation in pregnant women. 2018;14:e12532.

223. Omotayo MO, Dickin KL, O'Brien KO, Neufeld LM, De Regil LM, Stoltzfus RJ. Calcium supplementation to prevent preeclampsia: translating guidelines into practice in low-income countries. Advances in Nutrition. 2016;7(2):275-8.

224. Sanghvi T, Nguyen PH, Tharaney M, Ghosh S, Escobar-Alegria J, Mahmud Z, et al. Gaps in the implementation and uptake of maternal nutrition interventions in antenatal care services in Bangladesh, Burkina Faso, Ethiopia and India. Maternal & Child Nutrition. 2022;18(2):e13293.

225. Bezabih AM, Wereta MH, Kahsay ZH, Getahun Z, Bazzano AN. Demand and supply side barriers that limit the uptake of nutrition services among pregnant women from rural Ethiopia: an exploratory qualitative study. Nutrients. 2018;10(11):1687.

226. Billah SM, Chowdhury MAK, Khan ANS, Karim F, Hassan A, Zaka N, et al. Quality of care during childbirth at public health facilities in Bangladesh: a cross-sectional study using WHO/UNICEF 'Every Mother Every Newborn (EMEN)'standards. BMJ Open Quality. 2019;8(3):e000596.

227. McFadden A, Siebelt L, Marshall JL, Gavine A, Girard L-C, Symon A, et al. Counselling interventions to enable women to initiate and continue breastfeeding: a systematic review and meta-analysis. International Breastfeeding Journal. 2019;14(1):1-19.

228. Rana R, McGrath M, Sharma E, Gupta P, Kerac M. Effectiveness of breastfeeding support packages in low-and middle-income countries for infants under six months: a systematic review. Nutrients. 2021;13(2):681.

229. Tuan NT, Nguyen PH, Hajeebhoy N, Frongillo EA. Gaps between breastfeeding awareness and practices in Vietnamese mothers result from inadequate support in health facilities and social norms. The Journal of Nutrition. 2014;144(11):1811-7.

230. Nsiah-Asamoah C, Doku DT, Agblorti S. Mothers' and Grandmothers' misconceptions and socio-cultural factors as barriers to exclusive breastfeeding: A qualitative study involving Health Workers in two rural districts of Ghana. PloS one. 2020;15(9):e0239278.

231. Kavle JA, Picolo M, Buccini G, Barros I, Dillaway CH, Pérez-Escamilla R. Strengthening counseling on barriers to exclusive breastfeeding through use of job aids in Nampula, Mozambique. PLoS One. 2019;14(12):e0224939.

232. Lepre B, Trigueiro H, Johnsen JT, Khalid AA, Ball L, Ray S. Global architecture for the nutrition training of health professionals: a scoping review and blueprint for next steps. BMJ Nutrition, Prevention & Health. 2022:e000354.

233. Saha KK, Billah M, Menon P, El Arifeen S, Mbuya NV. Bangladesh National Nutrition Services: assessment of implementation status: The World Bank; 2015.

234. Sarma H, Gerth-Guyette E, Shakil SA, Alom KR, Abu-Haydar E, D'Rozario M, et al. Evaluating the use of job AIDS and user Instructions to improve adherence for the treatment of childhood pneumonia using amoxicillin dispersible tablets in a low-income setting: a mixed-method study. BMJ open. 2019;9(5):e024978.

235. Modi D, Dholakia N, Gopalan R, Venkatraman S, Dave K, Shah S, et al. mHealth intervention "ImTeCHO" to improve delivery of maternal, neonatal, and child care services—A cluster-randomized trial in tribal areas of Gujarat, India. PLoS medicine. 2019;16(10):e1002939.

236. USAID Advancing Nutrition. Using Digital Tools to Strengthen Nutrition Service Delivery: An Overview. Arlington, VA: USAID Advancing Nutrition; 2020.

237. Islam ST, Paul A. Geography in Bangladesh: Concepts, Methods and Applications. Oxford, UK and New York, USA: Taylor & Francis; 2019.

238. Ministry of Foriegn Affairs. Know Bangladesh 2017 [Available from: http://www.mofa.gov.bd/site/page/6dde350b-1ca6-4c69-becd-a3f12cf14ac1/Bangladesh--An-Introduction.

239. Government of the People's Republic of Bangladesh, Ministry of health and Family Welfare. Health Bulletin 2017. Management Information System, Directorate General of Health Services; 2018.

240. Brammer HJIJoES. Bangladesh's diverse and complex physical geography: implications for agricultural development. 2017;74(1):1-27.

241. Dewan A, Shahid S, Bhuian M, Hossain SMJ, Nashwan MS, Chung E-S, et al. Developing a high-resolution gridded rainfall product for Bangladesh during 1901–2018. Scientific Data. 2022;9(1):1-16.

242. Husain SS, Tinker HR. Bangladesh [Available from: https://www.britannica.com/place/Bangladesh.

243. Ehsan SMA. The Local Government System in Bangladesh: An Anatomy of Perspectives & Practices. South Asian Journal of Policy and Governance. 2021;44:1-22.

244. Bangladesh Bureau of Statistics, Ministry of Planning, Government of People's Republic of Bangladesh. Population and Housing Cencus 2022: Preliminary Report. Dhaka: Bangladesh Bureau of Statistics; 2022.

245. National Institute of Population Research and Training (NIPORT), ICF International. Bangladesh Demographic and Health Survey 2017-18. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT and ICF; 2020.

246. The World Bank. The World Bank in Bangladesh: Overview 2022 [Available from: https://www.worldbank.org/en/country/bangladesh/overview#1.

247. Asian Development Bank. Economic indicators for Bangladesh 2022 [Available from: https://www.adb.org/countries/bangladesh/economy.

248. Zaman KAU, Sarker T. Demographic dividend, digital innovation, and economic growth: Bangladesh experience. Tokyo: Asian Development Bank Institute (ADBI); 2021.

249. Chowdhury MB, Chakraborty M. The impact of COVID-19 on the migrant workers and remittances flow to Bangladesh. South Asian Survey. 2021;28(1):38-56.

250. The World Bank. Globally Bangladesh is a Model for Poverty Reduction: World Bank Washington and Dhaka: The World Bank; 2020 [Available from: https://www.worldbank.org/en/news/press-release/2020/01/29/globally-bangladesh-is-a-model-for-poverty-reduction-world-bank.

251. Barai MK, editor. Bangladesh's Economic and Social Progress: From a Basket Case to a Development Model: Springer Nature; 2020.

252. Asian Development Bank. Basic Statistics 2022. Manila: Statistics and Data Innovation Unit, Economic Research and Regional Cooperation Department; 2022.

253. Headey D. Developmental drivers of nutritional change: a cross-country analysis. World Development. 2013;42:76-88.

254. Headey D, Hoddinott J, Ali D, Tesfaye R, Dereje M. The other Asian enigma: explaining the rapid reduction of undernutrition in Bangladesh. World Development. 2015;66:749-61.

255. Bangladesh Bureau of Statistics (BBS), UNICEF Bangladesh. Progotir Pathey, Bangladesh Multiple Indicator Cluster Survey 2019, Survey Findings Report. Dhaka, Bangladesh: Bangladesh Bureau of Statistics (BBS); 2019.

256. Chowdhury MRK, Khan HT, Rashid M, Kabir R, Islam S, Islam MS, et al. Differences in risk factors associated with single and multiple concurrent forms of undernutrition (stunting, wasting or underweight) among children under 5 in Bangladesh: a nationally representative cross-sectional study. BMJ Open. 2021;11(12):e052814.

257. United Nations Children's Fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and Trends in Child Malnutrition: Key Findings of the 2021 Edition of the Joint Child Malnutrition Estimates. Geneva: World Health Organization; 2021. Report No.: 9240025251.
258. National Nutrition Services (NNS), Directorate General of Health Services (DGHS), icddr b, editors. National Micronutrient Survey in Bangladesh 2019-2020. National dissemination program; 2022; Dhaka: National Nutrition Services, Directorate General of Health Services.
259. Nisbett N, Davis P, Yosef S, Akhtar N. Bangladesh's story of change in nutrition: Strong improvements in basic and underlying determinants with an unfinished agenda for direct community level support. Global Food Security. 2017;13:21-9.
260. Zongrone A, Winskell K, Menon P. Infant and young child feeding practices and child undernutrition in Bangladesh: insights from nationally representative data. Public Health Nutrition. 2012;15(9):1697-704.
261. Ahmed MS, Whitfield KC, Yunus FM. Trends and predictors of early initiation, exclusive and continued breast-feeding in Bangladesh (2004–2018): a multilevel analysis of demographic and health survey data. British Journal of Nutrition. 2022;128(9):1857-67.
262. Nahar Z, Sohan M, Hossain MJ, Islam MR. Unnecessary Cesarean Section Delivery Causes Risk to Both Mother and Baby: A Commentary on Pregnancy Complications and Women's Health. INQUIRY: The Journal of Health Care Organization, Provision, and Financing. 2022;59:00469580221116004.
263. Islam MM, Sanin KI, Mahfuz M, Ahmed AS, Mondal D, Haque R, et al. Risk factors of stunting among children living in an urban slum of Bangladesh: findings of a prospective cohort study. BMC Public Health. 2018;18(1):197.
264. Choudhury S, Headey DD, Masters WA. First foods: Diet quality among infants aged 6–23 months in 42 countries. Food Policy. 2019;88:101762.
265. Ahmed F, Prendiville N, Narayan A. Micronutrient deficiencies among children and women in Bangladesh: progress and challenges. Journal of Nutritional Science. 2016;5.
266. Khanam R, Lee AC, Mitra DK, Ram M, Gupta SD, Quaiyum A, et al. Maternal short stature and under-weight status are independent risk factors for preterm birth and small for gestational age in rural Bangladesh. European Journal of Clinical Nutrition. 2019;73(5):733-42.
267. Mondal D, Minak J, Alam M, Liu Y, Dai J, Korpe P, et al. Contribution of enteric infection, altered intestinal barrier function, and maternal malnutrition to infant malnutrition in Bangladesh. Clinical Infectious Diseases. 2012;54(2):185-92.
268. Ali D, Saha KK, Nguyen PH, Diressie MT, Ruel MT, Menon P, et al. Household food insecurity is associated with higher child undernutrition in Bangladesh, Ethiopia, and Vietnam, but the effect is not mediated by child dietary diversity. The Journal of Nutrition. 2013;143(12):2015-21.
269. Integrated Food Security Phase Classification (IPC). Bangladesh IPC Chronic Food Insecurity Report. Integrated Food Security Phase Classification (IPC); 2022.
270. Raihan MJ, Farzana FD, Sultana S, Saha KK, Haque MA, Rahman AS, et al. Effect of seasons on household food insecurity in Bangladesh. Food and Energy Security. 2018;7(3):e00136.
271. Panezai S, Saqib SE, Rahman MS, Ferdous Z, Asghar S, Ullah A, et al. Rural households' food security and its determinants in coastal regions of Bangladesh. Natural Resources Forum. 2022;46(2):200-20.
272. Hamadani JD, Hasan MI, Baldi AJ, Hossain SJ, Shiraji S, Bhuiyan MSA, et al. Immediate impact of stay-at-home orders to control COVID-19 transmission on socioeconomic conditions, food insecurity, mental health, and intimate partner violence in Bangladeshi women and their families: an interrupted time series. The Lancet Global Health. 2020;8(11):e1380-e9.
273. Khanam M, Ara G, Rahman AS, Islam Z, Farhad S, Khan SS, et al. Factors affecting food security in women enrolled in a program for vulnerable group development. Current Developments in Nutrition. 2020;4(4):nzaa037.
274. Mostafa I, Naila NN, Mahfuz M, Roy M, Faruque AS, Ahmed T. Children living in the slums of Bangladesh face risks from unsafe food and water and stunted growth is common. Acta Paediatrica. 2018;107(7):1230-9.

275. Islam MA, Rahman M, Uddin MF, Tariqujjaman M, Karmakar G, Rahman MA, et al. Household Food Insecurity and Unavailability of Toilet Facility Contribute to Adverse Health Outcomes of Under-five Children in Bangladesh: A Cross-sectional Study. BMC Public Health. 2021.

276. Headey DD, Ruel MT. Economic shocks predict increases in child wasting prevalence. Nature Communications. 2022;13(1):2157.

277. Hasan MM, Kader A, Asif CAA, Talukder A. Seasonal variation in the association between household food insecurity and child undernutrition in Bangladesh: Mediating role of child dietary diversity. Maternal & Child Nutrition. 2023;19(2):e13465.

278. Tariqujjaman M, Rahman M, Wangdi K, Karmakar G, Ahmed T, Sarma H. Geographical variations of food insecurity and its associated factors in Bangladesh: Evidence from pooled data of seven cross-sectional surveys. Plos one. 2023;18(1):e0280157.

279. Das S, Baffour B, Richardson A. Prevalence of child undernutrition measures and their spatio-demographic inequalities in Bangladesh: an application of multilevel Bayesian modelling. BMC Public Health. 2022;22(1):1008.

280. National Institute of Population Research and Training (NIPORT), ICF International. Bangladesh Health Facility Survey 2017: Final Report. Dhaka, Bangladesh: NIPORT and ICF; 2019.

281. Haque MA, Choudhury N, Farzana FD, Ali M, Raihan MJ, Ahmed ST, et al. Determinants of maternal low mid-upper arm circumference and its association with child nutritional status among poor and very poor households in rural Bangladesh. Maternal and Child Nutrition. 2021;17(4):e13217.

282. Carpenter RM, Billah SM, Lyons GR, Siraj MS, Rahman QS, Thorsten V, et al. U-Shaped Association between Maternal Hemoglobin and Low Birth Weight in Rural Bangladesh. The American Journal of Tropical Medicine Hygiene. 2022;106(2):424.

283. Rabbani A, Khan A, Yusuf S, Adams A. Trends and determinants of inequities in childhood stunting in Bangladesh from 1996/7 to 2014. International Journal for Equity in Health. 2016;15(1):1-14.

284. Nisha MK, Raynes-Greenow C, Rahman A, Alam A. Perceptions and practices related to birthweight in rural Bangladesh: implications for neonatal health programs in low-and middle-income settings. PLoS One. 2019;14(12):e0221691.

285. Islam MM, Islam MK, Hasan MS, Hossain MB. Adolescent motherhood in Bangladesh: Trends and determinants. Plos One. 2017;12(11):e0188294.

286. Nguyen PH, Scott S, Khuong LQ, Pramanik P, Ahmed A, Rashid SF, et al. Adolescent birth and child undernutrition: an analysis of demographic and health surveys in Bangladesh, 1996–2017. Annals of the New York Academy of Sciences. 2021;1500(1):69-81.

287. Rahman M, Nasrin SO, Rahman M, Rahman A, Mostofa G, Jesmin SS, et al. Maternal pregnancy intention and its association with low birthweight and pregnancy complications in Bangladesh: findings from a hospital-based study. International Health. 2019;11(6):447-54.

288. Rahman MM. Is unwanted birth associated with child malnutrition in Bangladesh? International Perspectives on Sexual Reproductive Health. 2015;41(2):80-8.

289. Holland C, Rammohan A. Rural women's empowerment and children's food and nutrition security in Bangladesh. World Development. 2019;124:104648.

290. Kabir A, Rashid MM, Hossain K, Khan A, Sikder SS, Gidding HFJBwsh. Women's empowerment is associated with maternal nutrition and low birth weight: Evidence from Bangladesh Demographic Health Survey. 2020;20(1):1-12.

291. Pike V, Kaplan Ramage A, Bhardwaj A, Busch-Hallen J, Roche ML. Family influences on health and nutrition practices of pregnant adolescents in Bangladesh. Maternal and Child Nutrition. 2021;17:e13159.

292. Ahmed F, Khosravi-Boroujeni H, Khan MR, Roy AK, Raqib R. Prevalence and predictors of vitamin D deficiency and insufficiency among pregnant rural women in Bangladesh. Nutrients. 2021;13(2):449.

293. Lee V, Ahmed F, Wada S, Ahmed T, Ahmed AS, Banu CP, et al. Extent of vitamin A deficiency among rural pregnant women in Bangladesh. Public Health Nutrition. 2008;11(12):1326-31.

294. Nguyen PH, Sanghvi T, Kim SS, Tran LM, Afsana K, Mahmud Z, et al. Factors influencing maternal nutrition practices in a large scale maternal, newborn and child health program in Bangladesh. PloS One. 2017;12(7):e0179873.

295. Khatun W, Rasheed S, Dibley MJ, Alam A. Understanding maternal dietary behaviour and perceived attributes of foods in the context of food insecurity in rural Bangladesh: a qualitative study. Journal of Global Health Reports. 2020;4:e2020018.
296. Uddin M, Jabeen I, Islam MA, Rahman M, Chisti MJ, Ahmed T, et al. Barriers to breastfeeding are shaped by sociocultural context: an exploratory qualitative study in Bangladesh. Journal of Health, Population and Nutrition. 2022;41(1):1-13.
297. Mahmud S, Shah NM, Becker S. Measurement of women's empowerment in rural Bangladesh. World Development. 2012;40(3):610-9.
298. Ali M, Alauddin S, Khatun M, Maniruzzaman M, Islam SMS. Determinants of early age of mother at first birth in Bangladesh: a statistical analysis using a two-level multiple logistic regression model. Journal of Public Health. 2021;29(5):1081-7.
299. Methun M, Haq I, Haq I, Uddin M, Rahman A, Islam S, et al. Socioeconomic correlates of Adequate Maternal Care in Bangladesh: Analysis of the Bangladesh Demographic and Health Survey 2017-18. BioMed Research International. 2022;2022.
300. Ministry of Health and Family Welfare, Bangladesh National Nutrition Council. Bangladesh National Plan of Action for Nutrition. Dhaka: Bangladesh National Nutrition Council; 1997.
301. The World Bank. The Bangladesh Integrated Nutrition Project: Effectiveness and Lessons. Dhaka: The World Bank; 2005.
302. White H. Comment on contributions regarding the impact of the Bangladesh Integrated Nutrition Project. Health Policy and Planning. 2005;20(6):408-11.
303. Derectorate General of Heath Services, Ministry of Health and Family Welfare. Operational Plan for Nutritional Nutrition Services. July 2011- June 2016. . Dhaka: Derectorate General of Heath Services, Ministry of Health and Family Welfare; 2011.
304. Government of People's Republic of Bangladesh. National Nutrition Policy 2015. Dhaka: Government of People's Republic of Bangladesh; 2015.
305. Ministry of Health and Family Welfare. Second National Plan of Action for Nutrition (2016-2025). Dhaka: Government of People's Republic of Bangladesh; 2017.
306. Government of People's Republic of Bangladesh. 4th Health, Population and Nutrition Sector Programme (4th HPNSP), Operational Plan, National Nutrition Service (NNS) Dhaka: Institute of Public Health Nutrition, Directorate General of Health Service, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh; 2017.
307. Ash D, Mahmud Z, Kappos K, Ireen S, Forissier T. Delivery of maternal nutrition interventions at scale and mainstreaming into the health system in Bangladesh. Field Exchange. 2020(63):64.
308. Haque MA, Choudhury N, Ahmed ST, Farzana FD, Ali M, Naz F, et al. The large-scale community-based programme 'Suchana'improved maternal healthcare practices in north-eastern Bangladesh: Findings from a cluster randomized pre-post study. Maternal and Child Nutrition. 2022;18(1):e13258.
309. de Hoop T, Fallon S, Yunus FM, Munrat S, Jolly SP, Sehrin F, et al. Mothers' education and the effectiveness of nutrition programmes: evidence from a matched cross-sectional study in rural Bangladesh. Journal of Development Effectiveness. 2020;12(4):279-97.
310. de Hoop T, Yunus FM, Munrat S, Fallon S, Sehrin F, Sennett J, et al. The Effects of Mainstreaming Nutrition and Early Childhood Development under BRAC's Maternal, Newborn, and Child Health Programme. A Mixed-Methods Impact Evaluation in. Dhaka: American Institutes for Research and BRAC Research and Evaluation Division; 2016.
311. Ara G, Sanin KI, Khanam M, Sarker SA, Khan SS, Rifat M, et al. Study protocol to assess the impact of an integrated nutrition intervention on the growth and development of children under two in rural Bangladesh. BMC Public Health. 2019;19(1):1-10.
312. Afsana K, Rifat M, Ara R, editors. Integration and scaling up nutrition within NGO programs-challenges and opportunities in Bangladesh. IUNS 21st International Congress of Nutrition 2017; Buenos Aires, Argentina: Annals of Nutrition and Metabolism.
313. Khan S, Angeles G, Rahman M, Chakraborty N, Haider MM, Escudero G, et al. Evaluation of the Improving Nutrition through Community Approaches (INCA) Project in Bangladesh: Outcome and Impact Evaluation. Chapel Hill, NC, USA: Data for Impact; 2020.

314. Hossain J, Rahman N, Islam MH, Hasanuzzaman M, Roy K, Jenkins D. A multi-sector approach to improve nutrition: Experiences of the Nutrition at the Center project, Bangladesh. Field Exchange. 2019(59):54.

315. Tumilowicz A, Ruel MT, Pelto G, Pelletier D, Monterrosa EC, Lapping K, et al. Implementation science in nutrition: concepts and frameworks for an emerging field of science and practice. Current Developments in Nutrition. 2019;3(3):nzy080.

316. UNICEF. Joint UNICEF Bangladesh – Government of Bangladesh Nutrition Programme Mid-Term Evaluation 2017-2020. Dhaka: UNICEF Bangladesh Country Office; 2020.

317. Rahman M, Mahmud Z, Ali M, Mathema P. Strengthening nutrition information systems to improve maternal nutrition in Bangladesh: Emergency Nutrition Network (ENN); 2019 [Available from: https://www.ennonline.net/nex/southasia/informationsystemsbangladesh.

318. Raza W, Chaudhery D. Impact of Health Sector Support Project on Essential Nutrition Services. Washington, DC: The World Bank; 2022.

319. Ireen S, Raihan MJ, Choudhury N, Islam MM, Hossain MI, Islam Z, et al. Challenges and opportunities of integration of community based management of acute malnutrition into the government health system in Bangladesh: a qualitative study. BMC Health Services Research. 2018;18(1):1-12.

Chapter 3: Improving quality of nutrition service provision

Paper 1: Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh

RESEARCH ARTICLE

Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh

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Data Availability Statement: All relevant data are held on a public repository and can be accessed

Abstract

Malnutrition during pregnancy is associated with increased maternal morbidity and mortality and has a long-term negative impact on child growth and development. Antenatal care (ANC) is the formal point of contact for pregnant women to receive preventive health and nutrition services. We assessed the quality of nutrition service delivery during ANC and examined its influencing factors related to the health facility, health care provider (HCP) and client characteristics. We conducted a cross-sectional assessment in 179 facilities, including 1,242 ANC observations and exit interviews of pregnant women from 21 districts in Bangladesh. We considered four essential nutrition services at each ANC contact including maternal weight measurement, anaemia assessment, nutrition counselling and iron-folic acid (IFA) supplement provision. We defined a composite 'quality nutrition service' outcome by counting the number of services (out of four) provided at each ANC from observation data. We explored both the supply-side and the client-level factors of quality nutrition service using multilevel Poisson regression. Overall, only 15% of clients received all four nutrition services. Performance of weight measurement (79%) was higher than IFA provision (56%), anaemia assessment (52%) and nutrition counselling (52%). The multivariable analysis showed that quality nutrition service delivery is positively associated with good logistical readiness of the facilities (aIRR: 1.23, 95% CI: 1.08–1.39), consultation by paramedics (aIRR 1.23, 95% CI: 1.06–1.42) and community health care providers (aIRR 1.32, 95% CI: 1.12–1.57), HCPs' knowledge on maternal nutrition (aIRR 1.04; 95% CI: 1.01–1.08), better HCP-client communication (aIRR 1.14; 95% CI: 1.04–1.26) and use visual aids or ANC card (aIRR 1.18; 95% CI: 1.11–1.27). We found limited associations between HCP training and external supervision with the quality of nutrition services. In conclusion, the quality of nutrition service provision during ANC is suboptimal. Public health nutrition programmers should

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ensure the facilities' logistical readiness, and revisit and reinforce the content and modality of training and supportive supervision of the HCPs. They should also emphasize positive HCP-client communication and the use of job aids to improve the quality of nutrition service provision during ANC.

Introduction

Maternal nutrition is a major global public health concern. Undernutrition and micronutrient deficiencies during pregnancy are associated with increased maternal morbidity and mortality and have a long-term negative impact on child growth and development [1, 2]. Despite gradual progress in low and middle-income countries (LMIC) during the last two decades, maternal and child nutrition improvements remain an unfinished agenda, especially with the interruptions by the COVID-19 pandemic [1]. In Bangladesh, 42% of women of reproductive age (15–49 years) and nearly half of all pregnant women are anaemic, 12% are thin and 14% have short stature [3, 4]. The principal drivers for maternal malnutrition are poor-quality diets, low intake of micronutrient supplements and lack of access to quality healthcare during pregnancy [5, 6]. A comprehensive analysis of data from 69 LMICs suggested that receiving antenatal care (ANC) from appropriate sources and with recommended frequency was associated with positive birth outcomes and childhood nutrition [7]. Evidence also suggests receiving three or more ANC visits is likely to reduce maternal malnutrition by three-fold [8]. All these findings highlight the need for improving coverage and quality of nutrition services during pregnancy.

ANC is the first contact for pregnant women to health and nutrition services. "WHO antenatal care guideline for positive pregnancy experience" recommends routine supplementation of iron-folic acid (IFA), nutrition counselling and weight monitoring during ANC to ensure greater coverage of nutrition interventions during pregnancy [9]. Aligned with global recommendations, the Government of Bangladesh prioritized maternal nutrition service delivery using the ANC platform in their fourth Health Nutrition and Population Sector Program to continue 'mainstreaming nutrition' in the health systems [10]. Like several LMICs, timely utilisation and quality of ANC remain a major challenge to increase the reach and coverage of nutrition interventions in Bangladesh [11]. In 2017, the coverage of four ANC visits was 47%, indicating more than half of pregnant women were missing the opportunity of maternal nutrition services [4]. Another challenge is ensuring the quality of nutrition interventions provided at ANC contacts, without which programmes will not fully harness the benefits of these interventions on maternal and child nutrition outcomes. Moreover, a recent study reported incomplete readiness of healthcare facilities to provide nutrition interventions during ANC (51%) [12]. Nutrition input-adjusted coverage was suboptimal (18% for ANC) and disproportionately affected the poor and women with lower educational attainment. Suboptimal quality of care for nutrition services during ANC further deteriorates the situation. An assessment of the quality of nutrition services in primary care facilities showed that only 30% of mothers received four nutrition services during ANC [13].

The quality of health service delivery primarily depends on three levels of factors: structure (readiness of the health facilities), process (provision and experience of care) and outcomes (effective coverage and health outcomes) [14]. Previous studies from LMICs have mainly reported on the quality of ANC service by using one or some of the following indicators: frequency of visits, structural readiness to provide the service, content on maternity care, client experience and their determinants [11, 15–21]. Although most of these studies covered the structural and outcome-level indicators, very few explored process-level indicators. One of the few attempts in exploring process-level factors and adherence to recommended quality provisions during ANC was made in 2016 in Tanzania [21]. The study reported that female providers, availability of routine tests and basic medicines at the public facilities and providers who received refresher training were positively associated with better adherence to quality ANC provision at a single point of contact. However, this study lacked the client-level factor and experience of care domains. Another study conducted in Ghana explored the client-level factors for quality ANC but lacked structural and provider-level factors [22]. A recent systematic review (2018) looking at the effectiveness of nutrition programming highlighted the need for additional analysis on barriers and enablers of nutrition service delivery using ANC and maternal, newborn and child health platforms in South Asia [23]. Considering the existing evidence and current research needs, a comprehensive analysis of quality ANC service delivery including structural, process and client-level factors, will be beneficial for effective programme planning [21]. This paper aims to assess the quality of nutrition service provision during ANC and examine its influencing factors related to facility readiness, health care providers, the process of care, and client characteristics.

Methods

Study design and setting

This study is a part of an initial cross-sectional assessment of coverage and quality of maternal and child nutrition services for a health system strengthening project, Accelerating Implementation of the National Nutritional Services (AINNS) in Bangladesh. The project included interventions to improve coordination of nutrition service delivery both at the national and sub-national levels and health care providers' (HCP) skills for maternal and child nutrition service delivery at public health care platforms. Details of the project evaluation plan have been reported elsewhere [24, 25]. Briefly, the initial assessment was done in 21 out of 64 districts in Bangladesh. We selected public health facilities from 14 of 40 AINNS intervention districts and seven of 24 non-intervention districts. We selected the districts based on comparability of population density, literacy rate, housing characteristics, people in the lowest wealth quintile, access to a safe drinking water source, electricity connection, improved sanitation, coverage of childhood immunization, ANC, skilled birth attendance, postnatal care and modern methods of family planning, under-five mortality rate and childhood stunting prevalence. We created a score for each district by principal component analysis of these variables. Then, we applied nearest neighbour matching of the district's PCA score to match two intervention districts with one non-intervention district. Finally, we selected seven matched groups of districts (each having two AINNS intervention districts and one non-intervention), which had the minimum difference in the PCA score.

The initial assessment included secondary to community-level public health facilities, namely district hospitals, sub-district hospitals, union health and family welfare centres and community clinics at the ward-level. At the district and sub-district-level hospitals, physicians with or without specialisation in obstetrics and gynaecology, nurses and paramedics provide maternal care services, including ANC. At union-level facilities, which serves a catchment of 25–30 thousand people, paramedics are the main ANC service providers. These paramedics have either a four-year medical diploma or 18 months of pre-service training including six months on midwifery skills. At community clinics, which serve six to eight thousand people in each ward, community health care providers and frontline community health workers provide ANC services. From each district, we selected the district hospital and two upazila health complexes (sub-district hospitals) from two randomly selected subdistricts for this assessment. We also randomly selected four union-level health facilities and four community clinics from a list of functioning facilities prepared in consultation with the sub-district health manager in each chosen sub-district. We conducted the initial assessment between February and June 2016.

Data collection

We used the structure and process domains of the Donabedian framework for the factors influencing quality nutrition service provision. Globally, the Donabedian framework is widely used for measuring the quality of healthcare service delivery [14, 26]. This framework identifies structure, process and outcome level indicators for a comprehensive measurement of quality of care [26, 27]. We have also considered the client characteristics as they have been found to influence the provision of ANC services [21]. We collected data at both supply and client-levels from different sources, including i) a health facility readiness assessment, ii) health care provider interviews, iii) direct observation of ANC practices, and iv) exit interviews with the ANC clients. For health facility assessment, we used a structured checklist adapted from the Bangladesh Health Facility Assessment tool [28] to collect information on facility infrastructure, and availability of specific logistics items (including weighing scale, haemoglobin testing tool, health education material/visual aids, ANC card, clinical guideline, registers and iron-folic acid (IFA) supplements). Interviews with ANC service providers included information about their duration of work in the facility, training status and knowledge regarding nutrition services. For direct observation, we developed the observation checklist following the standard operating procedures for maternal health services [29] to document the nutrition services provided during ANC consultations. Finally, we conducted exit interviews with clients after receiving ANC to collect information on their background, demographic and obstetric characteristics and ANC service care-seeking. S1 Table summarizes the outcome and explanatory measures, definitions and data collection methods.

Sample size

We assessed the readiness to provide ANC services in 231 facilities (Fig 1). ANC services were not sought in 47 out of the 231 facilities on the assessment days; thus, we observed 1295 ANC service consultations at 184 facilities. We had complete background information from 201 HCPs who offered ANC services on the day of the visit. We excluded 53 observations from the analysis due to missing information on HCPs or the client characteristics. Finally, we included 1,242 observations of ANC service consultation provided by 201 service providers at 179 facilities in the analysis for this paper.

Measures of quality of nutrition services (outcome measures)

We considered maternal weight measurement, screening for anaemia, nutrition counselling and provision of IFA supplements as the ANC nutrition services [10]. During the observations of ANC, the assessors recorded if these services were provided. We considered weight assessment performed if the HCPs took the weight of pregnant women using either a digital or analogue weighing scale. We included anaemia assessment in the quality of nutrition service during ANC due to the high prevalence of anaemia among women of reproductive age in Bangladesh [30]. Screening for anaemia included assessing blood haemoglobin levels either using Tallquist paper onsite, by previous laboratory investigation or examining eye or palm (clinical assessment). Provision of nutrition counselling included HCPs providing messages on dietary diversity, quantity and types of nutritious food. We defined IFA provision as HCPs distributing IFA supplements during the ANC consultation; however, we did not include HCPs prescribing IFA to be bought from outside pharmacies. We created a composite score variable for

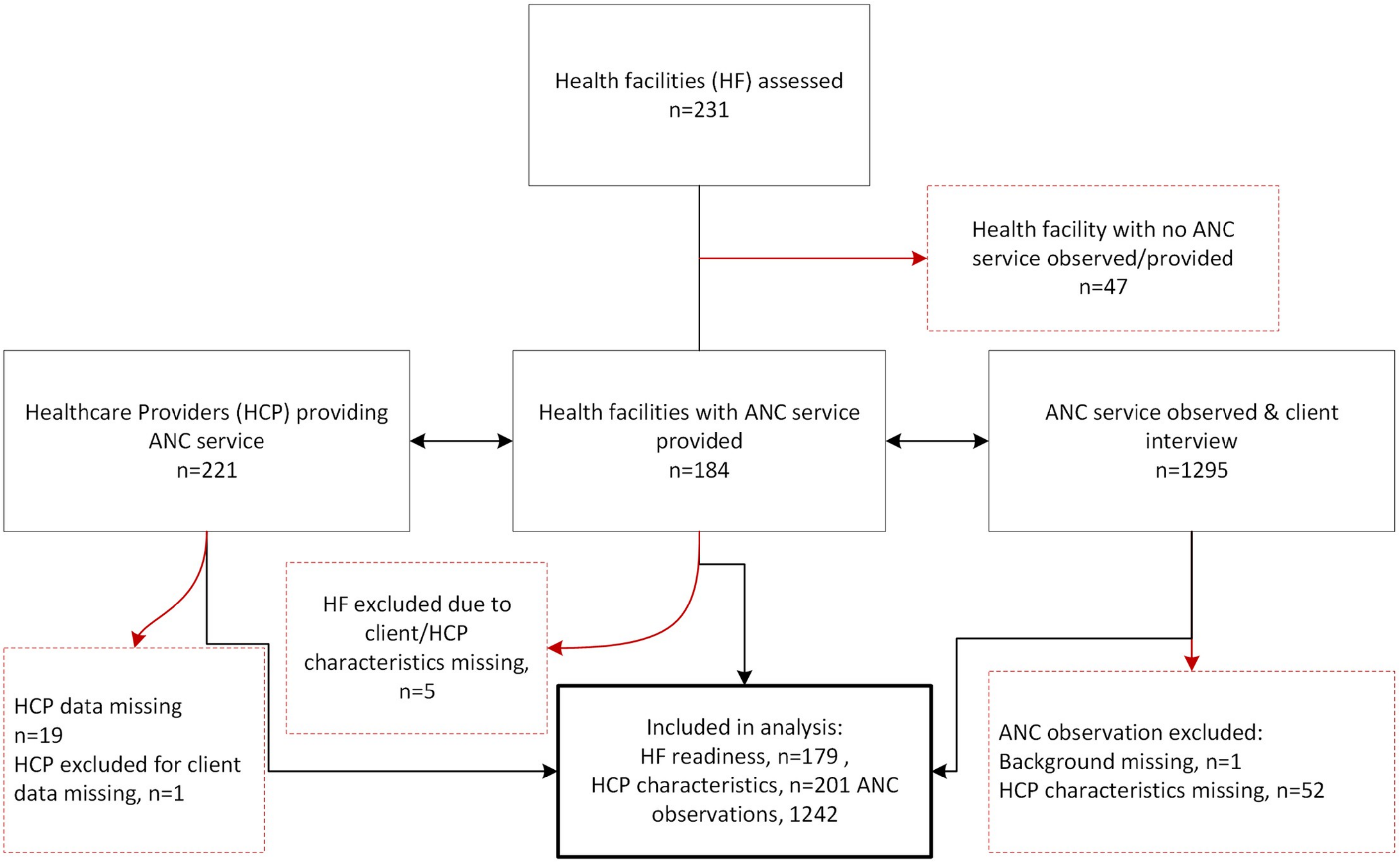

Fig 1. Study flow diagram showing health facilities, health care providers and participants recruited and final sample size. ANC: Antenatal care, HCP: Health care provider, HF: Health facility.

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'quality nutrition service' by adding the number of services (out of four) provided at the ANC consultation. Similar methods of defining a composite score for quality service have been used in previous studies [11, 31].

Explanatory variables

We explored the supply-side and the client-level factors of quality nutrition services provided at ANC (S1 Table). According to the 'structure' domain of the Donabedian framework [14], we considered the health facility characteristics and readiness and HCP characteristics and knowledge as supply-side factors. At the health facility-level, we constructed two indicators. The first was structural readiness (if all five readiness items were available). The second was the logistical readiness indicator created from seven logistic and supplies items using principal component analysis and then categorized into four logistical readiness quantiles. Cronbach's alpha for the logistics and supplies included in the composite score calculation was 0.62. HCP characteristics included age, sex, duration of service at the facility and receiving external supervision at least once in the last six months. HCPs' knowledge of nutrition services at ANC was a composite score derived by adding the correct responses to four questions (S1 Table). The process-level factor included two variables on HCP-client interaction: 'HCP-client communication' (HCP discussing the progress of pregnancy and asking if the client has any questions) and the 'use of visual aids and ANC card' during ANC service provision. Client-level factors included client characteristics, namely age, education, gestational age and the number of ANC visits.

Statistical analysis

We used descriptive analysis to summarise the client and provider characteristics, health facility readiness to provide nutrition services at ANC, and client-provider interactions during ANC consultation. We reported summary statistics by frequency and proportion or by mean (±SD) for categorical and continuous variables, respectively. We explored the differences in provider characteristics and provider-client interactions by types of providers and facility readiness by types of facilities using Analysis of Variance (ANOVA) and chi-square test for continuous and categorical characteristics variables, respectively. We checked for the linearity in the relationship between each continuous explanatory variable and nutrition service quality score by fitting the locally estimated scatterplot smoothing (loess) curve. As the outcome variable includes counts of nutrition services, we used Poisson regressions to examine the potential influencing factors of quality nutrition service at ANC [32]. We included provider and facility as the random effects in the model as clients were nested within the providers and providers were nested within the facilities. We calculated p-values using Wald tests with robust standard errors to adjust for model violations, such as under-dispersion. In the multivariable regression model, we included the explanatory variables that showed an association with quality nutrition service in the bivariate analysis at a p-value <0.2. The facility type had collinearity (correlation coefficient: 0.72) with HCP type. We compared Akaike's information criterion (AIC) and Bayesian information criterion (BIC) between the models with and without facility type and excluded facility type from the final model. We also ran multivariable Poisson regression using each of the four elements of quality nutrition services as the outcome. We reported the adjusted incidence rate ratios (aIRR) and their 95% confidence interval as the measure of association. Associations were considered statistically significant at a p-value<0.05 in the final model. We used Stata version 14 software in all statistical analyses.

Ethical approval

We obtained ethical approval from the Ethical Review Committee of icddr,b (Protocol Number-15107), and written informed consent from HCPs, health facility managers and ANC clients before data collection.

Results

The study includes data from 21 district hospitals, 40 sub-district hospitals, 61 union-level facilities and 57 community clinics. Most of the facilities (88%) had one HCP who provided ANC services on the day of assessment and participated in the study. Overall, 58% of facilities had all five infrastructural readiness items considered in this analysis (Table 1). Infrastructural readiness of community clinics (21%) and family welfare centres (56%) was poorer than higher-tier facilities, including district hospitals (95%) and sub-district hospitals (91%). The overall availability of supplies like weighing scales (82%), ANC registers (99%), IFA supplements (93%) and visual aids for counselling (88%) was high. However, only 35% of facilities had a haemoglobin testing kit to detect maternal anaemia and about one third had an ANC guideline. We found significant differences in the availability of haemoglobin testing kits, visual job aids, ANC cards and IFA supplements across different types of facilities (all $p<0.01$).

Most of the HCPs (86%) were female (Table 2). About half of the community HCPs received nutrition training compared to only 9% of physicians. Knowledge of nutrition services was similar across the HCP types. Although 84% of HCPs received external supervision

Table 1. Characteristics and readiness of the healthcare facilities by types of facility.

	Overall(	District hospital	Sub-district hospital	Union health centre	Community clinic	p-value
	N = 179)	(N = 21)	(N = 40)	(N = 61)	(N = 57)	
All structural readiness[1] items available	57.5	90.5	95.0	55.7	21.0	<0.001
Logistics and supplies						
Weighing scale	82.1	81.0	72.5	85.3	86.0	0.318
Haemoglobin testing tool	35.2	9.5	17.5	50.8	40.4	<0.001
Health education materials/visual aids	88.3	81.0	72.5	93.4	96.5	0.001
ANC card	84.9	71.4	72.5	95.1	87.7	0.004
ANC guideline	30.2	38.1	30.0	32.8	24.6	0.642
ANC register	99.4	95.2	100	100	100	0.056
IFA supplement	93.3	95.2	97.5	83.6	100	0.002
Average number of ANC services provided on a day						
<5	44.7	9.5	42.5	57.4	45.6	<0.001
5–10	35.8	23.8	30.0	36.1	43.9	
≥11	19.6	66.7	27.5	6.6	10.5	

Values are %; p-values are test of difference in facility readiness across facility types;

[1] Structural readiness: Availability of examination room/area, privacy, examination bed, electricity and functioning toilet for clients

ANC: Antenatal care, IFA: Iron- folic acid

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Table 2. Characteristics of health care providers and provider-client interaction by types of health care provider.

	Overall	Physician	Nurse	Paramedics	CHCP/CHW	p-value
	(N = 201)	(N = 35)	(N = 20)	(N = 88)	(N = 58)	
HCP characteristics						
Age of provider (years)	38.1 (±10.0)	35.7 (±6.8)	41.4 (±9.1)	43.1 (±10.2)	30.9 (±6.2)	<0.001
Sex of the provider						
Male	13.9	5.7	0	4.6	37.9	<0.001
Female	86.1	94.3	100	95.5	62.1	
Duration of work at the current facility (years)						
≤3	32.3	62.9	35.0	35.2	8.6	<0.001
4–7	37.8	25.7	15.0	15.9	86.2	
≥8	29.9	11.4	50.0	48.9	5.2	
Received any in-service training on nutrition	28.9	8.6	20.0	23.9	51.7	<0.001
Knowledge (score out of 6) on nutrition services at ANC[1]	4.3 (±1.4)	4.2 (±1.6)	4.3 (±1.1)	4.3 (±1.4)	4.3 (±1.4)	0.994
Received any external supervision in last 6 months	83.6	82.9	55.0	83.0	94.8	0.001
Place of work						
District hospital	13.9	40.0	30.0	9.1	0	<0.001
Sub-district hospital	26.9	60.0	70.0	21.6	0	
Union health centre	30.4	0	0	69.3	0	
Community clinic	28.9	0	0	0	100	
HCP-client interaction	**N = 1242**	**N = 338**	**N = 179**	**N = 497**	**N = 228**	
HCP-client communication[2]	72.6	61.8	63.1	87.7	63.2	<0.001
Used visual aids or ANC card	47.0	29.9	71.5	56.3	32.9	<0.001

Values are % or mean (± SD), p-values test difference of HCP characteristics by types of health care provider;

[1] includes knowledge on the provision of Iron-folic acid, diagnosis and management of anaemia, weight measurement and diet counselling;

[2] HCP discussing the progress of pregnancy, asked if the client had any question

HCP: health care providers, ANC: antenatal care, CHCP: community health care providers, CHW: community health workers

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at least once in six months preceding the assessment, the external supervision of nurses was much lower (55%) compared to other types of HCP (>80%). HCP-client interaction during ANC consultation varied significantly by types of providers (Table 2). While the proportion of HCPs informing clients about the progress of their pregnancy or allowing clients to ask questions was high (73%), visual aid or ANC card usage during counselling was low (only in 47% of ANC consultations). Clients who received ANC from the facilities had a mean age of 23 years (SD±4.3 years) and had a mean eight years (SD±2.9 years) of schooling. Clients were mostly first-time pregnant women (42%), in their second trimester (46%), and came for either the second or third ANC visit (44%).

Among the four nutrition services to be provided during ANC, assessment of weight for maternal weight gain during pregnancy was the highest (79%), followed by IFA provision (56%) (Fig 2A). In nearly half of the ANC consultations, HCPs screened for anaemia either by testing haemoglobin or by clinical examination of eye or palm and provided counselling on appropriate dietary practices. Overall, only 15% of clients received all four nutrition services components and about one third received three services (Fig 2B).

We summarized the factors influencing the overall quality of ANC nutrition services in Table 3. The unadjusted results showed that logistical readiness of the facilities, types of HCP, knowledge of the HCP on maternal nutrition, provision for external supervision, HCP-client communication, use of visual aids or ANC cards during the consultation, and gestational age at ANC visit were positively associated with quality nutrition service at ANC. In the adjusted analysis, there was an association between facilities with average and good logistical readiness with higher quality nutrition service provision (aIRR: 1.17, 95% CI: 1.04–1.32 and aIRR: 1.23, 95% CI: 1.08–1.39, respectively) compared to facilities with low readiness. Although nurses provided services of similar quality to the physicians, paramedics were 23% (aIRR: 1.23, 95% CI: 1.06–1.42) and community health care providers were 32% (aIRR: 1.32, 95% CI: 1.12–1.57) more likely to provide quality nutrition services. Each point increase in HCPs' knowledge of nutrition was associated with a 4% higher quality of nutrition services at ANC (aIRR: 1.04; 95% CI: 1.01–1.08). There was no association between HCPs' training on nutrition and receiving external supervision in the last six months with quality nutrition service provision in the adjusted analysis. There was an association between HCP-client communication (aIRR: 1.14; 95% CI: 1.04–1.26) and the use of visual aids or ANC cards (aIRR: 1.18; 95% CI: 1.11–1.27) with quality nutrition service provision. Finally, the clients in the second and third trimesters of pregnancy received higher-quality nutrition service (aIRR: 1.23, 95% CI: 1.11–1.35 and aIRR: 1.19, 95% CI: 1.08–1.32, respectively) compared to those in the first trimester.

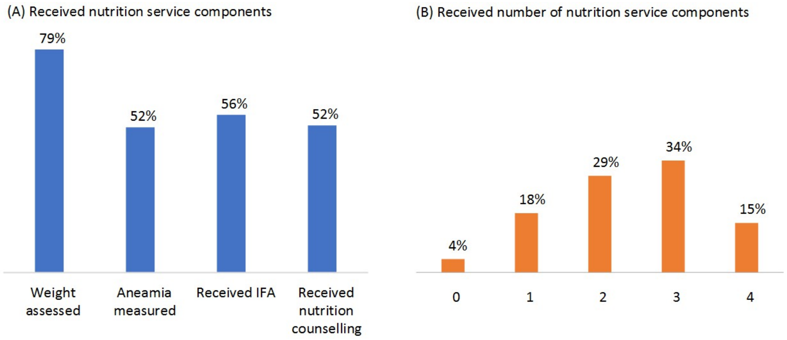

Fig 2. Percentage of clients received (A) nutrition service components and (B) number of nutrition service components at ANC. IFA: Iron-folic acid.

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Table 3. Unadjusted and adjusted incidence rate ratio of quality nutrition service at ANC according to health facility readiness, HCP characteristics, client-provider interactions and client characteristics.

Variables	Unadjusted models		Adjusted model	
	IRR (95% CI)	p-value	aIRR (95% CI)	p-value
Facility characteristics and readiness				
All structural readiness[1] available	0.86 (0.77–0.96)	0.007	1.00 (0.98–1.03)	0.884
Logistical readiness quantile[2] (ref: Level 1 (poor))		0.015		0.013
Level 2 (average)	1.23 (1.04–1.45)	0.016	1.17 (1.04–1.32)	0.011
Level 3 (good)	1.31 (1.11–1.54)	0.001	1.23 (1.08–1.39)	0.002
Level 4 (best)	1.27 (1.03–1.58)	0.024	1.10 (0.95–1.28)	0.201
Average number of ANC services provided per day (ref: <5)		0.107		0.302
5–10	0.92 (0.81–1.05)	0.220	0.98 (0.89–1.07)	0.614
≥11	0.85 (0.73–0.99)	0.039	0.91 (0.82–1.02)	0.123
Provider characteristics				
Age of provider (years)	1.00 (0.99–1.00)	0.447		
Sex of provider (ref: female)	0.99 (0.84–1.17)	0.919		
Duration of work at this facility (years) (ref: ≤3)		0.062		0.731
4–7	1.16 (1.02–1.32)	0.024	1.04 (0.93–1.16)	0.537
≥8	1.13 (1.00–1.27)	0.055	1.05 (0.93–1.18)	0.464
Type of provider (ref: physician)		<0.001		<0.001
Nurse	0.99 (0.80–1.21)	0.900	0.89 (0.74–1.05)	0.169
Paramedic	1.41 (1.17–1.69)	<0.001	1.23 (1.06–1.42)	0.006
CHCP/CHW	1.46 (1.21–1.76)	<0.001	1.32 (1.12–1.57)	0.001
Received any training on nutrition	1.11 (1.00–1.24)	0.060	1.00 (0.91–1.10)	0.949
Knowledge on nutrition service (score out of 6)	1.07 (1.03–1.11)	0.001	1.04 (1.01–1.08)	0.012
Received external supervision in last 6 months	1.17 (1.01–1.36)	0.034	1.09 (0.97–1.24)	0.154
HCP-client interaction (process)				
HCP-client communication[3]	1.24 (1.11–1.38)	<0.001	1.14 (1.04–1.26)	0.007
Used visual aids or ANC card	1.19 (1.10–1.28)	<0.001	1.18 (1.11–1.27)	<0.001
Client characteristics				
Age of women (years)	1.00 (0.99–1.00)	0.169	1.00 (0.99–1.01)	0.946
Education (years of schooling)	1.00 (0.99–1.01)	0.781		
Gravida (ref: 1)		0.184		0.188
2	1.01 (0.96–1.05)	0.784	1.00 (0.96–1.05)	0.841
≥3	0.95 (0.90–1.01)	0.127	0.94 (0.87–1.02)	0.149
Gestational age (ref: 1st trimester)		<0.001		<0.001
2nd trimester	1.28 (1.16–1.42)	<0.001	1.23 (1.11–1.35)	<0.001
3rd trimester	1.23 (1.10–1.37)	<0.001	1.19 (1.08–1.32)	0.001
Number of ANC visits (ref: 1st visit)		0.234		
2nd– 3rd	1.05 (0.99–1.11)	0.108		
≥4th	1.04 (0.99–1.09)	0.156		

[1] Structural readiness: availability of examination room, privacy, examination bed, electricity and functioning toilet for clients;

[2] Logistical readiness quantile was derived by categorizing score from principal component analysis of the availability of weighing scale, haemoglobin testing tool, health education materials/visual aids, ANC card, ANC guideline, ANC register and IFA supplement;

[3] HCP discussing the progress of pregnancy, asked if the client had any question;

IRR: incidence rate ratio, aIRR: adjusted incidence rate ratio, ANC: antenatal care, CHCP: community health care providers, CHW: community health workers; HCP: health care provider, ref: reference

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Table 4. Adjusted incidence rate ratio of weight measurement and anaemia assessment at ANC according to health facility readiness, HCP characteristics, client-provider interactions and client characteristics.

Variables	Weight measured		Anaemia[1] assessed	
	aIRR (95% CI)	p-value	aIRR (95% CI)	p-value
Facility characteristics				
All structural readiness[2] available	1.00 (0.97–1.04)	0.876	1.03 (0.96–1.10)	0.483
Logistical readiness quantile[3] (ref: Level 1 -poor)		0.002		0.386
Level 2 (average)	1.61 (1.22–2.12)	0.001	0.94 (0.67–1.33)	0.749
Level 3 (good)	1.59 (1.21–2.11)	0.001	1.18 (0.87–1.60)	0.276
Level 4 (best)	1.39 (1.03–1.87)	0.030	0.94 (0.63–1.40)	0.761
Average number of ANC services provided per day (ref: <5)		0.699		0.163
5–10	1.00 (0.86–1.16)	0.999	1.06 (0.81–1.38)	0.668
≥11	1.06 (0.92–1.23)	0.456	0.78 (0.57–1.07)	0.130
Provider characteristics				
Duration of work in facility (years) (ref: ≤3)		0.486		0.334
4–7	1.07 (0.90–1.28)	0.429	1.17 (0.87–1.57)	0.298
≥8	1.11 (0.94–1.30)	0.212	0.95 (0.73–1.24)	0.712
Type of provider (ref: Physician)		0.001		0.132
Nurse	0.94 (0.76–1.18)	0.615	0.77 (0.51–1.17)	0.222
Paramedic	1.23 (1.01–1.49)	0.042	1.07 (0.80–1.43)	0.658
CHCP/CHW	1.32 (0.99–1.74)	0.055	0.76 (0.50–1.16)	0.202
Received training on nutrition	0.95 (0.85–1.06)	0.327	1.02 (0.76–1.37)	0.882
Knowledge on nutrition service (score out of 6)	0.98 (0.93–1.03)	0.404	1.18 (1.08–1.29)	<0.001
Received external supervision in last 6 months	1.00 (0.86–1.17)	0.959	0.77 (0.60–0.99)	0.042
HCP-client interaction (process)				
HCP-client communication[4]	1.06 (0.92–1.20)	0.427	0.87 (0.69–1.09)	0.222
Used visual aids or ANC card	1.23 (1.11–1.37)	<0.001	1.28 (1.08–1.53)	0.005
Client characteristics				
Age of women (years)	1.01(1.00–1.01)	0.144	1.00 (0.98–1.01)	0.546
Gravida (ref: 1)		0.084		0.927
2	1.02 (0.96–1.08)	0.546	0.99 (0.88–1.13)	0.907
≥3	0.92 (0.82–1.02)	0.120	1.03 (0.87–1.20)	0.790
Gestational age (ref: 1st trimester)		0.026		0.128
2nd trimester	1.19 (1.05–1.33)	0.005	1.03 (0.85–1.25)	0.763
3rd trimester	1.19 (1.04–1.35)	0.009	1.14 (0.93–1.38)	0.206

[1] Anaemia assessment included HCPs assessing blood haemoglobin levels or examining eye or palm (clinical assessment);

[2] Structural readiness: Availability of examination room/area, privacy, examination bed, electricity and functioning toilet for clients;

[3] Logistical readiness quantile was derived by categorizing score from principal component analysis of the availability of weighing scale, haemoglobin testing tool, health education materials/visual aids, ANC card, ANC guideline, ANC register and IFA supplement;

[4] HCP discussing the progress of pregnancy, asked if the client had any question;

CHCP: community health care providers, CHW: community health workers; HCP: health care provider, aIRR: adjusted incidence rate ratio

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We also explored facility, HCP and client-level factors influencing each of the components of nutrition services at ANC (Tables 4 and 5). The key influencing factors for weight measurement were the logistical readiness of the health facilities, clients seeing a lower-level provider like a paramedic or CHCP/CHW, using visual aids or ANC cards during service provision, and clients attending health facilities in the second and third trimester (Table 4). Anaemia assessment was also positively associated with higher HCPs' knowledge on nutrition and the

Table 5. Adjusted incidence rate ratio of IFA provision and nutrition counselling at ANC according to health facility readiness, HCP characteristics, client-provider interactions and client characteristics.

Variables	IFA provided		Nutrition counselling	
	aIRR (95% CI)	p-value	aIRR (95% CI)	p-value
Facility characteristics				
All structural readiness[1] available	0.97 (0.91–1.04)	0.383	1.00 (0.94–1.06)	0.996
Logistical readiness quantile[2] (ref: Level 1 -poor)		0.410		0.236
Level 2 (average)	0.83 (0.61–1.13)	0.253	1.29 (0.96–1.75)	0.095
Level 3 (good)	0.81 (0.62–1.05)	0.108	1.35 (1.00–1.82)	0.047
Level 4 (best)	0.84 (0.61–1.17)	0.306	1.25 (0.90–1.74)	0.190
Average number of ANC services provided per day (ref: <5)		0.799		0.045
5–10	0.93 (0.72–1.18)	0.538	0.89 (0.72–1.10)	0.271
≥11	1.01 (0.73–1.39)	0.950	0.70 (0.53–0.94)	0.016
Provider characteristics				
Duration of work in facility (years) (ref: ≤3)		0.454		0.471
4–7	0.81 (0.58–1.14)	0.235	1.15 (0.88–1.51)	0.302
≥8	0.94 (0.68–1.33)	0.779	1.18 (0.89–1.56)	0.260
Type of provider (ref: Physician)		0.023		0.029
Nurse	0.87 (0.51–1.46)	0.594	0.88 (0.57–1.38)	0.586
Paramedic	1.41 (0.99–2.00)	0.058	1.28 (0.89–1.85)	0.182
CHCP/CHW	1.74 (1.19–2.56)	0.005	1.56 (1.03–2.34)	0.034
Received training on nutrition	1.11(0.88–1.40)	0.357	1.01(0.85–1.20)	0.886
Knowledge on nutrition service (score out of 6)	0.99 (0.91–1.07)	0.745	1.08(1.01–1.16)	0.040
Received external supervision in last 6 months	2.42(1.42–4.11)	0.001	1.00(0.75–1.31)	0.949
HCP-client interaction (process)				
HCP-client communication[3]	1.34 (1.06–1.70)	0.013	1.51 (1.17–1.95)	0.002
Used visual aids or ANC card	1.05 (0.90–1.22)	0.571	1.20 (1.01–1.42)	0.038
Client characteristics				
Age of women (years)	1.00(0.99–1.01)	0.955	1.00(0.98–1.01)	0.675
Gravida (ref: 1)		0.239		0.432
2	1.06 (0.96–1.15)	0.245	0.96 (0.87–1.06)	0.443
≥3	0.96 (0.84–1.11)	0.599	0.90 (0.76–1.06)	0.219
Gestational Age (ref: 1st trimester)		<0.001		0.360
2nd trimester	2.13 (1.58–2.88)	<0.001	0.92 (0.79–1.09)	0.354
3rd trimester	1.84 (1.35–2.51)	<0.001	0.89 (0.75–1.05)	0.164

[1] Structural readiness: availability of examination room/area, privacy, examination bed, electricity and functioning toilet for clients;

[2] Logistical readiness quantile was derived by categorizing score from principal component analysis of the availability of weighing scale, haemoglobin testing tool, health education materials/visual aids, ANC card, ANC guideline, ANC register and IFA supplement;

[3] HCP discussing the progress of pregnancy, asked if the client had any question;

CHCP: community health care providers, CHW: community health workers; HCP: health care provider, aIRR: adjusted incidence rate ratio

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use of visual aids or ANC cards but inversely associated with providers receiving external supervision. For IFA provision, the key influencing factors included lower-level HCPs like CHWs, clients in the second and third trimester of pregnancy, external supervision in the last six months, and HCP-client communication (Table 5). Provision of nutrition counselling was lower at facilities with 11 or more ANC services provided daily, but higher among community-level providers and HCPs with better knowledge of nutrition services. The use of visual aids or ANC cards and good HCP-client communication during the consultation also resulted in greater provision of nutrition counselling at ANC.

Discussion

ANC is the formal point of contact for pregnant women to receive preventive health and nutrition services. We found that only 15% of women received all four nutrition services at ANC. Anaemia measurement and nutrition counselling were the least provided (52%) nutrition service. Logistical readiness of the facilities, types of ANC provider, HCPs' knowledge of nutrition services, client-provider interactions during the consultation and gestational age of clients were the factors influencing quality nutrition services during ANC. We found limited associations of training and external supervision of the providers with the quality of nutrition services. Our study adds to the knowledge about the quality of nutrition services provided during pregnancy. It provides some critical insights on areas to intervene for improving the nutrition service provision at ANC in a low-resource setting.

Our findings of the quality of nutrition service provision at ANC is consistent with the poor content of ANC services reported in Bangladesh and other low-income settings [11, 17, 20]. However, previous studies mostly focused on the content of ANC, asking women who had recently given birth if they had received any of the specified services at any point during their pregnancy, rather than on a specific service contact [11, 15, 20]. Studies from Peru and Tanzania observing-ANC service at the point-of-care reported low adherence to recommended service provision [19, 21]. A study in Bangladesh also reported high weight measurement and IFA provision but inadequate counselling on nutrition at ANC [13].

Adequate readiness of the health facilities is essential to ensure quality service provision [11, 33–35]. Our study showed that improved logistical readiness of health facilities is strongly associated with higher quality nutrition services provision at ANC. In the disaggregated analysis, we found weight assessment was substantially lower in the facilities with poor logistical readiness compared to the service at better equipped facilities. However, the provision of IFA did not differ significantly by the facilities' logistical readiness level as IFA was available in most (93%) of the facilities. Although unadjusted analysis showed an inverse association between infrastructural readiness of facilities and quality nutrition service provision, this association was attenuated and no longer significant in the adjusted analysis. The crude association was likely to be confounded by the higher-tier facilities with better infrastructural readiness but poorer service provision, as shown in our descriptive analysis. The National Nutrition Services programme should ensure a consistent supply of the logistics and supplies that are essential for nutrition service provision at ANC to improve the quality of service.

Lower-level providers who mainly offer services at lower-tier facilities provided a better quality of nutrition service than physicians and nurses at higher-tier facilities. Previous studies from LMICs including Bangladesh have also reported that lower-level providers had similar or better compliance with standard maternal and child out-patient care than higher-level providers [22, 36]. All physicians and nurses in our study provided services at the district and subdistrict hospitals where HCP shortage is a challenge [37]. These physicians and nurses often provide service under high workload pressure, are responsible for multiple tasks and manage patients with complications [38, 39]. In such situations, HCPs often prioritise curative health services over preventive nutrition services such as counselling and weight assessments for weight gain monitoring [39]. We also found nutrition counselling was lower at facilities where a higher number of ANC services were provided, and this occurs mostly at district and subdistrict hospitals. The role of the higher-level providers should be clarified based on WHO and national recommendations for nutrition services during pregnancy. Further in-depth qualitative assessment is necessary to better understand provider attitudes and motivation factors influencing their provision of nutrition services.

Our study demonstrates that HCP-client interactions such as informing them about the progress of pregnancy and giving them the opportunity to ask questions had a significant association with the quality of nutrition service provision. The WHO's standards for maternal and newborn care and guidelines on ANC recommend treating clients with dignity and compassion and providing information on health status and potential interventions for making an informed choice by clients [9, 40]. Earlier studies also reported the importance of HCPs' interpersonal communication and attitude towards clients to improve the quality of ANC services at health facilities [16, 18]. A study in Laos reported that HCP behaviour, mutual communication and treating clients with dignity are important considerations to improve ANC service quality [16]. This evidence highlights the importance of client-provider interactions for improving the quality of ANC nutrition services.

We also found that the application of job aids such as visual aids and ANC cards during ANC consultations improved the quality of nutrition services, especially for weight measurement, anaemia assessment, and nutrition counselling. A possible explanation for this is that documenting the key components of nutrition services provided on the ANC card, prompts HCP to provide the services [41]. Similarly, visual aids likely remind HCPs of the counselling contents, improved communication techniques and service provision [42]. However, there was no association between the use of ANC cards or visual aids and increased provision of IFA supplements. The ANC card used in public facilities in Bangladesh does not mention IFA provision. Moreover, IFA provision is more likely to depend on the availability of the supplements, HCPs perceptions about supplementation, and client characteristics.

In contrast to previous studies, we did not find any association between HCPs nutrition training and the quality of nutrition service delivery during ANC [21, 43]. The content and quality of their training in nutrition might explain this finding as there have been several criticisms of the government's Basic Nutrition Training that most HCPs received. There was too much content to cover in a short training time and it was overly focused on child feeding with few practical demonstrations [39]. The training quality declined when it was scaled up to a large number of HCPs nationwide using a cascade model [39, 44]. Only IFA provision was positively associated with receiving external supervision. Like training on nutrition, the quality of supervision visits to HCPs is often a question in resource-poor settings. HCPs often receive external supervision from administrative supervisors who have limited technical expertise and supervisory skills, resulting in a missed opportunity to reinforce the implementation of the knowledge and training obtained by HCPs into practice [39, 45]. Considering the quality issue of nutrition training, the current NNS operation plan introduced Comprehensive Competency-Based Training on Nutrition in 2017, which is implemented by technical experts [10]. The Competency-Based Training also addressed the supervision issue by developing and training supervisors on specifically designed modules to improve the technical competence of the supervisors. However, the success of Competency-Based Training in overcoming these challenges is yet to be evaluated.

Gestation was an important factor influencing the quality of nutrition services during ANC. Women coming for ANC in late trimesters received better quality nutrition services compared to women presenting in the first trimester [13, 22, 46]. The women presenting in the first trimester were less likely to have their weight assessed or receive IFA supplements. Low IFA supplement provision in the first trimester could be related to some inconsistent perceptions among HCPs on when to start IFA and the adverse effect of iron on foetal development [47, 48]. HCPs perception of the importance of different services and self-prioritisation of some services may also differ according to clients' gestational age. A study in Ghana suggested that HCPs sometimes disregard physical measurements in the first trimester [22]. However, the reasons for lower compliance with weight assessment in the earlier stage of pregnancy require in-depth research. Detection and management of anaemia and provision of IFA early in pregnancy are important to avoid anaemia's detrimental effect on maternal and child health outcomes [49]. Adaptation of the national ANC guideline to comply with the global recommendations and improving HCPs' awareness of the recommended nutrition services during ANC visits may improve the quality of services.

The main strength of our study is the collection of observation-based data on nutrition service provision during ANC and the assessment of facility, provider and client characteristics at the same time-point, which allowed us to undertake supply-side and client-level factor analysis. The sampling of facilities covered 21 out of 64 districts spread across all geographic regions, which improved the generalisability of the study findings to public facilities in Bangladesh. Our study has some limitations. First, the observation of service provision by an external assessor may have resulted in some improved practice by HCPs. However, we anticipate that such bias will have a limited effect on the analysis of factors influencing the quality of service as facility and HCPs characteristics will not change during the observation. To reduce the Hawthorne effect, we conducted the observations in a natural setting, spending a reasonable time (i.e., one to two full days) at each facility [50]. We assured HCPs about their anonymity when presenting findings and emphasised that our observations were not related to individual performance evaluation. Second, the study methodology did not involve any in-depth interviews with HCPs to explore the reasons for the relatively low proportion of pregnant women whose weight was assessed during the first trimester of pregnancy and the limited impact of training and supervision on quality service provision. Third, we did not account for hospital management and governance level factors influencing the quality of nutrition service provision at health care platforms such as ANC. Fourth, we assessed only the on-site availability of rapid haemoglobin testing kits at the ANC room, which may underestimate the haemoglobin testing readiness of district and sub-district hospitals as some of them might have advanced diagnostic tests for anaemia. Future research should explore these questions.

Conclusion

The quality of nutrition service provided at ANC in public health facilities in Bangladesh is sub-standard and varies by gestational age of the clients and type of HCPs proving the service. Increasing awareness of ANC standards and guidelines among HCPs is imperative. Logistical readiness of the facility influences the quality of nutrition service provision and demands urgent attention from nutrition programme managers. HCP-client communications and the use of simple but effective visual aids should be emphasised during ANC service. The limited impact of the traditional hierarchical administrative supervision calls for service-specific supportive supervision by technical experts to improve the quality of nutrition service provision at ANC.

Supporting information

S1 Table. Definition of outcome and explanatory variables and data collection methods. (DOCX)

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References

1. Victora CG, Christian P, Vidaletti LP, Gatica-Domínguez G, Menon P, Black RE. Revisiting maternal and child undernutrition in low-income and middle-income countries: variable progress towards an unfinished agenda. The Lancet. 2021. https://doi.org/10.1016/S0140-6736(21)00394-9 PMID: 33691094
2. Christian P, Mullany LC, Hurley KM, Katz J, Black RE. Nutrition and maternal, neonatal, and child health. Seminars in perinatology. 2015; 39(5):361–72. https://doi.org/10.1053/j.semperi.2015.06.009 PMID: 26166560
3. National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. Bangladesh Demographic and Health Survey 2014. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT, Mitra and Associates, and ICF International, 2016.
4. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF. Bangladesh Demographic and Health Survey 2017–18: Key Indicators. Dhaka, Bangladesh, and Rockville, Maryland, USA: National Institute of Population Research and Training (NIPORT), ICF, 2019.
5. Arsenault JE, Yakes EA, Islam MM, Hossain MB, Ahmed T, Hotz C, et al. Very low adequacy of micronutrient intakes by young children and women in rural Bangladesh is primarily explained by low food intake and limited diversity. The Journal of nutrition. 2013; 143(2):197–203. https://doi.org/10.3945/jn.112.169524 PMID: 23256144
6. Abera SF, Kantelhardt EJ, Bezabih AM, Tsadik M, Lauvai J, Ejeta G, et al. What factors are associated with maternal undernutrition in eastern zone of Tigray, Ethiopia? Evidence for nutritional well-being of lactating mothers. BMC public health. 2020; 20(1):1–12.

7. Kuhnt J, Vollmer S. Antenatal care services and its implications for vital and health outcomes of children: evidence from 193 surveys in 69 low-income and middle-income countries. BMJ open. 2017; 7 (11):e017122. https://doi.org/10.1136/bmjopen-2017-017122 PMID: 29146636

8. Haileslassie K, Mulugeta A, Girma M. Feeding practices, nutritional status and associated factors of lactating women in Samre Woreda, South Eastern Zone of Tigray, Ethiopia. Nutrition journal. 2013; 12 (1):1–11. https://doi.org/10.1186/1475-2891-12-28 PMID: 23452646

9. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience: WHO; 2016.

10. GoB. 4th Health, Population and Nutrition Sector Programme (4th HPNSP), Operational Plan, National Nutrition Service (NNS) Institute of Public Health Nutrition, Directorate General of Health Service, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh, 2017.

11. Islam MM, Masud MS. Determinants of frequency and contents of antenatal care visits in Bangladesh: Assessing the extent of compliance with the WHO recommendations. PLoS One. 2018; 13(9): e0204752. https://doi.org/10.1371/journal.pone.0204752 PMID: 30261046

12. Nguyen PH, Khương LQ, Pramanik P, Billah SM, Menon P, Piwoz E, et al. Effective coverage of nutrition interventions across the continuum of care in Bangladesh: insights from nationwide cross-sectional household and health facility surveys. BMJ open. 2021; 11(1):e040109. https://doi.org/10.1136/bmjopen-2020-040109 PMID: 33472778

13. Billah SM, Saha KK, Khan ANS, Chowdhury AH, Garnett SP, Arifeen SE, et al. Quality of nutrition services in primary health care facilities: Implications for integrating nutrition into the health system in Bangladesh. PLoS One. 2017; 12(5):e0178121–e. https://doi.org/10.1371/journal.pone.0178121 PMID: 28542530.

14. Donabedian A. The quality of care: How can it be assessed? JAMA. 1988; 260(12):1743–8.

15. Afulani PA, Buback L, Essandoh F, Kinyua J, Kirumbi L, Cohen CR. Quality of antenatal care and associated factors in a rural county in Kenya: an assessment of service provision and experience dimensions. BMC health services research. 2019; 19(1):1–16.

16. Phommachanh S, Essink DR, Jansen M, Broerse JE, Wright P, Mayxay M. Improvement of Quality of Antenatal Care (ANC) Service Provision at the Public Health Facilities in Lao PDR: Perspective and Experiences of Supply and Demand Sides. BMC pregnancy and childbirth. 2019; 19(1):1–13.

17. Kanyangarara M, Munos MK, Walker N. Quality of antenatal care service provision in health facilities across sub–Saharan Africa: Evidence from nationally representative health facility assessments. Journal of global health. 2017; 7(2). PMID: 29163936

18. Emiru AA, Alene G, Debelew GT. Women's satisfaction with the quality of antenatal care services rendered at public health facilities in Northwest Ethiopia: the application of partial proportional odds model. BMJ open. 2020; 10(9):e037085. https://doi.org/10.1136/bmjopen-2020-037085 PMID: 32948558

19. Wynne SJ, Duarte R, de Wildt G, Meza G, Merriel A. The timing and quality of antenatal care received by women attending a primary care centre in Iquitos, Peru: A facility exit survey. PLoS One. 2020; 15 (3):e0229852. https://doi.org/10.1371/journal.pone.0229852 PMID: 32134987

20. Singh L, Dubey R, Singh S, Goel R, Nair S, Singh P. Measuring quality of antenatal care: a secondary analysis of national survey data from India. BJOG: An International Journal of Obstetrics & Gynaecology. 2019; 126:7–13. https://doi.org/10.1111/1471-0528.15825 PMID: 31127680

21. Bintabara D, Nakamura K, Ntwenya J, Seino K, Mpondo BC. Adherence to standards of first-visit antenatal care among providers: A stratified analysis of Tanzanian facility-based survey for improving quality of antenatal care. PLoS One. 2019; 14(5):e0216520. https://doi.org/10.1371/journal.pone.0216520 PMID: 31083696

22. Amoakoh-Coleman M, Agyepong IA, Zuithoff NP, Kayode GA, Grobbee DE, Klipstein-Grobusch K, et al. Client factors affect provider adherence to clinical guidelines during first antenatal care. PLoS One. 2016; 11(6):e0157542. https://doi.org/10.1371/journal.pone.0157542 PMID: 27322643

23. Goudet S, Murira Z, Torlesse H, Hatchard J, Busch-Hallen J. Effectiveness of programme approaches to improve the coverage of maternal nutrition interventions in South Asia. Maternal & child nutrition. 2018; 14 Suppl 4(Suppl 4):e12699–e. https://doi.org/10.1111/mcn.12699 PMID: 30499258.

24. Billah SM, Arifeen SE. Evaluation of GoB, UNICEF, CIFF initiative to facilitate and accelerate implementation of the Bangladesh National Nutrition Services Registry for International Development for Impact Evaluations (RIDIE), 10.23846/ridie0902016. https://ridie.3ieimpact.org/index.php?r=search/detailView&id=415.

25. Billah SM, Khan ANS, Raihana S, Rahman M, Salam SS, Arifeen SE, et al. Evaluation of Accelerating Implementation of the Bangladesh National Nutrition Services: Initial Assessment 2016. 2016.

26. Campbell SM, Roland MO, Buetow SA. Defining quality of care. Social science & medicine. 2000; 51 (11):1611–25. https://doi.org/10.1016/s0277-9536(00)00057-5 PMID: 11072882

27. Bruce J. Fundamental elements of the quality of care: a simple framework. Studies in family planning. 1990; 21(2):61–91. PMID: 2191476

28. NIPORT, ACPR, ICF International. Bangladesh Health Facility Survey 2014. Dhaka, Bangladesh: National Institute of Population Research and Training (NIPORT), Associates for Community and Population Research (ACPR) and ICF International, 2016.

29. MOH&FW. Maternal Health Standard Operating Procedure (SOP) Volume-1. Bangladesh: Ministry of Health and Family Welfare, 2015.

30. NIPORT, Mitra and Associates, and ICF International. Bangladesh Demographic and Health Survey 2014. Dhaka, Bangladesh, and Rockville, Maryland, USA:: National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International., 2016.

31. Owili PO, Muga MA, Mendez BR, Chen B. Quality of maternity care and its determinants along the continuum in Kenya: A structural equation modeling analysis. PLoS One. 2017; 12(5):e0177756. https://doi.org/10.1371/journal.pone.0177756 PMID: 28520771

32. Harris T, Yang Z, Hardin JW. Modeling underdispersed count data with generalized Poisson regression. The Stata Journal. 2012; 12(4):736–47.

33. Mansur AM, Rezaul KM, Mahmudul HM. Quality of antenatal care in primary health care centers of bangladesh. Journal of family & reproductive health. 2014; 8(4):175. PMID: 25530770

34. Rahman A, Nisha MK, Begum T, Ahmed S, Alam N, Anwar I. Trends, determinants and inequities of 4+ ANC utilisation in Bangladesh. Journal of Health, Population and Nutrition. 2017; 36(1):2.

35. Stelfox HT, Straus SE. Measuring quality of care: considering measurement frameworks and needs assessment to guide quality indicator development. Journal of clinical epidemiology. 2013; 66 (12):1320–7. https://doi.org/10.1016/j.jclinepi.2013.05.018 PMID: 24018344

36. Hoque DE, Arifeen SE, Rahman M, Chowdhury EK, Haque TM, Begum K, et al. Improving and sustaining quality of child health care through IMCI training and supervision: experience from rural Bangladesh. Health Policy Plan. 2014; 29(6):753–62. https://doi.org/10.1093/heapol/czt059 PMID: 24038076

37. Organization WH. Bangladesh health system review: Manila: WHO Regional Office for the Western Pacific; 2015.

38. Joarder T, Tune SNBK, Nuruzzaman M, Alam S, de Oliveira Cruz V, Zapata T. Assessment of staffing needs for physicians and nurses at Upazila health complexes in Bangladesh using WHO workload indicators of staffing need (WISN) method. BMJ Open. 2020; 10(2):e035183. https://doi.org/10.1136/bmjopen-2019-035183 PMID: 32060164

39. Saha KK, Billah M, Menon P, El Arifeen S, Mbuya NV. Bangladesh National Nutrition Services: Assessment of Implementation Status: World Bank Publications; 2015.

40. World Health Organization. Standards for improving quality of maternal and newborn care in health facilities. Switzerland: WHO, 2016 9241511214.

41. Gross K, Schellenberg JA, Kessy F, Pfeiffer C, Obrist B. Antenatal care in practice: an exploratory study in antenatal care clinics in the Kilombero Valley, south-eastern Tanzania. BMC pregnancy and childbirth. 2011; 11(1):1–11. https://doi.org/10.1186/1471-2393-11-36 PMID: 21599900

42. Jennings L, Yebadokpo AS, Affo J, Agbogbe M. Antenatal counseling in maternal and newborn care: use of job aids to improve health worker performance and maternal understanding in Benin. BMC pregnancy and childbirth. 2010; 10(1):1–13. https://doi.org/10.1186/1471-2393-10-75 PMID: 21092183

43. Omer AM, Haile D, Shikur B, Macarayan ER, Hagos S. Effectiveness of a nutrition education and counselling training package on antenatal care: a cluster randomized controlled trial in Addis Ababa. Health Policy Plan. 2020; 35(Supplement_1):i65–i75. https://doi.org/10.1093/heapol/czaa101 PMID: 33165586.

44. Ajeani J, Mangwi Ayiasi R, Tetui M, Ekirapa-Kiracho E, Namazzi G, Muhumuza Kananura R, et al. A cascade model of mentorship for frontline health workers in rural health facilities in Eastern Uganda: processes, achievements and lessons. Global health action. 2017; 10(sup4):1345497. https://doi.org/10.1080/16549716.2017.1345497 PMID: 28816629

45. Karuga RN, Mireku M, Muturi N, McCollum R, Vallieres F, Kumar M, et al. Supportive supervision of close-to-community providers of health care: Findings from action research conducted in two counties in Kenya. PLoS One. 2019; 14(5):e0216444. https://doi.org/10.1371/journal.pone.0216444 PMID: 31141509

46. Berehe TT, Modibia LM. Assessment of Quality of Antenatal Care Services and Its Determinant Factors in Public Health Facilities of Hossana Town, Hadiya Zone, Southern Ethiopia: A Longitudinal Study. Advances in Public Health. 2020; 2020:NA-NA.

47. Alam A, Rasheed S, Khan NU, Sharmin T, Huda TM, Arifeen SE, et al. How can formative research inform the design of an iron-folic acid supplementation intervention starting in first trimester of pregnancy in Bangladesh? 2015; 15(1):374.

48. Siekmans K, Roche M, Kung'u JK, Desrochers RE, De-Regil LMJM, nutrition c. Barriers and enablers for iron folic acid (IFA) supplementation in pregnant women. 2018; 14:e12532. https://doi.org/10.1111/mcn.12532 PMID: 29271115

49. Di Renzo GC, Spano F, Giardina I, Brillo E, Clerici G, Roura LC. Iron deficiency anemia in pregnancy. Women's Health. 2015; 11(6):891–900. https://doi.org/10.2217/whe.15.35 PMID: 26472066

50. Oswald D, Sherratt F, Smith S. Handling the Hawthorne effect: The challenges surrounding a participant observer. Review of social studies. 2014; 1(1):53–73.

Supporting information

S1 Table: Definition of outcome and explanatory variables and data collection methods

Variable type	Variable	Items/measurements included	Data collection methods
Outcome variable			
	Quality nutrition service at ANC: Summative score with equal weight of each item (0-4)	• Weight assessed • Anaemia measured • Provided iron-folic acid supplement • Provided nutrition counselling	Structured observation of the ANC consultation
Independent variables			
Facility level			
Facility characteristics and readiness	Type of facility	Type of facility	Structured health facility assessment
	Infrastructural readiness: (1=All five items available)	Availability of: • Examination room/area • Arrangement for privacy • Examination bed • Electricity • Functioning toilet for clients	
	Logistics and supplies: Principal component analysis score of seven items divided into quantile level 1 (low), level 2 (medium), level 3 (good), level 4 (best).	Availability of -Weighing scale -Haemoglobin testing tool (tallquist book) -IFA supplement -health education materials/visual aids -ANC card -ANC guideline -ANC register	
Facility utilization	• ANC service utilization	• Average number of ANC clients per day	
Provider level			
Provider characteristic	• Type of provider • Age • Sex • Duration of work	• Provider's designation • Age in years • Sex • Years of service at the facility	Interview of health care providers with a structured questionnaire
Training and knowledge of health care providers	• Training on nutrition	• Provider received in-service training on nutrition	
	• Knowledge on nutrition services to be provided during ANC: Summative score of four items (Score= 0-6)	• IFA supplementation (score=1) • Diagnosis and management of anaemia (score=1 • Measurement of weight and height (score =1) • Dietary counselling (score 3) - protein intake - green and leafy vegetables - seasonal fruits	
	• External supervision	• Service provider received external supervision in last six months	

Variable type	**Variable**	**Items/measurements included**	**Data collection methods**
Provider-client interaction	• Provider-client interaction: Two indicators were considered individually	• HCP-client communication: services provider informed the client about the progress of the pregnancy or service provider asked if the client had any question	Structured observation of the ANC consultation
		• Service provider used poster, pamphlet, booklets, visual aids or ANC card	
Client-level			
Client characteristics	Background characteristics of the clients: Four indicators were considered individually	• Age in years	Exit interviews of the clients (pregnant women)
		• Education in years	
		• Gestational age in weeks	
		• Number of ANC visit	

ANC: antenatal care, IFA: iron and folic acid

Chapter 4: Promoting iron and folic acid supplementation

Paper 2: Iron and Folic Acid Supplementation in Pregnancy: Findings from the Baseline Assessment of a Maternal Nutrition Service Programme in Bangladesh

Clarification: The statement in the introduction "The 2021 Lancet nutrition series also supports antenatal IFA and multiple micronutrient supplements as priority nutrition interventions during the "first 1000 days of life" refers to providing either IFA or multiple micronutrient supplements to pregnant women.

nutrients

Article

Iron and Folic Acid Supplementation in Pregnancy: Findings from the Baseline Assessment of a Maternal Nutrition Service Programme in Bangladesh

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Abstract: Effective coverage of antenatal iron and folic acid (IFA) supplementation is important to prevent adverse maternal and newborn health outcomes. We interviewed 2572 women from two rural districts in Bangladesh who had a live birth in the preceding six months. We analysed the number of IFA tablets received and consumed during pregnancy and examined the factors influencing IFA consumption by multiple linear regression and user adherence-adjusted effective coverage of IFA (consuming ≥180 IFA tablets) by Poisson regression. Overall, about 80% of women consumed IFA supplements in any quantity. About 76% of women received antenatal care at least once, only 8% received ≥180 IFA tablets, and 6% had user adherence-adjusted coverage of antenatal IFA supplementation. Multivariable analysis showed a linear relationship between the number of antenatal care (ANC) visits and the number of IFA supplements consumed, which was modified by the timing of the first ANC visit. Women's education, free IFA, and advice on IFA were also associated with higher IFA consumption. Interventions targeting at least eight ANC contacts, starting early in pregnancy, providing advice on the importance of IFA, and providing IFA supplements in higher quantity at ANC contacts are likely to increase effective coverage of antenatal IFA supplementation.

Keywords: iron and folic acid; supplement; maternal anaemia; pregnancy; effective coverage; antenatal care; Bangladesh

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1. Introduction

Anaemia in pregnancy remains a global public health concern affecting nearly 35 million women and is the most prevalent in South Asia [1,2]. The 2020 global nutrition reported that all 194 countries are currently "off course" to achieve the 2025 target of a 50% reduction of anaemia in women of reproductive age [1]. Iron deficiency is the biggest contributor to anaemia in pregnancy, adversely affecting maternal, foetal, and newborn health and survival [3–5]. Iron deficiency anaemia in pregnancy also has detrimental longer-term outcomes on the child's neurodevelopment and risk of intellectual disability

[6]. The national estimate of pregnancy anaemia in Bangladesh suggests that nearly half of women were anaemic [7]. A recent study in Tangail, a rural district of Bangladesh, identified a 48% prevalence of anaemia in pregnant women [8]. According to the national estimate, the prevalence of anaemia in women was higher in rural areas (45%) than in urban areas (36%) [7].

Daily oral supplementation of a combination of iron and folic acid (IFA) is the most cost-effective intervention to reduce iron deficiency anaemia in pregnancy, prevent adverse maternal and perinatal outcomes, and improve infants' linear growth [9,10]. WHO recommends a universal daily supplementation of IFA (30–60 mg elemental iron and 0.4mg folic acid) for at least 180 days during pregnancy [11]. A 2020 update of the recommendations on antenatal care interventions included context-specific supplementation of multiple micronutrient supplements, including iron and folic acid [12]. The 2021 Lancet nutrition series also supports antenatal IFA and multiple micronutrient supplements as priority nutrition interventions during the "first 1000 days of life" [13,14].

In 2001, the government of Bangladesh adopted universal daily oral supplementation of IFA (60 mg elemental iron and 0.4 mg folic acid) for pregnant women, starting from pregnancy detection until birth. It has continued to reinforce IFA's importance and improvement of coverage in national policy, strategy, and action plans [15–18]. The current National Nutrition Services Operation Plan of the fourth sector program further emphasised improving effective coverage of IFA supplementation (compliance to recommend ≥180 IFA tablets) during pregnancy [19]. Based on the latest recommendation by WHO, the National Nutrition Service has initiated a maternal nutrition demonstration programme to identify implementation strategies for multiple micronutrient supplements with 30 mg elemental iron and 0.4mg folic acid through antenatal care services at public facilities [20]. In Bangladesh, pregnant women can receive IFA supplements (tablets) at antenatal care contacts at public health facilities, receive or purchase IFA during private ANC or home visits by community health workers, or purchase IFA from pharmacies over the counter [21,22]. Although widely available and relatively cheap, coverage and adherence to IFA supplementation in pregnancy have been poor [23,24]. The latest national estimate suggested ~74% crude coverage of antenatal IFA supplementation (consumed IFA of any quantity) but only 46% of women consumed ≥90 IFA tablets [25].

Effective coverage of antenatal IFA supplementation is essential to achieve its expected benefits on maternal and child health [26]. Recent frameworks for measuring the effective coverage of health and nutrition interventions provide a cascade-based framework, extending the traditional measurement of crude coverage to input, quality, user adherence, and outcome-adjusted coverage [26,27]. Effective coverage of antenatal IFA supplementation is usually measured by user adherence-adjusted coverage, e.g., adherence to the recommended ≥180 IFA supplements during pregnancy [26]. However, the national survey in Bangladesh did not report adherence to the recommended minimum dose (≥180 IFA tablets). Some earlier studies qualitatively explored IFA supplementation policy, programmes, and barriers to IFA supplementation [21,22,28]. However, very few studies reported the factors influencing the coverage of antenatal IFA supplementation based on population-level data [29]. Nonetheless, no study has reported the number and sources of IFA supplements that women receive during pregnancy, which is important for programmatic inputs on where to intervene to address the coverage gap of IFA. In the baseline situation assessment for the National Nutrition Service's maternal nutrition demonstration programme, we explored three broad areas concerning antenatal IFA supplementation: (i) the source and consumption of IFA during pregnancy; (ii) faltering points for adherence to recommended IFA supplementation; (iii) factors influencing consumption of IFA and user adherence-adjusted effective coverage of IFA supplementation.

2. Materials and Methods

2.1. Setting and Study Design

We conducted the study in Kurigram and Bhola Districts, northern and southern districts of Bangladesh, respectively. Approximately four million people live in these two districts and have predominantly rural and agriculture-based livelihoods [30]. Both districts are below national averages in most maternal and child health service indicators [31].

The study is a randomised controlled trial to assess the effectiveness of a demonstration programme for improving coverage and quality of maternal nutrition services through the public health ANC platform. A detailed description of the trial design and interventions have been reported elsewhere [32]. In brief, in the cluster trial, we randomly assigned 40 unions (the lowest administrative units in Bangladesh) into intervention and control arms in a 1:1 allocation ratio. Each union's primary health care facilities usually consist of one union health and family welfare centre and two to three community clinics serving approximately 25,000–30,000 residents. The demonstration programme aims to strengthen three priority nutrition interventions delivered through ANC contacts. The interventions were appropriate dietary counselling, gestational weight gain monitoring, and introducing MMS with iron and folic acid instead of the existing IFA supplements, based on WHO's recent recommendation [12]. The programme emphasised improving health facility readiness to provide quality nutrition services at ANC by ensuing relevant logistics and equipment, improving health care provider's knowledge and skills, ensuring a consistent supply of MMS, and strengthening monitoring and supervision. A set of community-based demand creation strategies aimed to increase the utilisation of primary health care centres for ANC services. The control clusters had the usual practice of maternal nutrition interventions. The programme implementation started in June 2022. As part of the baseline situation analysis for the programme, we conducted a household survey to explore the existing practice and coverage of the priority maternal nutrition interventions, including receiving and consuming IFA supplements during pregnancy.

2.2. Sampling and Data collection

We interviewed women who had a pregnancy outcome within six months preceding the interview in the household survey. We selected the women by a multistage cluster sampling process. At first, in consultation with the National Nutrition Service, we purposively selected three subdistricts from each district where the demonstration programme will start in the first phase. Then, we selected 40 out of 60 available unions from the three subdistricts based on their similarity on a score created from population size, area, female literacy rate, sanitation coverage, availability of functioning primary health care facility, childhood immunisation coverage, and utilisation of public facilities for ANC and birth. We selected seven village clusters (sampling units) in the next stage, each of 250–300 households from each union following a probability proportional to size sampling approach. Finally, we identified and interviewed all (approximately ten on average) women who had a pregnancy outcome within six months in each selected cluster. Women who had a live birth outcome were included in the final analysis for this paper (Figure 1). Trained data collectors interviewed the selected women using a structured questionnaire developed based on the national demographic and health survey questionnaire [25]. We included questions on the number and source of IFA supplements received during pregnancy to the existing questions on the consumption of IFA supplements. We completed the survey between September and December 2020.

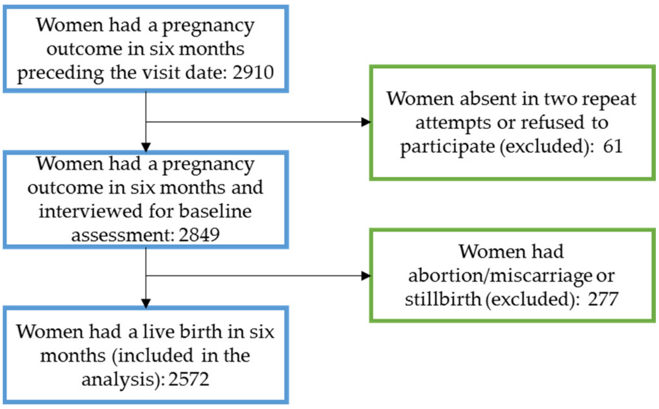

Figure 1. Participant flow diagram.

2.3. Outcome Variables

Outcome variables for this analysis were the total number of antenatal IFA supplements that women with a live birth outcome within six months before the interview had received and consumed. We asked the mothers to self-report the number of IFA tablets they received or purchased during pregnancy. We recorded the number of tablets they received or purchased during and outside the ANC contacts separately. Women also reported IFA sources in response to a multiple-answer question. Then, women were asked about the total number of IFA tablets they consumed during pregnancy. Following the effective coverage measurement cascade proposed by Marsh et al., [27] and Amouzou et al., [26], we created a binary outcome variable for user adherence-adjusted effective coverage of antenatal IFA supplementation if women consumed the recommended ≥180 IFA tablets during pregnancy (yes = 1, no = 0). We also conducted a modified falter point estimate of IFA supplementation using the method developed by Fiedler and colleagues [24], which identifies the critical falter points in receiving and consuming the recommended ≥180 IFA tablets. Our framework expands the falter point schematics proposed by Fiedler and colleagues and includes five sequential falter points [24]. The first falter point is women receiving ANC during pregnancy. The second falter point is women who received ANC or purchased IFA in any amount. The third falter point is women who received ANC, received or purchased, and consumed IFA in any amount. The fourth falter point is women who received ANC and received or purchased recommended ≥180 IFA, and the fifth falter point is women who received ANC and received/purchased and consumed ≥180 IFA.

2.4. Explanatory Factors

We used a conceptual framework (Figure 2) to explore the factors associated with receiving and consuming antenatal IFA supplements based on Andersen’s Behavioral Model of health care utilisation and Siekmans et al.,’s framework for IFA supplementation [21,33]. A modified version of Andersen’s model underpinned the theoretical framework for explaining health-seeking behaviour, including antenatal health care utilisation in several studies in low-income countries [34,35]. We relied on the versions of the model proposed to explain ANC care-seeking for its relevance to antenatal IFA supplementation [35–37]. Our adapted conceptual framework includes three broad domains of factors, predisposing, enabling, and need factors, that influenced the receipt and consumption of antenatal IFA in previous studies from similar settings [23,29,38–42]. We also considered the barriers and enablers of IFA supplementation identified by Siekmans et al., in their conceptual framework [33]. We examined maternal background characteristics such as the mother’s age, education, engagement income earnings, and religion as predisposing factors. Enabling factors consisted of maternal background characteristics such as household wealth and mother’s exposure to print or electronic media, exposure to antenatal healthcare services such as the number of antenatal visits, receiving advice on IFA during pregnancy, receiving IFA free of cost, and relying only on ANC platforms for IFA. We included maternal obstetric characteristics such as birth order, previous history of pregnancy loss and complications during pregnancy, and perceived need for antenatal healthcare, i.e., the timing of the first ANC visit, as the need factors in the conceptual model. We also considered the two districts from the two geographical regions as the external environmental factor.

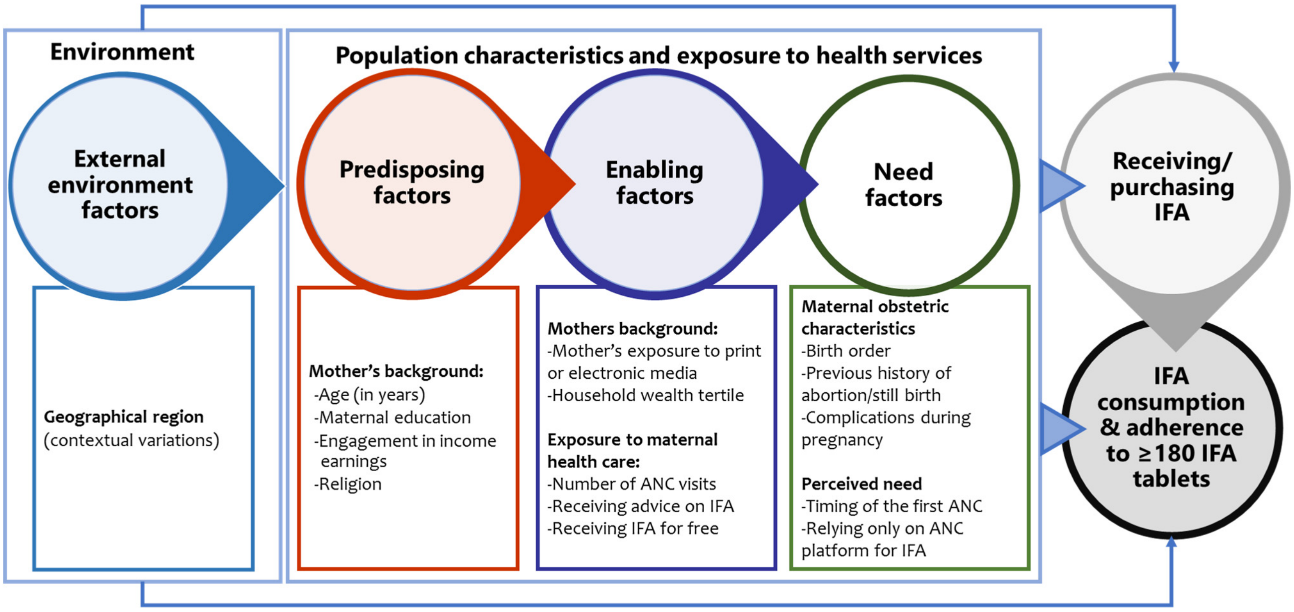

Figure 2. Conceptual diagram of factors influencing receiving and consumption of IFA based on Andersen's Behavioral Model of health care utilisation and Siekmans et al.,'s framework for IFA supplementation [21,33]. ANC – antenatal care, IFA – iron and folic acid.

2.5. Statistical Analysis

We used descriptive statistics to analyse and report the participant's background, obstetric characteristics, and antenatal care-seeking practices. We summarised the number of IFA tablets received, platforms and sources, and the number of IFA tablets consumed during pregnancy by descriptive statistics such as mean(±SD) and proportions for continuous and categorical variables, respectively. We used simple linear regressions to explore the unadjusted associations between the number of IFA received, the number of IFA consumed, and the potential predisposing, enabling, need factors, and external environment indicators included in the conceptual framework (Figure 2).

We checked the linearity assumptions before fitting the linear regressions with continuous independent variables. We added factors associated with the outcomes at a p-value <0.2 in the multiple linear regression models. We tested for interaction between the number of ANC visits and the timing of the first ANC and included an interaction term in the final model. We compared Akaike Information Criteria (AIC) between models with the number of ANC as continuous and categorical variables. We reported mean difference and adjusted mean difference and their 95% confidence interval (CI) from simple and multiple linear regressions, respectively. A p-value <0.05 in the multiple regression models indicated a statistically significant association.

We fitted simple and multiple Poisson regressions for exploring factors associated with user adherence-adjusted coverage of antenatal IFA (consumption of ≥180 tablets) due to its advantage of providing an unbiased estimate of risk ratio (RR) [43]. We reported unadjusted RR and adjusted RR (aRR) for user adherence-adjusted coverage of IFA and their 95% CI from respective Poisson models. Finally, from the multiple Poisson regression, we estimated the expected user adherence-adjusted coverage of IFA in three hypothetical ideal scenarios of universal coverage of programmatically modifiable antenatal healthcare interventions using the "punaf" post-estimation command [44]. Hypothetical scenarios were: (i) all women received four or more ANC visits plus first ANC early (≤4 gestational months in pregnancy), (ii) all women received four or more ANC visits plus first ANC early plus advice on IFA during pregnancy, (iii) all women received eight or more ANC visits plus first ANC early plus advice on IFA during pregnancy. We used Stata (14, StataCorp LLC, College Station, TX, USA) for the analyses and adjusted the multi-stage cluster sampling survey design using the "svyset" command in all analyses [45].

3. Results

We interviewed 2572 women who had a live birth six months before the interview. Most mothers (73%) were less than 30 years old and 47% had completed secondary level education (Table 1). Nearly all women (98%) were not in formal employment and about a quarter (26%) had exposure to print or electronic media at least once a week. A little more than a third of the women (37%) were primiparous and 13% had a previous history of pregnancy loss. About a quarter of women received ANC four or more times during pregnancy (26%) and more than one-third (39%) had the first ANC within four months of gestational age.

Table 1. Socio-demographic and obstetric characteristics and antenatal care-seeking practices among 2572 women who had a live birth in the six months preceding the interview.

Background Characteristics	Weighted * n	Weighted %
Region		
North (Kurigram)	762	29.6
South (Bhola)	1810	70.4
Mother's age		
<20	462	18.0
20–29	1409	54.8
30 or more	701	27.2
Mother's education		
Up to primary	1031	40.1
Secondary	1201	46.7
Higher secondary and above	340	13.2
Religion		
Muslim	2485	96.6
Others	87	3.4
Mother's employment status		
Employed	65	2.5
Unemployed	2507	97.5
Household Wealth index (tertile)		
Poor	794	30.8
Middle	854	33.2
Rich	925	36.0
Mother's exposure to print or electronic media (at least once a week)		
No	1905	74.0
Yes	667	26.0
Birth Order of the last child		
1	955	37.1
2	793	30.8

Background Characteristics	Weighted * n	Weighted %
3 or more	825	32.1
History of abortion/stillbirth before this pregnancy		
No	2235	86.9
Yes	337	13.1
Women who had reported complication(s) during pregnancy		
No	1948	75.8
Yes	624	24.2
Number of ANC visits		
No ANC	621	24.2
1–3	1289	50.1
4 or more	662	25.7
Timing of first ANC (N = 1951)		
Early (≤4 months gestational age)	754	38.6
Late (≥5 months gestational age)	1197	61.4

* Weighting adjustment for multi-stage cluster sampling, ANC—antenatal care.

Overall, 19% of women did not receive or purchase IFA supplements during pregnancy (Table 2). On average, women received or purchased 75 (±62) IFA tablets. Among those who received or purchased IFA supplements in any quantity, 46% received or purchased it only during ANC visits, while 22% from both ANC visits and other sources. The mean (±SD) number of tablets received at each ANC visit was 17 (±15). Of those who received or purchased IFA, approximately equal proportions received IFA supplements from public and private health facilities, 57% and 53%, respectively, while 38% purchased IFA from the pharmacy. On average, women consumed 62 (±58) IFA supplements during pregnancy and one in five women did not consume any IFA supplement.

Table 2. Women receiving IFA supplements during pregnancy by number of supplements, service delivery platform and source, and consumed IFA supplements.

Indicators	Weighted n	Weighted Mean [±SD] or % (95% CI) [a]
IFA supplements received		
Mean (±SD) number of IFA supplements received	2572	75 [±62]
Number of IFA supplements by pregnant women		
None	477	18.6 (16.3, 21.1)
1–89	1049	40.8 (38.2, 43.4)
90–179	805	31.3 (28.7, 34.0)
180 or more	242	9.4 (7.9, 11.2)
Platforms for receiving/purchasing IFA supplements	2095	
Only at ANC	956	45.7 (41.9, 49.5)
Only outside ANC	677	32.3 (28.6, 36.3)
Both at ANC and outside ANC	461	22.0 (19.4, 24.9)
Mean (±SD) IFA received at each ANC contact	1958	17 [±15]
Source of IFA supplements (multiple responses)	2095	
Home	428	20.4 (18.0, 23.1)
Public health facilities	1188	56.7 (53.4, 60.0)
Private hospital/doctor	1107	52.8 (49.0, 56.6)
Pharmacy/drug shop	796	38.0 (34.5, 41.6)
NGO health facility	63	3.0 (2.2, 4.2)
Others	43	2.0 (1.4, 3.0)

IFA supplements consumed		
Mean (±SD) number of IFA supplements consumed	2572	62 [±58]
Number of IFA supplements consumed		
None	527	20.5 (18.2, 23.0)
1–89	1205	46.8 (44.2, 49.5)
90–179	663	25.8 (23.2, 28.6)
180 or more	178	6.9 (5.8, 8.3)

SD— standard deviation, IFA – iron and folic acid, ANC—antenatal care, NGO- Non-Government Organisation; [a] weighted % if not mentioned otherwise in the row.

We examined coverage of IFA supplements among women receiving ANC using a falter point analysis. Of all women interviewed, 24% did not receive any ANC during pregnancy (Figure 3). About 69% of women received at least one ANC check-up and IFA supplements in any quantity, resulting in a 7% additional faltering of IFA coverage. A similar proportion (67%) of women received ANC and consumed any IFA. The largest gap (61 percentage points) was between receiving any IFA and adequate (≥180 tablets) IFA supplements. Only 6% of women received ANC and consumed the recommended ≥180 IFA tablets. Consumption of received supplements was higher ($p < 0.001$) if women had received a higher number of supplements, for example, women who received ≤90 IFA tablets consumed 81% of the received tablets, while women who received ≥180 IFA tablets consumed 90% of the received tablets.

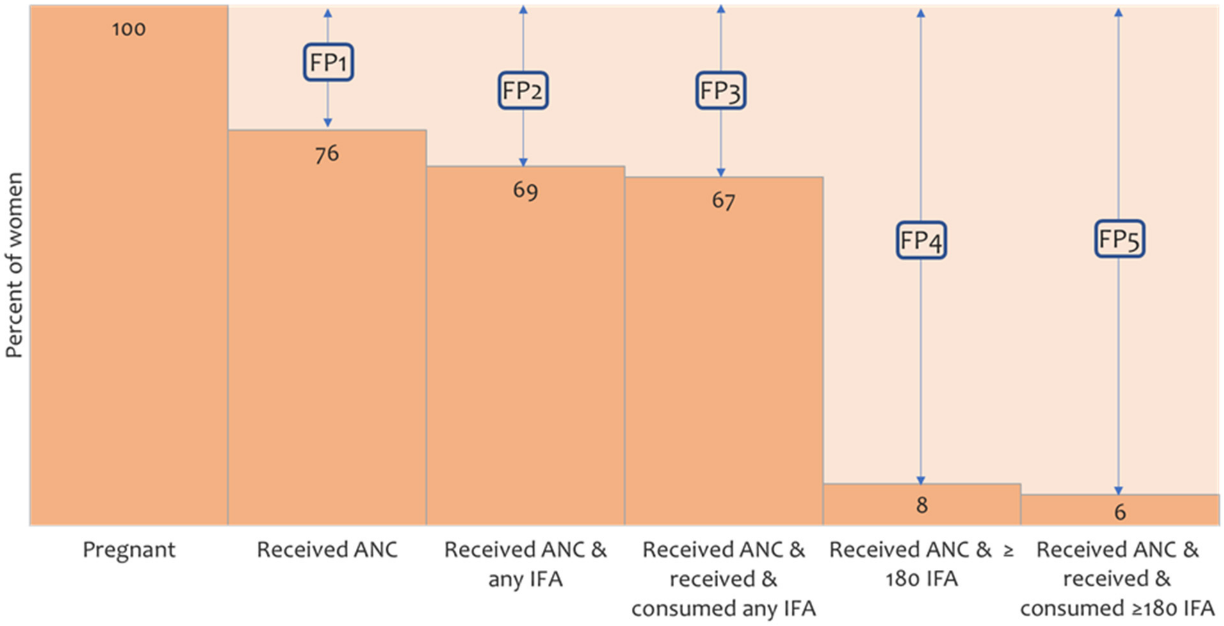

Figure 3. The five falter points (FP) in user adherence-adjusted coverage of IFA supplementation (consumption of ≥180 IFA). FP1—falter in receiving ANC, FP2—falter in receiving any IFA, FP3—falter in consuming any IFA, FP4—falter in receiving adequate IFA (≥180 tablets), FP5—falter in consuming adequate IFA. ANC—antenatal care, IFA – iron and folic acid.

Maternal education was associated with the number of IFA supplements consumed during pregnancy (Table 3). On average, women who had higher secondary schooling (≥10 years) and above consumed 24 more supplements (95% CI: 16, 32), and women with secondary education consumed 6 more supplements (95% CI: 1, 11) compared with women who had education up to the primary level. In the multivariable model, women's age, employment, exposure to mass media, and socio-economic status were not associated with the number of IFA supplements consumed during pregnancy. Obstetric characteristics like birth order of the child and history of previous pregnancy loss also had no association with the number of IFA supplements consumed. However, women who reported pregnancy complications consumed an average of eight tablets (95% CI: -13, -2) less than those who did not have pregnancy complications after adjusting for all other variables in the model. Exposure to maternal health care interventions during pregnancy was strongly associated with antenatal IFA supplement consumption. We found a linear relationship between the number of ANC visits and the number of IFA supplements consumed. This association was modified by the timing of the first ANC visit ($p < 0.01$). Participants who attended ANC services on or before four months of gestational age consumed 14 more IFA tablets (95% CI: 12, 17) for every additional ANC contact. In contrast, women who started ANC on or after five months of gestational age consumed an average of 10 extra IFA tablets (95% CI: 8, 12) for every additional ANC contact. Receiving advice on IFA supplements resulted in women consuming 31 more IFA tablets (95% CI: 24, 38) compared with those who did not receive such advice. Women receiving free IFA supplements had a higher consumption of IFA supplements (14 tablets, 95% CI: 9, 19) than those who did not receive free IFA. However, relying on the ANC service only for IFA supplements resulted in a lower mean consumption of IFA by 39 tablets (95% CI: -45, -33). We found similar associations between background and antenatal care-seeking characteristics and the number of IFA supplements received during pregnancy (Supplement Table S1). However, in contrast to the number of IFA supplements consumed, we did not find any association between maternal pregnancy complications and the number of IFA supplements received during pregnancy.

Table 3. Factors associated with the number of IFA supplements consumed.

Variables	**N (Weighted)**	**Number of IFA Consumed**		
	2572	**Mean (±SD)**	**Mean Difference (95% CI)**	**Adjusted Mean Difference (95% CI)**
Region/area				
North (Kurigram)	762	71.7 (±82.1)	Ref	Ref
South (Bhola)	1810	58.1 (±46.2)	-13.5 (-20.9, -6.2)	2.2 (-3.2, 7.6)
Mother's age				
<20	462	64.2 (±56.3)	Ref	Ref
20-29	1409	65.4(±57.3)	1.3 (-5.5, 8.0)	6.0 (-0.0, 12.1)
30 or more	701	54.1(±58.6)	-10.0 (-17.3, -2.8)	3.4 (-4.04, 11.9)
Mother's education				
Up to primary	1031	46.7 (±50.6)	Ref	Ref
Secondary	1201	65.7 (±57.3)	19.0 (13.9, 24.1)	6.0 (1.2, 10.8)
Higher secondary and above	340	96.2 (±62.2)	49.4 (39.5, 59.3)	23.6 (15.8, 31.5)
Religion				
Muslim	2485	61.5 (±57.5)	Ref	Ref
Other	87	80.8(±59.7)	19.3 (5.3, 33.2)	9.2 (-1.8, 20.1)
Work involvement				
Not employed	2507	61.8 (±57.4)	Ref	Ref
Employed	65	74.9 (±69.9)	13.1 (-4.0, 30.3)	6.5 (-8.3, 21.3)
Household Wealth (tertile)				
Poor	794	53.5 (±56.8)	Ref	Ref
Middle	854	56.6 (±54.9)	3.1 (-4.1, 10.2)	1.5 (-4.2, 7.2)
Rich	925	74.6 (±58.5)	21.1 (13.9, 28.3)	3.0 (-3.4, 9.4)
Mother's exposure to print or electronic media (at least once a week)				
No	1905	58.0 (±54.1)	Ref	Ref
Yes	667	74.1 (±66.2)	16.1 (9.5, 22.7)	4.2 (-1.5, 9.9)
Birth Order of the last child				

1	955	72.3 (±57.7)	Ref	Ref
2	793	62.7 (±60.2)	-9.6 (-16.5, -2.7)	-4.5 (-10.0, 1.1)
3+	825	49.8 (±52.9)	-22.4 (-29.1, -15.7)	-5.2 (-12.7, 2.3)
Any history of abortion/stillbirth before this pregnancy				
No	2235	61.8 (±57.3)	Ref	**
Yes	337	64.3 (±60.6)	2.5 (-5.2, 10.3)	**
Women who had pregnancy complications				
No	1948	70.8 (±58.9)	Ref	Ref
Yes	624	66.2 (±53.8)	5.4 (-2.0, 12.7)	-7.8 (-13.0, -2.0)
Number of ANC and timing of first ANC				
Number of ANC visits among mothers who received none or started late (≥5 months GA) $^{\alpha}$	1818	19.2 (±28.5) $^{\alpha}$	11.2 (9.4, 13.0)	9.8 (7.8, 11.8)
Number of ANC visits among mothers who started early (≤4 months GA) $^{\alpha}$	754	25.7 (±20.3) $^{\alpha}$	14.4 (11.7, 17.1)	14.1 (11.5, 16.6)
Received advice on IFA				
No	1232	42.9 (±52.2)	Ref	Ref
Yes	1340	79.8 (±56.9)	36.9 (30.9, 43.0)	30.9 (24.2, 37.5)
Received IFA free				
No	1498	50.5 (±55.6)	Ref	Ref
Yes	1074	78.4(±56.5)	27.9 (22.2, 33.5)	14.1 (9.3, 18.8)
Received IFA only from ANC contacts				
No	1616	60.2 (±59.4)	Ref	Ref
Yes	956	65.4 (±53.1)	5.2 (-0.4, 10.8)	-39.2 (-45.0, -33.2)

SD — standard deviation, IFA – iron and folic acid, ANC— antenatal care, GA—gestational age; $^{\alpha}$ Mean(±SD) refers to the mean number of IFA consumed per ANC visit among women receiving the first ANC late (≥5 months of gestational age) and early (≤4 months of gestational age), **variable not included in the adjusted model.

Adherence to IFA consumption of the recommended dose (user adherence-adjusted coverage of IFA, consumption of ≥180 tablets) showed a stronger interaction effect between the number of ANC visits and the timing of the first ANC received by the women (Figure 4A, Supplement Table S2). The predicted proportion of user adherence-adjusted coverage showed no substantial change in up to three ANC contacts, irrespective of the timing of the first ANC. However, among women who started receiving ANC early, user adherence-adjusted coverage of IFA increased sharply with the number of ANC visits after four or more visits. Among women who began receiving ANC late, user adherence-adjusted coverage of IFA had no considerable increase beyond four or more ANC visits. The scenario-based analysis of expected user adherence-adjusted coverage of IFA assumed a hypothetical universal coverage of antenatal healthcare services. The analysis demonstrates that after adjusting for all other background and obstetric characteristics, if all women received four or more ANC visits and commenced ANC before five months of gestation, the estimated user adherence-adjusted coverage of IFA would be 16% (Figure 4B). If these women received advice on IFA and had four or more ANC contacts, user adherence-adjusted coverage would increase to 21%. Ensuring eight ANC contacts, starting ANC early, and receiving advice on IFA would result in 56% user adherence-adjusted coverage of IFA supplementation in pregnancy.

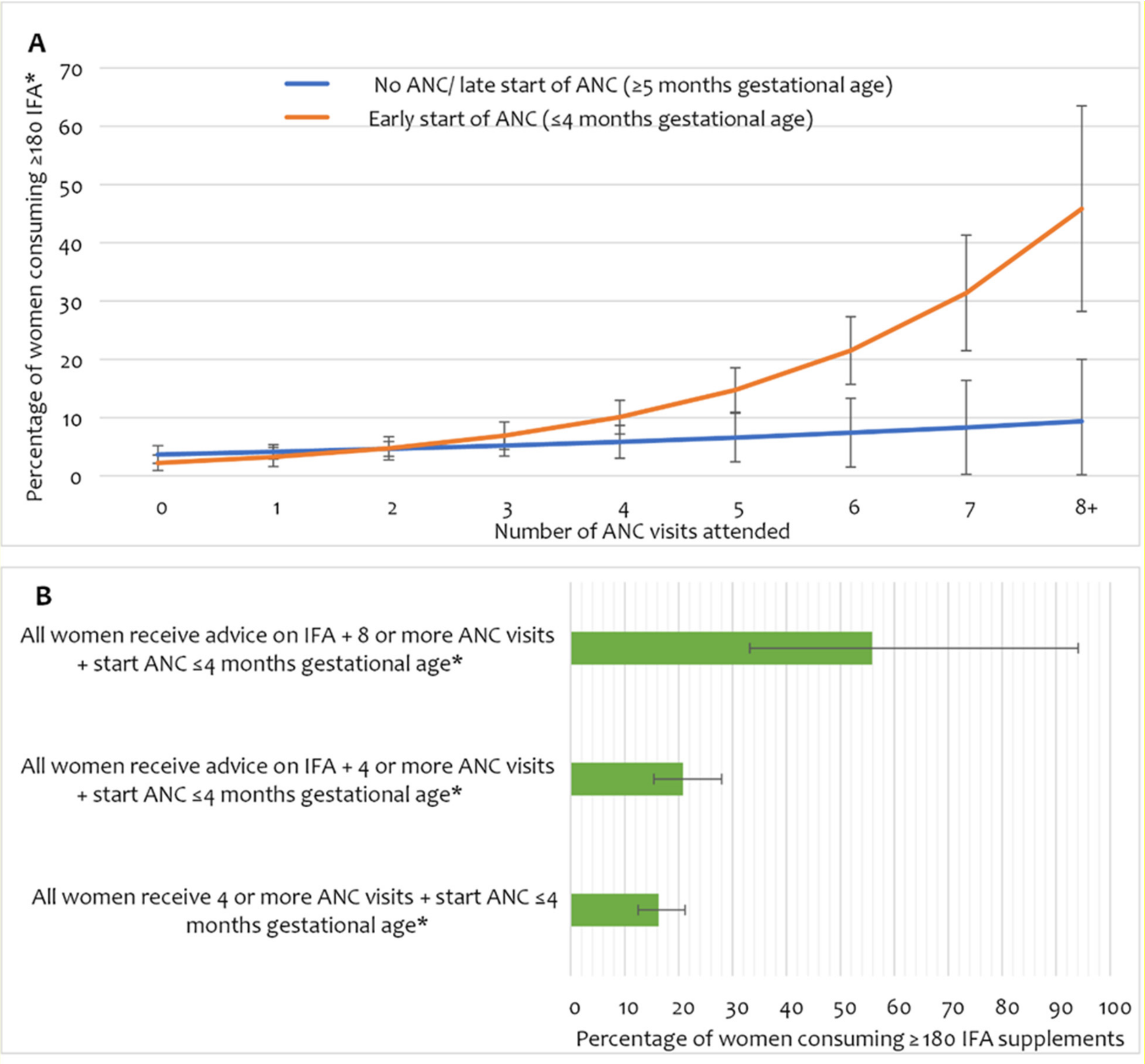

Figure 4. (**A**) User adherence-adjusted effective coverage of IFA supplementation (consuming ≥ 180 IFA) by the number of ANC and timing of first ANC, (**B**) scenario-based projections of user adherence-adjusted coverage of IFA assuming universal coverage of relevant antenatal interventions. * Adjusted for region/area, mother's education, wealth, exposure to mass media, birth order, receiving free IFA, and receiving IFA only from ANC contracts. IFA – iron and folic acid, ANC— antenatal care.

4. Discussion

Adherence to antenatal IFA supplementation is low in Bangladesh [29]. Our study reports the critical predisposing, enabling, and need factors of Andersen's Behavioral Model of healthcare utilisation that influence receiving and consuming antenatal IFA. We uniquely report the difference in the quantity of IFA supplements received and consumed during pregnancy. The user adherence-adjusted coverage of antenatal IFA supplementation is positively associated with the number of ANC visits, early start of ANC, and receiving advice on IFA. Our modified falter point analysis of IFA coverage fills the data gap on the consumption of adequate ≥180 IFA supplements in the previous analysis [46]. Lastly, our scenario-based projections provide important programmatic decision inputs such as promoting early start and multiple ANC contacts and providing women with advice on IFA at ANC for improving the user adherence-adjusted coverage of antenatal IFA supplementation.

About one in five women did not consume any IFA, which approximates recent estimates from the same geographic regions [25]. We found most women consumed <90 IFA tablets, while previous estimates reported that most women consumed ≥90 tablets [25,29]. The large within-country geographic variations in IFA coverage and the population covered in the previous studies explains this difference [25,47]. Moreover, disruption of antenatal care seeking due to COVID-19 lockdown from late March to May 2020 may have also impacted the total number of IFA supplements received and consumed during pregnancy [48].

Low consumption of adequate IFA tablets is consistent with previous findings from Bangladesh and other low- and middle-income countries [24,29]. Our modified falter point analysis showed that consumption of any IFA was high, and consumption of adequate doses (≥180 tablets) accounted for the largest falter point [24]. Likewise, we did not find an overall difference between receiving and consuming IFA [24]. Our analysis closed the gap in previous research and identified that not receiving or purchasing an adequate number of tablets resulted in low consumption of a sufficient number of IFA supplements. Studies from other South Asian settings, including the supply-side factors of IFA adherence, also indicated that not receiving IFA was a key reason for non-adherence to adequate IFA during pregnancy [21,49]. We found a higher difference between the number of tablets received and consumed among women who received a lower number of tablets (<90). This finding can be explained by the perceived side-effects such as nausea, vomiting, metallic taste, dark stool colour, and constipation that women experience, leading to non-adherence to adequate consumption [41,49–51]. We also demonstrated an independent negative association between pregnancy complications and the number of IFA supplements consumed. It is likely that the women who did not face and/or were aware of the side effects of IFA, understood the importance of adequate IFA, received/purchased more tablets repeatedly, and consumed them [21,24].

Consistent with the findings in several previous studies, maternal education was a strong predictor for higher and user adherence-adjusted coverage of IFA supplementation [38,42,52,53]. Women with a higher education are more likely to receive and understand messages on anaemia and IFA, perceive the importance of adequate IFA, understand the health care provider’s advice, read package labelling, and are less affected by the perceived side effects [54]. Educated mothers may also have fewer perceived barriers and misconceptions that are common in the community, for example, consumption of “many” IFA tablets leads to oversized babies with more pregnancy complications and need caesarean section births [22]. Educated mothers are also more likely to have higher autonomy in healthcare decision making, influence over household expenditure, and receive their husbands’ support, which is associated with better adherence to adequate IFA consumption [29,55]. In contrast to previous studies in other low- and middle-income countries, we did not find that a higher maternal household wealth status was associated with receiving and consuming IFA during pregnancy [38,39,42,56]. However, a previous study in Bangladesh reported similar findings [29]. One likely explanation for this is women receive free IFA from public facilities and the cost of purchasing IFA from private sector sources is affordable [21,22,57].

The number of IFA received and consumed and the user adherence-adjusted coverage of IFA were strongly associated with the number of ANC services received. These findings are consistent with the prior evidence [23,24,29,38,42,58]. Our analysis also showed that ANC contacts were the most utilised platform for accessing IFA supplements. Similar to our findings, a study in India also found the timing of the first ANC visit modified the positive association between the number of ANC visits and adherence to adequate IFA consumption during pregnancy [58]. Women who started ANC early are more likely to receive multiple ANC visits and information on IFA, receive or purchase more tablets from multiple visits, and adhere to adequate IFA consumption [54]. In contrast, women who commence ANC late in pregnancy do not have sufficient time to consume ≥180 tablets. Further, the recommendations for starting IFA supplementation in the first trimester in maternal care standard operating procedures and management guidelines for iron deficiency anaemia in Bangladesh are inconsistent [59–61].

Women who received IFA only from ANC were less likely to consume an adequate dose. One possible reason is that women are given approximately 20-30 tablets at each ANC visit; they would require multiple visits to receive recommended ≥180 tablets [21,24]. However, only a quarter of the women received four or more ANC visits in our study population. The limited number of IFA tablets provided at each ANC also explains the sharp increase of user adherence-adjusted coverage tablets beyond five or more ANC visits among women who started receiving ANC early. Previous formative research studies in Bangladesh also identified that insufficient and interrupted supply and provision of IFA during ANC at public facilities are important bottlenecks in adequate IFA consumption during pregnancy [21,28]. Several previous studies also support our finding that receiving counselling and information on the importance, recommended number/days, and side effects of IFA during pregnancy influence user adherence to adequate IFA consumption [23,29,40–42,54,58]. Receiving counselling or information on IFA may have improved the adherence leading to adequate consumption [21]. This change may have resulted from enhanced awareness of the value of IFA, reduced misconceptions around perceived side-effects, understanding the correct duration of supplementation, knowing alternative sources of IFA, and increasing the frequency of visits to receive IFA.

We acknowledge some limitations of this study. Firstly, we did not have the data on selected supply-side factors, including consistent availably of IFA at the facilities where the women sought ANC and distance to the nearest public or private source of IFA, which we could not include in the multiple regression model. However, our disaggregated data on IFA received from ANC and non-ANC platforms and sources partly address this data gap. We did not ask women about their anaemia status, as routine screening for anaemia is low, and universal antenatal IFA supplementation is recommended [19,62]. Secondly, we did not have observation-based data on the quality of the services provided during ANC at any of the facilities. Thus, we could not analyse the quality-adjusted coverage step proposed in the effective-coverage assessment cascade [26,27]. However, our assessment of user adherence-adjusted coverage stays at a higher endpoint on the effective coverage assessment cascade. Thirdly, the reliance on retrospective self-reported data on the number of IFA tablets received and consumed is prone to response bias. To improve recall, we restricted our participant selection window to six months post-partum. Finally, we can generalise our findings to the rural population as we conducted the study in rural sub-districts. Nonetheless, we propose future research should include an analysis of all steps of the effective coverage cascade following a cohort of women during pregnancy and collecting information on the quality of service at both public and private sources of ANC and IFA and the number of IFA consumed. A detailed qualitative exploration of women's perception and attitude to IFA and choice of IFA sources would identify the strategies to raise women's awareness and demand for and compliance to recommend IFA consumption and improve user adherence-adjusted coverage of IFA in pregnancy.

Our study has several policies and programmatic implications for improving user adherence-adjusted coverage of IFA during pregnancy. Emphasis on >4 ANC contacts from health facilities is essential to improve receiving and consumption of antenatal IFA. However, adherence to adequate consumption largely depends on commencing ANC in the first trimester. The inconsistencies in the national ANC protocol and guidelines about starting IFA in the first trimester need correction in line with global guidelines (WHO). Our scenario-based projection suggests that ensuring the current national recommendation of a minimum of four ANC visits would achieve only ~16% user adherence-adjusted coverage [19]. National maternal health and nutrition programmes should consider adopting the 2016 WHO recommendation of eight ANC contacts [11]. A large proportion of women received/purchased IFA from private sector sources. Ensuring quality ANC with counselling on IFA is important in public and private sector ANC contacts. Similarly, increasing the number of supplements provided at each ANC visit, from the current practice of delivering 20-30 IFA tablets, is needed to cover the time until the next appointment. Programmes should explore the targeted community-based distribution of supplements for the women who do not attend ANC multiple times [57].

5. Conclusions

This study is the first to report user adherence-adjusted effective coverage of recommended ≥180 IFA tablet consumption during pregnancy in Bangladesh. It identifies the faltering points and factors influencing optimal effective coverage of IFA supplementation in rural areas of Bangladesh. Our findings demonstrate that less than one in ten pregnant women consumed ≥180 IFA tablets during pregnancy. An early start to ANC in the first trimester and a higher number of ANC visits had an incremental benefit in increasing IFA consumption during pregnancy. Interventions targeting the early start of ANC, eight or more ANC contacts, and providing pregnant women with advice on the importance of IFA and IFA supplements in higher quantity at the ANC contacts have the potential to improve effective coverage of IFA during pregnancy.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/nu14153114/s1, Table S1: factors associated with the number of IFA supplements received; Table S2: factors associated with user adherence-adjusted effective coverage (consumed 180+ tablets) during pregnancy.

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Institutional Review Board Statement: We obtained ethical approval of the study protocol from the Ethical Review Committee of icddr,b (Protocol number: PR-19124). We registered the study at ClinicalTrials.gov (Trial Registration # NCT04559711).

Informed Consent Statement: Written informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data supporting reported results can be found from https://figshare.com/articles/dataset/Coverage_of_IFA_supplementation_in_pregnancy/20105399 (accessed on 29 June 2022).

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References

1. Micha, R.; Mannar, V.; Afshin, A.; Allemandi, L.; Baker, P.; Battersby, J.; Zulfiqar, B.; Kevin, C.; Camilla, C.; Cesera, D.; et al. *2020 Global Nutrition Report: Action on Equity to End Malnutrition*; Report No.: 1916445276; Development Initiatives: Bristol, UK, 2020.
2. Stevens, G.A.; Finucane, M.M.; De-Regil, L.M.; Paciorek, C.J.; Flaxman, S.R.; Branca, F.; Peña-Rosas, J.P.; Bhutta, Z.A.; Ezzati, M.; on behalf of Nutrition Impact Model Study Group (Anaemia). Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: A systematic analysis of population-representative data. *Lancet Glob. Health* **2013**, *1*, e16–e25.
3. Di Renzo, G.C.; Spano, F.; Giardina, I.; Brillo, E.; Clerici, G.; Roura, L.C. Iron deficiency anemia in pregnancy. *Women's Health* **2015**, *11*, 891–900.
4. Breymann, C. Iron deficiency anemia in pregnancy. In *Seminars in Hematology*; Elsevier: Amsterdam, The Netherlands, 2015.
5. Goonewardene, M.; Shehata, M.; Hamad, A. Anaemia in pregnancy. *Best Pract. Res. Clin. Obstet. Gynaecol.* **2012**, *26*, 3–24.
6. Wiegersma, A.M.; Dalman, C.; Lee, B.K.; Karlsson, H.; Gardner, R.M. Association of prenatal maternal anemia with neurodevelopmental disorders. *JAMA Psychiatry* **2019**, *76*, 1294–1304.
7. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International. In *Bangladesh Demographic and Health Survey 2011*; NIPORT, Mitra and Associates, and ICF International: Dhaka, Bangladesh; Calverton, MD, USA, 2012.
8. Carpenter, R.M.; Billah, S.M.; Lyons, G.R.; Siraj, S.; Rahman, Q.S.; Thorsten, V.; McClure, E.M.; Haque, R.; Petri, W.A. U-Shaped Association between Maternal Hemoglobin and Low Birth Weight in Rural Bangladesh. *Am. J. Trop. Med. Hyg.* **2022**, *106*, 424–431.
9. Peña-Rosas, J.P.; De-Regil, L.M.; Garcia-Casal, M.N.; Dowswell, T. Daily oral iron supplementation during pregnancy. *Cochrane Database Syst. Rev.* **2015**, *12*, CD004736.
10. Nisar, Y.B.; Aguayo, V.M.; Billah, S.M.; Dibley, M.J. Antenatal Iron-Folic Acid Supplementation Is Associated with Improved Linear Growth and Reduced Risk of Stunting or Severe Stunting in South Asian Children Less than Two Years of Age: A Pooled Analysis from Seven Countries. *Nutrients* **2020**, *12*, 2632.
11. World Health Organization. WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience; World Health Organization: Geneva, Switzerland, 2016.
12. World Health Organization. WHO Antenatal Care Recommendations for a Positive Pregnancy Experience: Nutritional Interventions Update: Multiple Micronutrient Supplements During Pregnancy; Report No.: 9240007784; World Health Organization: Geneva, Switzerland, 2020.
13. Bhutta, Z.A.; Das, J.K.; Rizvi, A.; Gaffey, M.F.; Walker, N.; Horton, S.; Webb, P.; Lartey, A.; Black, R.E.; The Lancet Nutrition Interventions Review Group; et al. Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *Lancet* **2013**, *382*, 452–477.
14. Keats, E.C.; Das, J.K.; Salam, R.A.; Lassi, Z.S.; Imdad, A.; Black, R.E.; Bhutta, Z.A. Effective interventions to address maternal and child malnutrition: An update of the evidence. *Lancet Child Adolescent Health* **2021**, *5*, 367–384.
15. IPHN. *National Strategy for Anaemia Prevention and Conrol in Bangladesh*; Institute of Public Health Nutrition (IPHN), Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh: Dhaka, Bangladesh, 2007.
16. MOH&FW. *Second National Plan of Action for Nutrition (2016–2015)*; Government of People's Republic of Bangladesh: Dhaka, Bangladesh, 2017.
17. Institute of Public Health Nutrition. *National Strategy on Prevention and Control of Micronutrient Deficiencies, Bangladesh (2015–2024)*; Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh: Dhaka, Bangladesh, 2015.
18. Government of People's Republic of Bangladesh. *National Nutrition Policy 2015*; Government of People's Republic of Bangladesh: Dhaka, Bangladesh, 2015.
19. Government of People's Republic of Bangladesh. 4th Health, Population and Nutrition Sector Programme (4th HPNSP), Operational Plan, National Nutrition Service (NNS) Institute of Public Health Nutrition; Directorate General of Health Service, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh: Dhaka, Bangladesh, 2017.
20. Engle-Stone, R.; Kumordzie, S.M.; Meinzen-Dick, L.; Vosti, S.A. Replacing iron-folic acid with multiple micronutrient supplements among pregnant women in Bangladesh and Burkina Faso: Costs, impacts, and cost-effectiveness. *Ann. N. Y. Acad. Sci.* **2019**, *1444*, 35.
21. Siekmans, K.; Roche, M.; Kung'u, J.K.; Desrochers, R.E.; De-Regil, L.M. Barriers and enablers for iron folic acid (IFA) supplementation in pregnant women. *Matern. Child Nutr.* **2018**, *14*, e12532.
22. Alam, A.; Rasheed, S.; Khan, N.U.; Sharmin, T.; Huda, T.M.; Arifeen, S.E.; Dibley, M.J. How can formative research inform the design of an iron-folic acid supplementation intervention starting in first trimester of pregnancy in Bangladesh? *BMC Public Health* **2015**, *15*, 374.
23. Fite, M.B.; Roba, K.T.; Oljira, L.; Tura, A.K.; Yadeta, T.A. Compliance with Iron and Folic Acid Supplementation (IFAS) and associated factors among pregnant women in Sub-Saharan Africa: A systematic review and meta-analysis. *PLoS ONE* **2021**,*16*, e0249789.
24. Sununtnasuk, C.; D'Agostino, A.; Fiedler, J.L. Iron+ folic acid distribution and consumption through antenatal care: Identifying barriers across countries. *Public Health Nutr.* **2016**, *19*, 732–742.
25. National Institute of Population Research and Training (NIPORT); ICF. *Bangladesh Demographic and Health Survey 2017-18*; NIPORT and ICF: Dhaka, Bangladesh; Rockville, MD, USA, 2020.
26. Amouzou, A.; Leslie, H.H.; Ram, M.; Fox, M.; Jiwani, S.S.; Requejo, J.; Marchant, T.; Munos, M.K.; Vaz, J.M.E.; Weiss, W.; et al. Advances in the measurement of coverage for RMNCH and nutrition: From contact to effective coverage. *BMJ Glob. Health* **2019**, *4* (Suppl. 4), e001297.

27. Marsh, A.D.; Muzigaba, M.; Diaz, T.; Requejo, J.; Jackson, D.; Chou, D.; Cresswell, A.; Guthold, R.; Moran, A.C.; Strong, K.L.; et al. Effective coverage measurement in maternal, newborn, child, and adolescent health and nutrition: Progress, future prospects, and implications for quality health systems. *Lancet Glob. Health* **2020**, *8*, e730-e6.
28. Rashid, M.; Flora, M.; Moni, M.; Akhter, A.; Mahmud, Z. Reviewing anemia and iron folic acid supplementation program in Bangladesh-a special article. *Bangladesh Med. J.* **2010**, *39, 3*.
29. Nguyen, P.H.; Sanghvi, T.; Kim, S.S.; Tran, L.M.; Afsana, K.; Mahmud, Z.; Aktar, B.; Menon, P. Factors influencing maternal nutrition practices in a large scale maternal, newborn and child health program in Bangladesh. *PLoS ONE* **2017**, *12*, e0179873.
30. BBS. *Statistical Pocket Book Bangladesh 2016*; Bangladesh Bureau of Statistics; Government of the People's Republic of Bangladesh: Dhaka, Bangladesh, 2017.
31. National Institute of Population Research and Training (NIPORT); International Centre for Diarrhoeal Disease Research B, MEASURE Evaluation. *Bangladesh District Level Socio-demographic and Health Care Utilization Indicators*; NIPORT, ICDDRB, and MEASURE Evaluation: Dhaka, Bangladesh; Chapel Hill, NC, USA, 2019.
32. National Library of Medicine (US). cRCT to Improve Maternal Nutrition Service Delivery During ANC 2020. Available online: https://clinicaltrials.gov/ct2/show/study/NCT04559711 (accessed on 23 November 2021).
33. Andersen, R.M. Revisiting the behavioral model and access to medical care: Does it matter? *J. Health Soc. Behav.* **1995**, *36*, 1–10.
34. Babitsch, B.; Gohl, D.; Von Lengerke, T. Re-revisiting Andersen's Behavioral Model of Health Services Use: A systematic review of studies from 1998–2011. *Psycho-Social-Medicine* **2012**, *9, 1-15*.
35. Saad–Haddad, G.; DeJong, J.; Terreri, N.; Restrepo–Méndez, M.C.; Perin, J.; Vaz, L.; Newby, H.; Amouzou, A.; Barros, A.J.; Bryce, J. Patterns and determinants of antenatal care utilization: Analysis of national survey data in seven countdown countries. *J. Glob. Health* **2016**, *6*, 010404.
36. Neupane, B.; Rijal, S.; Gc, S.; Basnet, T.B. Andersen's model on determining the factors associated with antenatal care services in Nepal: An evidence-based analysis of Nepal demographic and health survey 2016. *BMC Pregnancy Childbirth* **2020**, *20*, 308.
37. Tolera, H.; Gebre-Egziabher, T.; Kloos, H. Using Andersen's behavioral model of health care utilization in a decentralized program to examine the use of antenatal care in rural western Ethiopia. *PLoS ONE* **2020**, *15*, e0228282.
38. Nisar, Y.B.; Dibley, M.J.; Mir, A.M. Factors associated with non-use of antenatal iron and folic acid supplements among Pakistani women: A cross sectional household survey. *BMC Pregnancy Childbirth* **2014**, *14*, 305.
39. Chourasia, A.; Pandey, C.M.; Awasthi, A. Factors influencing the consumption of iron and folic acid supplementations in high focus states of India. *Clin. Epidemiol. Glob. Health* **2017**, *5*, 180–184.
40. Lyoba, W.B.; Mwakatoga, J.D.; Festo, C.; Mrema, J.; Elisaria, E. Adherence to iron-folic acid supplementation and associated factors among pregnant women in Kasulu communities in North-Western Tanzania. *Int. J. Reprod. Med.* **2020**, *2020*, 3127245.
41. Kamau, M.W.; Mirie, W.; Kimani, S. Compliance with Iron and folic acid supplementation (IFAS) and associated factors among pregnant women: Results from a cross-sectional study in Kiambu County, Kenya. *BMC Public Health* **2018**, *18*, 580.
42. Felipe-Dimog, E.B.; Yu, C.-H.; Ho, C.-H.; Liang, F.-W. Factors Influencing the Compliance of Pregnant Women with Iron and Folic Acid Supplementation in the Philippines: 2017 Philippine Demographic and Health Survey Analysis. *Nutrients* **2021**, *13*, 3060.
43. Chen, W.; Qian, L.; Shi, J.; Franklin, M. Comparing performance between log-binomial and robust Poisson regression models for estimating risk ratios under model misspecification. *BMC Med. Res. Methodol.* **2018**, *18*, 63.
44. Newson, R.B. Attributable and unattributable risks and fractions and other scenario comparisons. *Stata J.* **2013**, *13*, 672–698.
45. StataCorp. Stata Survey Data Reference Manual Release 14; StataCorp LP: College Station, TX, USA, 2015.
46. Fiedler, J.; D'Agostino, A.; Sununtnasuk, C. Nutrition Technical Brief: A Rapid Initial Assessment of the Distribution and Consumption of Iron–Folic Acid Tablets through Antenatal Care in Bangladesh; USAID/Strengthening Partnerships, Results and Innovations in Nutrition Globally (SPRING) Project: Arlington, VA, USA, 2014.
47. Sendeku, F.W.; Azeze, G.G.; Fenta, S.L. Adherence to iron-folic acid supplementation among pregnant women in Ethiopia: A systematic review and meta-analysis. *BMC Pregnancy Childbirth* **2020**, *20*, 138.
48. Ahmed, T.; Rahman, A.E.; Amole, T.G.; Galadanci, H.; Matjila, M.; Soma-Pillay, P.; Gillespie, B.M.; El Arifeen, S.; Anumba, D.O.C. The effect of COVID-19 on maternal newborn and child health (MNCH) services in Bangladesh, Nigeria and South Africa: Call for a contextualised pandemic response in LMICs. *Int. J. Equity Health* **2021**, *20*, 77.
49. Varghese, J.S.; Swaminathan, S.; Kurpad, A.V.; Thomas, T. Demand and supply factors of iron-folic acid supplementation and its association with anaemia in North Indian pregnant women. *PLoS ONE* **2019**, *14*, e0210634.
50. Bahati, F.; Kairu-Wanyoike, S.; Nzioki, J.M. Adherence to iron and folic acid supplementation during pregnancy among postnatal mothers seeking maternal and child healthcare at Kakamega level 5 hospital in Kenya: A cross-sectional study. *Wellcome Open Res.* **2021**, *6*, 80.
51. Pathirathna, M.L.; Wimalasiri, K.; Sekijima, K.; Sadakata, M. Maternal Compliance to Recommended Iron and Folic Acid Supplementation in Pregnancy, Sri Lanka: A Hospital-Based Cross-Sectional Study. *Nutrients* **2020**, *12*, 3266.
52. Titaley, C.R.; Dibley, M.J. Factors associated with not using antenatal iron/folic acid supplements in Indonesia: The 2002/2003 and 2007 Indonesia Demographic and Health Survey. *Asia Pac. J. Clin. Nutr.* **2015**, *24*, 162–176.
53. Agegnehu, G.; Atenafu, A.; Dagne, H.; Dagnew, B. Adherence to iron and folic acid supplement and its associated factors among antenatal care attendant mothers in Lay Armachiho health centers, Northwest, Ethiopia, 2017. *Int. J. Reprod. Med.* **2019**, *2019*, 5863737.

54. Desta, M.; Kassie, B.; Chanie, H.; Mulugeta, H.; Yirga, T.; Temesgen, H.; Leshargie, C.T.; Merkeb, Y. Adherence of iron and folic acid supplementation and determinants among pregnant women in Ethiopia: A systematic review and meta-analysis. *Reprod. Health* **2019**, *16*, 182.
55. Mainuddin, A.; Begum, H.A.; Rawal, L.B.; Islam, A.; Islam, S.S. Women empowerment and its relation with health seeking behavior in Bangladesh. *J. Fam. Reprod. Health* **2015**, *9*, 65.
56. Urgessa, B.T.; Abdo, Z.A. Adherence to iron/folic acid supplementation and associated factors among pregnant women attending governmental health center in Yeka Sub City, Addis Ababa, Ethiopia. *BLDE Univ. J. Health Sci.* **2020**, *5*, 145.
57. Kavle, J.A.; Landry, M. Community-based distribution of iron–folic acid supplementation in low-and middle-income countries: A review of evidence and programme implications. *Public Health Nutr.* **2018**, *21*, 346–354.
58. Wendt, A.; Stephenson, R.; Young, M.; Webb-Girard, A.; Hogue, C.; Ramakrishnan, U.; Martorell, R. Individual and facility-level determinants of iron and folic acid receipt and adequate consumption among pregnant women in rural Bihar, India. *PLoS ONE* **2015**, *10*, e0120404.
59. MOH&FW. Maternal Health Standard Operating Procedure (SOP) Volume-1; Ministry of Health and Family Welfare: Dhaka, Bangladesh, 2015.
60. DGHS; WHO Bangladesh; OGSB. *Guideline on Antenatal Care (ANC*); MOHFW: Dhaka, Bangladesh, 2020.
61. IPHN. National Guidelines: Prevention and Treatment of Iron Deficiency Anaemia; Institute of Public Health Nutrition: Dhaka, Bangladesh, 2001.
62. Billah, S.M.; Ali, N.B.; Khan, A.N.S.; Raynes-Greenow, C.; Kelly, P.J.; Siraj, M.S.; Askari, S.; Menon, P.; El Arifeen, S.; Dibley, M.J.; et al. Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh. *PLoS ONE* **2022**, *17*, e0262867.

Supplementary Materials

Table S1: Factor associated with the number of IFA supplements received

Variables	N(weighted)	Number of IFA received	
	2572	Mean difference (95% CI)	Adjusted mean difference (95% CI)
Region/area			
North (kurigram)	762	Ref	Ref
South (Bhola)	1810	-11.7(-20.1, -3.9)	7.3(1.5, 13.0)
Mother's age			
<20	462	Ref	Ref
20-29	1409	-3.3(-11.5, 5.0)	1.8(-5.1, 8.6)
30 or more	701	-16.7(-25.3, -8.1)	-1.5(-9.5, 6.6)
Mother's education			
Up to primary	1031	Ref	Ref
Secondary	1201	20.1(14.2, 26.1)	4.1(-1.3, 9.6)
Higher secondary and above	340	54.5(44.3, 64.7)	25.6(17.3, 33.9)
Religion			
Muslim	2485	Ref	Ref
Others	87	18.4(2.0, 34.8)	7.9(-5.8, 21.6)
Work involvement			
Not employed	2507	Ref	Ref
Employed	65	12.0(-5.3, 29.4)	7.2(-7.3, 21.7)
Household Wealth (tertile)			
Poor	794	Ref	Ref
Middle	854	3.9(-3.9, 11.7)	1.9(-4.2, 8.1)
Rich	925	23.8(16.0-31.5)	3.6(-3.6, 10.8)
Mother's exposure to print or electronic media (at least once a week)			
No	1905	Ref	Ref
Yes	667	17.4(10.4, 24.5)	5.1(-0.9, 11.1)
Birth order of the last child			
1	955	Ref	Ref
2	793	-13.9(-21.5, -6.2)	-5.8(-12.0, 0.3)
≥3	825	-27.7(-34.7, -20.6)	-5.6(-13.1, 1.8)
Any history of abortion/stillbirth before this pregnancy			
No	2235	Ref	-
Yes	337	2.3 (-6.3, 10.8)	-
Women who had pregnancy complications			
No	1948	Ref	Ref
Yes	624	9.3(0.9, 17.7)	-5.5(-11.0, 0.3)
Number of ANC and timing of first ANC			

Variables	**N(weighted)**	**Number of IFA received**	
	2572	**Mean difference (95% CI)**	**Adjusted mean difference (95% CI)**
Number of ANC visits among mothers who received none/ started late (≥5 months GA) $^{\alpha}$	1818	13.4(11.6, 15.2)	11.1(9.1, 13.2)
Number of ANC visits among mothers who started early (≤4 months GA) $^{\alpha}$	754	15.8(12.8, 18.8)	15.3(12.6, 18.0)
Received advice on IFA			
No	1232	Ref	Ref
Yes	1340	44.2(37.8, 50.7)	31.8(24.6, 39.0)
Received IFA free			
No	1498	Ref	Ref
Yes	1074	36.6(30.7, 42.5)	21.2(16.2, 26.2)
Received IFA only from ANC contacts			
No	1616	Ref	Ref
Yes	956	11.3(5.6, 16.9)	-37.6(-43.5, -31.6)

GA: gestational age, - variables not included in the adjusted model

Table S2: Factor associated with user adherence-adjusted effective coverage (consumed 180+ tablets) during pregnancy

Variables	N(weighted)	Women consumed 180+ tablets	
	2572	Risk Ratio	Adjusted Risk Ratio
Region/area			
North (kurigram)	762	Ref	Ref
South (Bhola)	1810	0.49(0.35-0.69)	0.65(0.48-0.88)
Mother's age			
<20	462	Ref	
20-29	1409	1.34(0.83-2.17)	-
30 or more	701	1.00(0.60-1.65)	-
Mother's education			
Up to primary	1031	Ref	Ref
Secondary	1201	1.67(1.15-2.44)	1.21(0.80-1.81)
Higher secondary and above	340	4.21(2.74-6.48)	2.2(1.29-3.82)
Religion			
Muslim	2485	Ref	-
Others	87	1.39(0.68-2.85)	-
Work involvement			
Not employed	2507	Ref	-
Employed	65	1.54(0.74-3.19)	-
Household Wealth (tertile)			
Poor	794	Ref	Ref
Middle	854	0.94(0.58-1.51)	0.90(0.58-1.41)
Rich	925	1.76(1.22-2.56)	0.97(0.63-1.51)
Mother's exposure to print or electronic media (at least once a week)			
No	1905	Ref	Ref
yes	667	1.84(1.38-2.45)	1.21(0.88-1.65)
Birth order of the last child			
1	955	Ref	Ref
2	793	1.03(0.73-1.45)	1.09(0.80-1.48)
≥3	825	0.55(0.34-0.73)	0.89(0.56-1.41)
Any history of abortion/stillbirth before this pregnancy			
No	2235	Ref	-
Yes	337	1.10 (0.69-1.77)	-
Women who had pregnancy complications			
No	1948	Ref	-
Yes	624	0.82(0.54-1.24)	-
Number of ANC and timing of first ANC			
Number of ANC visits among mothers who received none or started late (≥5 months GA)	1818	1.11(0.94, 1.31)	1.24(0.94, 1.34)

Variables	**N(weighted)**	**Women consumed 180+ tablets**	
	2572	**Risk Ratio**	**Adjusted Risk Ratio**
Number of ANC visits among mothers who started early (≤4 months GA)	754	1.49(1.33, 1.65)	1.46(1.32, 1.62)
Received advice on IFA			
No	1232	Ref	Ref
Yes	1340	1.68(1.18-2.38)	1.52(1.03, 2.23)
Received IFA free			
No	1498	Ref	Ref
Yes	1074	1.29(0.92-1.81)	0.95(0.66, 1.36)
Received IFA only from ANC contacts			
No	1616	Ref	Ref
Yes	956	0.66(0.45-0.97)	0.30(0.20, 0.70)

GA: gestational age, - variables not included in the adjusted model.

Chapter 5: Promotion of exclusive breastfeeding

Paper 3: The effect of electronic job aid assisted one-to-one counselling to support exclusive breastfeeding among 0–5-month-old infants in rural Bangladesh

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ORIGINAL ARTICLE

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The effect of electronic job aid assisted one-to-one counselling to support exclusive breastfeeding among 0–5-month-old infants in rural Bangladesh

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Abstract

Exclusive breastfeeding (EBF) for the first 6 months has established benefits, yet had slow improvements globally. Little is known about electronic job aid-assisted counselling to support EBF. As a secondary outcome of a cluster randomized controlled trial in Bangladesh, we assessed the effect of electronic job aid-supported nutrition counselling and practical demonstration on EBF. We randomized pregnant women to one of five study arms in the trial and followed mother–child dyads until 2 years of age. Community health workers (CHWs) provided breastfeeding counselling with or without prenatal and complementary nutrient supplements in all four intervention arms. The comparison arm continued with the usual practice where mothers could receive nutrition counselling at routine antenatal and postnatal care, and during careseeking for childhood illnesses. We assessed breastfeeding indicators at birth and monthly until the child was 6 months old, in both intervention and comparison arms. To evaluate the effect of nutrition counselling on breastfeeding, we combined all four intervention arms and compared them with the comparison arm. Intervention newborns had half the risk (relative risk [RR]: 0.54, 95% confidence interval [CI]: 0.39, 0.76) of receiving prelacteal feeds than those in the comparison arm. EBF declined steeply in the comparison arm after 3 months of age. EBF was 16% higher in the intervention than the comparison arm at 4 months (RR: 1.16, 95% CI: 1.08, 1.23) and 22% higher at 5 months of age (RR: 1.22, 95% CI: 1.12, 1.33). Maternal background and household characteristics did not modify the intervention effect, and we observed no difference in EBF among caesarean versus vaginal births. Breastfeeding counselling and practical demonstration using an electronic job aid by CHWs are promising interventions to improve EBF and are scalable into existing community-based programmes.

KEYWORDS
breastfeeding, cluster randomised controlled trial, community-based, community health workers, counselling, low- and middle-income countries, mHealth, newborn feeding behaviours

1 | INTRODUCTION

Key messages

- Using an electronic job aid, repeated, one-to-one counselling and practical demonstration to mothers by locally recruited CHWs reduced prelacteal feeding and improved EBF practice by delaying the early introduction of complementary food.
- The positive effect of counselling on EBF remains similar with or without nutrient supplementation.
- Electronic job aid supported counselling to promote breastfeeding should be integrated into existing community-based maternal and child health programmes.

Childhood undernutrition with high geographic disparities and socioeconomic inequalities remains a major challenge in low- and middle-income countries (LMICs), where nearly all under-5 children with inadequate growth reside (Local & Burden of Disease Child Growth Failure Collaborators, 2020; Micha et al., 2020). During the 'first 1000 days of a child's life', exclusive breastfeeding (EBF) for the first 6 months and optimal breastfeeding up to 2 years is among the priority nutrition interventions (Keats et al., 2021). Breastmilk provides the best combination of nutrients, immunologic components, and hormones for newborns and infants. It helps in developing children's gut microbiota, reduces the risk of infections and contributes to proper physical and cognitive growth through multiple interconnected pathways (Ho et al., 2018; Victora et al., 2016). These are linked to long-term positive health effects including reduced risk of obesity, metabolic syndrome, diabetes, and certain cancers (Victora et al., 2016; Wisnieski et al., 2018). Despite the known benefits, breastfeeding practices are suboptimal globally and achieving universal coverage of 90% EBF remains a far-reaching target (Cai et al., 2012; Jones et al., 2003). In Bangladesh, the prevalence of EBF among 0–5-month-old children stagnated at around 65% between 2011 and 2017 (NIPORT et al., 2019). The high EBF prevalence (82%) among 0–2-month-old infants reduces by half to only 40% in those aged 4–5 months.

Hurdles against optimal breastfeeding practices often remain pervasive. Previous studies identified several barriers against EBF in LMICS, grouped under the prenatal period, the first day of birth, and the first 6-month period. Overall, identified barriers included poor maternal knowledge and awareness on benefits and techniques of EBF, lack of breastfeeding self-efficacy and long-term intention to breastfeed, poor understanding of children's hunger cues, perceived importance of the early introduction of weaning food, especially through elders of the family, the perceived association between EBF with mothers' health problems and inadequate dietary intake, inadequate knowledge of health care providers, and contextual challenges such as increased caesarean section births and maternal employment (Brockway et al., 2017; Kavle et al., 2017).

Nutrition intervention frameworks consistently include supporting and promoting optimal breastfeeding (Bhutta et al., 2013; Keats et al., 2021). A recent comprehensive systematic review of evidence from LMICs by Lassi et al. (2020) suggested nutrition education interventions provided in facilities, communities or both settings resulted in increased prevalence of EBF. Challenges to optimal breastfeeding can be mitigated through bottom-up counselling by skilled counsellors who can deliver the messages and practical demonstration of breastfeeding techniques in a person-sensitive, culturally appropriate way (Schmied et al., 2011). Community health workers (CHWs) and peer support counsellors can effectively promote breastfeeding (Lassi et al., 2020; Shakya et al., 2017). However, proper training and job aids for them to support counselling are prerequisites, which remain challenging in LMICs. Breastfeeding counsellors need to be knowledgeable on breastfeeding issues and solutions for common problems, and job aids may be a useful tool for on-site support for counsellors.

With the global boost in digitalization of health interventions, electronic job aids showed improvements in health and nutrition service delivery (Källander et al., 2013). Several studies have shown a positive impact of electronic job aid tools in medical record-keeping and health applications. However, rigorous impact evaluations of mHealth (delivering health interventions with the support of mobile devices) are scarce (Aranda-Jan et al., 2014; Källander et al., 2013; Perri-Moore et al., 2015; Wang et al., 2017). Efforts to integrate digital health interventions to improve breastfeeding practices have mainly been made in high-income countries (Tang et al., 2019). Such initiatives include web-based learning and education platforms for healthcare providers and parents. These have been delivered through text messaging, phone calls, video conferencing and interactive kiosk or automated interactive agents for breastfeeding promotion and support to mothers, and mobile applications for improving paternal support in breastfeeding (Lau et al., 2016; Tang et al., 2019). Applications of electronic job aids for health care providers for supporting and promoting breastfeeding in LMIC settings are only emerging (Modi et al., 2019).

We conducted a community-based five-arm cluster randomized controlled trial (C-RCT) in a rural area of north-Eastern Bangladesh. The study primarily sought to explore the combined effect on children's linear growth of selected nutrition-specific interventions provided to mother–child pairs throughout the first 1000 days of life (Billah et al., 2017). The interventions included time-specific nutrition counselling and small quantities of lipid-based prenatal and complementary nutrient supplements (LNS), provided in different combinations in the intervention arms. Women in the intervention arms received electronic job aid-supported one-to-one counselling and practical demonstration on appropriate breastfeeding practices between their third trimester of pregnancy to 5 completed months of children's age. In the present study, we analysed and presented a secondary outcome of the trial: effectiveness of the electronic job aid-supported nutrition counselling and practical demonstration intervention package on improving EBF practices in the first 6 months of the infant's life.

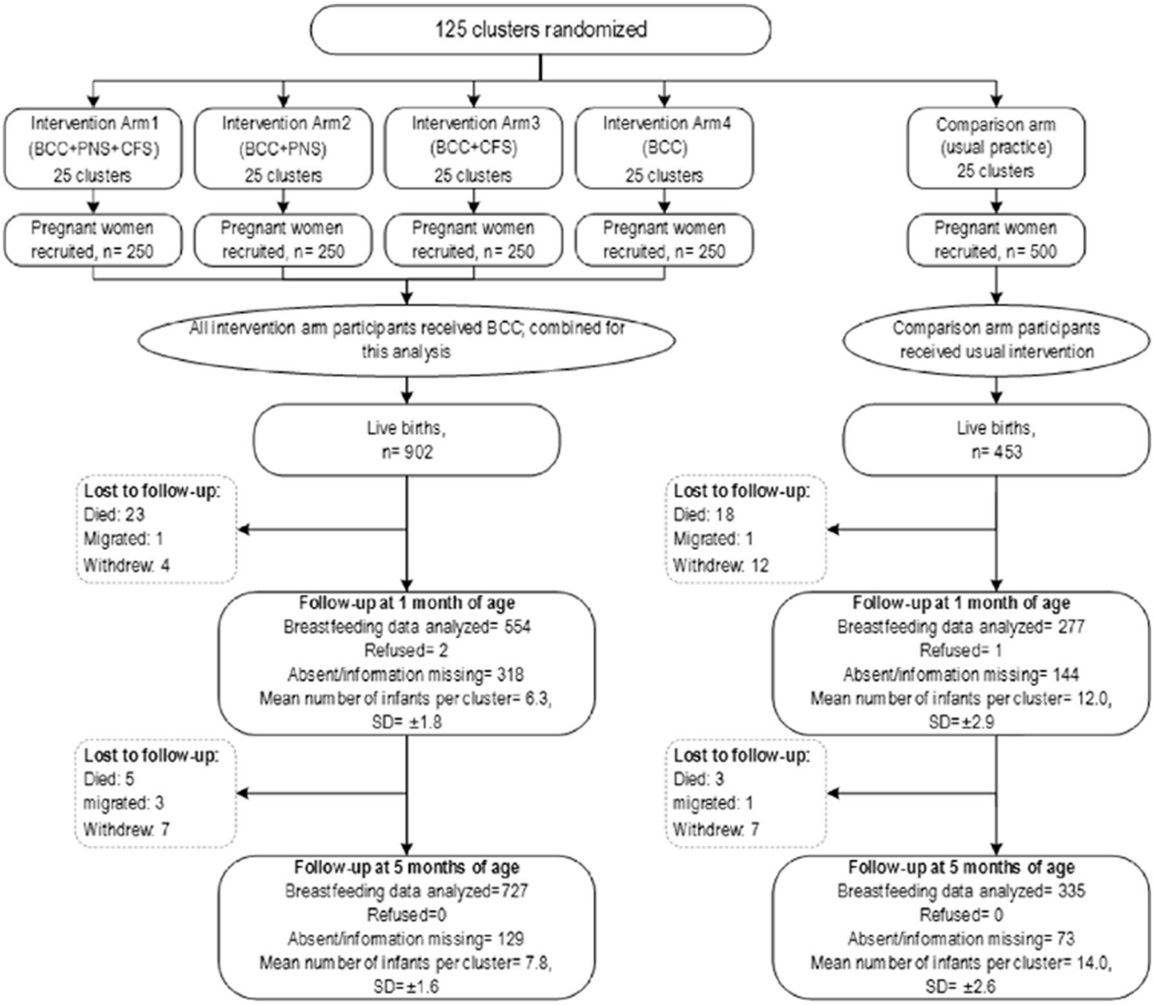
2 | METHOD

2.1 | Study settings

We implemented the C-RCT in Bahubal and Nabiganj sub-districts of Habiganj district, situated in Sylhet Division in the northeastern side of Bangladesh. This region has the highest infant mortality (52 per 1000 live births) and childhood stunting (43%; NIPORT et al., 2019). We selected 12 unions, the smallest administrative unit consisting of ~30,000 people, from the 2 subdistricts, excluding the unions with interrupted transport connectivity due to yearly monsoon flooding and ongoing targeted maternal and child nutrition promotion interventions in addition to routine public health nutrition services (Billah et al., 2017). The study area had ~350,000 inhabitants, about 40% literacy and agriculture was the main source of living (BBS, 2013).

2.2 | Trial design

We published a detailed description of the trial design in previous papers reporting the trial protocol and other outcomes (Billah et al., 2017, 2021). In summary, the C-RCT had four intervention arms and a usual practice comparison arm (Figure 1). All four intervention arms provided one-to-one counselling to participants on appropriate nutritional practices during pregnancy and age-appropriate feeding



BCC: Behaviour change communication, refers to counselling and practical demonstration on breastfeeding using an electronic job aid; PNS: Lipid-based prenatal nutrient supplement, CFS: Lipid-based complementary nutrient supplement during 6-23 months of age

FIGURE 1 Trial profile including study arms and participants.

practices for the child up to 2 years of age. Some counselling sessions also included practical demonstrations of breastfeeding techniques as required. Three of the four intervention arms also had LNS provided to pregnant women and/or children at 6–23 months. One arm had both pregnant mothers' and children's LNS (Arm 1: nutrition-specific behaviour change communication counselling [BCC] + lipid-based prenatal nutrient supplement [PNS] + lipid-based complementary nutrient supplement [CFS]), and two had either mothers' LNS or children's LNS (Arm 2: BCC + PNS; Arm 3: BCC + CNS; Arm 4 had BCC only). The LNS included 22 micronutrients and small amounts of lipid and protein. All intervention components were delivered by CHWs, extensively trained by the research team. Participants in the 'usual practice' comparison arm did not receive nutrition counselling visits by study CHWs. In all intervention and comparison arms, mothers could receive nutrition services during antenatal care (ANC) visits and advice on child feeding practices at postnatal care (PNC) and outpatient sick child management services, delivered at public, private and nongovernment health care services. Nonetheless, previous studies reported a low reach of these services during the antenatal and postpartum care continuum and suboptimal nutrition-specific services at these contacts (Billah et al., 2022; Saha et al., 2015). This study analyses the effect of one-to-one counselling and practical demonstration on breastfeeding indicators for children aged 0–5 months. We combined all four intervention arms into a single intervention arm and compared this intervention arm with the comparison arm (Billah et al., 2017, 2021).

2.3 | Randomization and participant enrolment

In the original C-RCT, we created clusters of an average size of 2000 people and randomized 125 clusters in the five study arms. We applied computer-assisted block randomization of clusters to ensure balance in cluster size across the study arms. An independent statistician ran the block randomization sequence for the study clusters blinded to the cluster name and location. During participant enrolment, the field-based study data collectors were unaware of the cluster allocation status. We removed blinding of the CHW after participant enrolment, and there was no blinding of the participants. The field team enrolled pregnant women within 125 days since the first date of the last menstrual period and permanent residents in the study village.

2.4 | Sample size

For the original study, we estimated the sample size for the study based on the primary outcome of 0.4 higher mean height-for-age Z score at 2 years of age (Billah et al., 2017). As presented in the current analysis, we doubled the sample size in the comparison arm to increase the power for estimating the intervention effect on secondary outcomes, such as EBF among 0–5-month-old children. We enrolled 1500 pregnant women, 1000 in the 4 intervention arms (250 per arm) and 500 in the comparison arm, adjusting for possible follow-up losses (miscarriages, abortions, stillbirths, migration-out, mortality among 0–23-month-old children and other dropouts). Accordingly, the sample size for the present analysis is as follows: 1355 live births (intervention, 903 and control, 453) from enrolled pregnancies for initial breastfeeding indicators, and 1250 children (intervention 847 and control 403) for whom breastfeeding practice data were available from at least one follow-up visit between 1 and 5 month of children's age.

2.5 | Ethics approval and participant consent

The ethical review committee of icddr,b approved the trial. We registered the trial at ClinicalTrials.gov before completing the enrolments and starting the outcome evaluations. We obtained written informed consent from each participant twice, once at initial enrolment during pregnancy and after that during enrolment of resultant live births/children.

2.6 | Intervention description: Exclusive breastfeeding counselling using an electronic job aid

Participant mothers in the intervention arms received extensive counselling and practical demonstration of exclusive breastfeeding provided by CHWs throughout the third trimester of pregnancy and during the first 6 months of the child's life. We adapted UNICEF's Infant and Young Child Feeding (IYCF) counselling package according to the national IYCF training manual and translated it into Bangla (MOH&FW, 2013; UNICEF, 2012). We developed an android application incorporating breastfeeding counselling modules, which the CHWs used as an electronic job aid. The application included images and short texts to aid the CHWs, while counselling on the importance and continuation of exclusive breastfeeding, and provided cues to common breastfeeding-related challenges and solutions. The application also assisted CHWs in a practical demonstration of breastfeeding techniques. The application was compatible with running online and offline, generated visit schedules, and triggered colour-coded notifications for the scheduled visits. CHWs synced the electronic application with the central database server daily, to check for application updates, new live births notified by the evaluation team and uploaded records of their home visits.

We deployed 25 female CHWs exclusively for the intervention team. Each CHW delivered interventions to ~40 participants. We recruited CHWs from the local community, who had at least 12 years of schooling, and some had previous experience in community-based programmes. CHWs received an 8-day training on counselling content and skills, techniques of observing and assessing a mother's breastfeeding behaviour, and providing practical culturally appropriate demonstrations for correct positioning and attachment. Expert trainers from the Training Assistance for Health and Nutrition foundation, a local nutrition training agency, conducted training sessions under the supervision of a national expert and the research team. Training also included the use of the application in android tablets and on record keeping. We held two practical sessions with mothers of children under 6 months of age following the classroom sessions.

During participants' pregnancy, CHWs counselled at 7 months of gestation and then at 8–9 months. In the postpartum period, CHWs provided counselling within 2 weeks of a live birth, followed by monthly visits for up to 6 months of children's age. Each counselling session was approximately half an hour and generally had three parts as follows: (i) providing general messages on maternal and child wellbeing, maternal nutrition, dispelling common misconceptions about maternal diet during lactation, appropriate hygiene and care-seeking practices for illness; (ii) specific breastfeeding counselling and observation of breastfeeding technique including EBF; and (iii) troubleshooting on common challenges related to breastfeeding. The two antenatal counselling sessions also included messages on colostrum feeding, early initiation of breastfeeding (EIBF) and health risks of prelacteal feeding. From the third gestational trimester to the child's fifth month, each mother received up to eight scheduled counselling visits, depending on their presence at home at those visits. We invited other adult females and fathers to join the counselling sessions and engage in the discussions.

2.7 | Outcome measures

For this analysis, we included indicators of breastfeeding practices among children aged 0–5 months. The percentage of EBF measured monthly between 1 and 5 months was the primary outcome indicator. Following the World Health Organization (WHO) guidelines, we defined EBF as children receiving nothing other than breastmilk within the past 24 h of the interview. We excluded prescribed oral rehydration solutions and medications when assessing EBF status (WHO, 2008). Secondary outcomes were as follows: EIBF (within 1 h of birth), colostrum feeding and prelacteal feeding, breastfeeding with the provision of water, breastfeeding with other nonmilk liquids, breastfeeding with formula feeding/nonhuman milk, early introduction of complementary food and bottle feeding. We defined early introduction of complementary food as a child below 6 months of age receiving any soft, solid or semisolid food irrespective of receiving breastmilk in the past 24 h of the interview.

2.8 | Data collection

We employed 24 data collectors exclusively for the evaluation team and trained them to collect information about participants' backgrounds, healthcare-seeking behaviour and IYCF practices from intervention and comparison arms. At enrolment during pregnancy, we collected data on maternal background and household characteristics, and maternal knowledge of IYCF. The knowledge assessment tool had 10 items on IYCF identified from the UNICEF IYCF guideline (UNICEF, 2012). We collected follow-up data within 2 weeks of birth, including information on care-seeking behaviour for ANC, delivery care and PNC, breastfeeding initiation, colostrum feeding, prelacteal feeding and perceived birth size. If the mother was absent from home at the first postbirth visit, we collected the information at the subsequent follow-up visit. Afterwards, interviewers conducted five home visits, once monthly, between 1 and 5 months of the children's age for interviewing mothers on IYCF practices. If a mother was absent on a scheduled visit date, up to two repeat attempts were made within the month. The minor change in data collection time alignment is not likely to have impact analyses and conclusions as the child remains in the same month of age. Interviewers used a structured 24 h dietary recall questionnaire adapted from the Bangladesh Demographic and Health Survey's child nutrition questionnaire (NIPORT et al., 2016). We developed an electronic data collection application based on structured questionnaires for the data collectors. They received extensive training on the purpose and description of the tools, consent taking, interviewing skills and using the tablets with the data collection application. We ensured data quality by setting internal consistency and range checks in the electronic application and conducting random spot checks by field supervisors and the study investigator.

2.9 | Statistical analysis

We summarized maternal baseline characteristics and healthcare-seeking behaviour by intervention and comparison arms, using frequencies, percentages or means and SDs. We used household wealth as quintiles based on a score comprising household possession of agricultural land and ownership of dwelling land, building materials of the house, type of household sanitation facility, furniture, connection to national grid electricity supply, motorized and nonmotorized vehicles, selected electronic appliances, and poultry and livestock (Vyas & Kumaranayake, 2006). We summarized maternal knowledge of IYCF as a score out of 10, with each item given a weight of 1 for the correct answer (Cronbach's α 0.65). We calculated maternal body mass index (BMI) by dividing mother's weight in kilogram (kg) with height in metre squared (m^2) and created three categories—too thin (BMI < 18.50 kg/m^2), normal (BMI 18.50–24.99 kg/m^2) and overweight/obese (BMI ≥ 25.0 kg/m^2; WHO, 2000).

All outcomes were binary. Each outcome indicator was coded 1, where 1 denoting the practice was done. We summarized raw percentages for each outcome by study arm. We reported intervention effects for each outcome by relative risks (RR), with 95% confidence interval (CIs) and Wald test *p*, estimated from Poisson models with empirically adjusted SEs (Zou, 2004). We analysed the outcome at the individual level using intention-to-treat according to the original study arms. We also analysed by aggregating participants into one arm receiving the nutrition counselling intervention versus a usual practice comparison arm. We applied separate Poisson models to estimate the effect on EIBF, colostrum feeding, prelacteal feeding and EBF. All models included study arm and randomization blocks as fixed effects and a random effect for the study cluster for C-RCT design. For EBF, we report the RR by month (1–5) after birth, estimated by adding month as a categorical fixed effect and an interaction effect with the study arm. We also included an additional random effect for the child nested within the random effect for study clusters in the model to take into account the repeated measurements of EBF. We conducted a sensitivity analysis for EBF and prelacteal feeding, which adjusted for any maternal, household or birth characteristics with an observed imbalance between study arms. We also explored posthoc whether any maternal background and household characteristics, knowledge of breastfeeding, healthcare-seeking during pregnancy and mode of birth altered the effect (modified) of counselling on EBF when the children were 5 months old. We conducted all analyses using a 0.05 significance level. We used Stata 14 for all statistical analyses (StataCorp 2015).

3 | RESULTS

The 1500 pregnant women enrolled in the trial delivered 1355 live births, for whom we collected information on initial breastfeeding indicators, that is, EIBF, colostrum feeding and prelacteal feeding (Figure 1). There were 847 mother–child pairs in the intervention arm and 403 pairs in the comparison arm, who provided information on breastfeeding practices up to a maximum of five visits between 1 and 5 months of age. Visit completion was lower at earlier ages of children due to the absence of participants from the enrolment address (Table S1). Most of these absences were due to mothers' relocation to their parents' home around birth.

Participants' background characteristics were similar between the combined intervention and the comparison arms at baseline (Table 1). However, participants in the intervention arm had more female infants (53% vs. 46%) and slightly higher term births (≥37 weeks of gestation; 84% vs. 79%). Place of birth, skilled attendance at birth, mode of birth and receiving PNC within the first 7 days of birth were similar in the two arms (Table 2). Receiving ANC visits four or more times was higher in the intervention arm (25% vs. 18%). At 5 months of infants' age, 83% of mothers reported receiving advice on IYCF in the intervention arm compared with 31% in the comparison arm. CHWs from the study were the main source of IYCF-related advice in the intervention arm (82%). In contrast, most mothers in the comparison arm reported receiving IYCF-related advice from relatives and neighbours (25%).

Overall, EIBF was similar (~75%) in both arms (Figure 2). Prelacteal feeding was already marginal in the comparison arm; further, children in the intervention arm had half the risk of receiving prelacteal feeds (6% vs. 11%, RR: 0.54, 95% CI: 0.39, 0.76) than those in the comparison arm. The effect of counselling on prelacteal feeding was similar (adjusted RR [aRR]: 0.57, 95% CI: 0.41, 0.78) after adjusting for maternal background, heath care-seeking during pregnancy and mode of birth covariates (Figure S2). Among infants who received prelacteal foods, honey was given to 18% of newborns

TABLE 1 Background characteristics of participants, maternal knowledge of IYCF and household characteristics

Characteristics	Intervention $N = 902$% (n)[a]	Comparison $N = 453$% (n)[a]
Maternal characteristics		
Age (in years)		
<24	53.1 (479)	48.8 (221)
25–29	30.3 (273)	30.2 (137)
30+	16.6 (150)	21.0 (95)
Education—Mean(±SD) years of schooling	5.94 (±3.22)	6.13 (±2.88)
Occupation		
Employed	4.2 (38)	4.4 (20)
Homemaker	95.8 (864)	95.6 (433)
BMI, Mean(±SD)	20.81 (±3.47)	20.74 (±3.44)
Normal (BMI = 18.50–24.99 kg/m^2)	62.1 (560)	58.5 (265)
Too thin (BMI < 18.50 kg/m^2)	25.5 (230)	28.3 (128)
Overweight/obese (BMI > 25.0 kg/m^2)	12.4 (112)	13.3 (60)
Parity		
Nulliparous	46.2 (417)	43.5 (197)
Multiparous	53.8 (485)	56.5 (256)
Knowledge of IYCF[b]—Median (IQR) of (0-10 score)	7 [6, 8]	7 [6, 9]
Infant characteristics		
Gestational age (in weeks)		
Less than 32	1.3 (12)	2.4 (11)
32–36	15.0 (135)	18.5 (84)
37 or more	83.7 (755)	79.0 (358)
Type of birth		
Singleton	98.7 (890)	98.0 (444)
Multiple	1.3 (12)	2.0 (9)
Sex*		
Male	47.2 (426)	53.9 (244)
Female	52.8 (476)	46.1 (209)
Perceived birth size[c]		
Normal	85.4 (770)	89.0 (403)
Larger than normal	4.4 (40)	4.0 (18)
Smaller than normal	8.2 (74)	5.3 (24)
Household characteristics		
Wealth quintile		
Lowest	20.7 (187)	17.7 (80)

TABLE 1 (Continued)

Characteristics	Intervention N = 902% (*n*)[a]	Comparison N = 453% (*n*)[a]
Second	18.1 (163)	22.5 (102)
Middle	20.7 (187)	20.8 (94)
Fourth	20.0 (180)	20.8 (94)
Highest	20.5 (185)	18.3 (83)
Household food insecurity[c]		
Secure	43.2 (390)	44.8 (203)
Mild insecurity	10.8 (97)	8.4 (38)
Moderate insecurity	33.6 (303)	36.0 (163)
Severe insecurity	12.2 (110)	10.8 (49)

Abbreviations: BMI, body mass index; EIBF, early initiation of breastfeeding; IYCF, UNICEF's Infant and Young Child Feeding.

[a] Cells reported % (*n*) if not mentioned otherwise in the variable name.

[b] Knowledge items included colostrum feeding, EIBF, duration of EBF and continued breastfeeding, benefits of breastfeeding, the timing of introduction to water, nonmilk liquids, and solids and semisolids, breastfeeding during child's and mother's illness.

[c] Missing information: perceived birth size ($n = 26$), household food insecurity ($n = 2$).

*$p < 0.05$.

(10/56) in the intervention arm compared with 40% (17/50) in the comparison arm.

Nearly all infants in both arms were breastfed during the first 6 months. The proportion of EBF was high until the second completed month of age in both arms and then the decline was steeper in the comparison arm (Figure 3a). In the intervention arm at 5 months of age, 83% of infants were exclusively breastfed compared with 68% in the comparison arm. The prevalence of predominant breastfeeding (breastfeeding with water and nonmilk liquids) and breastfeeding with other nonhuman milk were similar in both the intervention and comparison arms across ages (Figure 3b,c). However, early introduction to solid and semisolid complimentary food was higher in the comparison arm than in the intervention arm (9% vs. 25% at 5 months of age in intervention and comparison arms, respectively; Figure 2d). Overall, bottle feeding was low (<5%) with no substantial difference between intervention and comparison arms (Figure S3).

Not surprisingly, the effect of counselling and practical demonstration on EBF practice changed over time ($p = 0.001$). EBF in the intervention arm was higher compared with the comparison arm by 16% (RR: 1.16, 95% CI: 1.08, 1.23) and 22% (RR: 1.22, 95% CI: 1.12, 1.33) at 4 and 5 months of age, respectively (Figure 4). The effect of the intervention on EBF was the same after adjusting for maternal background, IYCF knowledge and healthcare-seeking behaviour covariates in the sensitivity analysis (aRR: 1.15, 95% CI: 1.08, 1.23 at 4 months of age and aRR: 1.22, 95% CI: 1.12, 1.33 at 5 months of age, respectively; Figure S2).

TABLE 2 Maternal and newborn healthcare-seeking and source of receiving IYCF advice

Characteristics Maternal and newborn healthcare-seeking	Intervention % (*n*) *N* = 902	Comparison % (*n*) *N* = 453
Number of ANC visits[a,*]		
None	25.3 (206)	35.3 (160)
1–3	49.8 (449)	46.4 (210)
4 or more	24.6 (222)	18.3 (83)
Place of birth		
Home	59.7 (538)	60.5 (274)
Health facility	39.9 (360)	39.3 (178)
Others	0.4 (4)	0.2 (1)
Attendance at birth[a]		
Skilled birth attendant	46.8 (422)	42.6 (193)
Unskilled/traditional health provider	48.8 (440)	53.6 (243)
Others	4.0 (36)	3.3 (15)
Mode of childbirth		
Normal vaginal delivery	76.3 (688)	75.3 (341)
Assisted vaginal delivery	6.1 (55)	7.5 (34)
Caesarean section delivery	17.6 (159)	17.2 (78)
Service provider of PNC for a newborn within 7 days of birth[a]		
None/no PNC received	44.6 (363)	40.2 (202)
Medically trained provider	51.4 (463)	47.2 (214)
Other providers	2.4 (22)	1.6 (7)
Source of IYCF advices[b]	**N = 728**	**N = 335**
From any source[***]	83.4 (607)	31.0 (104)
Govt/NGO health care provider[*]	4.4 (32)	8.1 (27)
Study CHWs[***]	81.6 (594)	3.0 (10)
Other untrained providers	1.4 (10)	1.5 (5)
Relatives and neighbours[***]	12.9 (94)	24.5 (82)

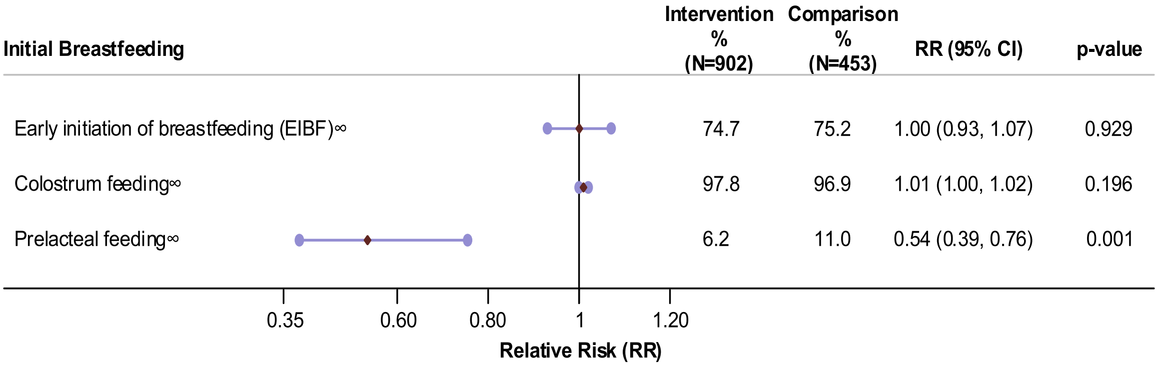
Abbreviations: ANC, antenatal care; CHW, community health worker; IYCF, UNICEF's Infant and Young Child Feeding; PNC, prenatal care.

[a] Information missing: number of ANC ($n = 3$), attendance at birth ($n = 6$), PNC ($n = 84$).

[b] Source of IYCF advice was assessed at 5 months of child's age.

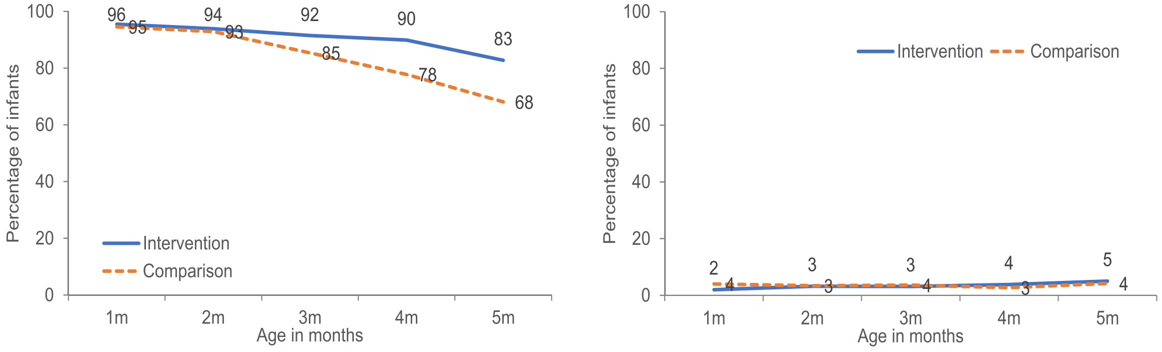
*$p < 0.05$; ***$p < 0.001$.

Maternal background characteristics and maternal knowledge of IYCF at baseline did not modify the effect of the intervention on EBF practice at 5 months of age (interaction $p > 0.05$; Table 3). However, the intervention effect varied by mode of birth (interaction $p = 0.012$). In the



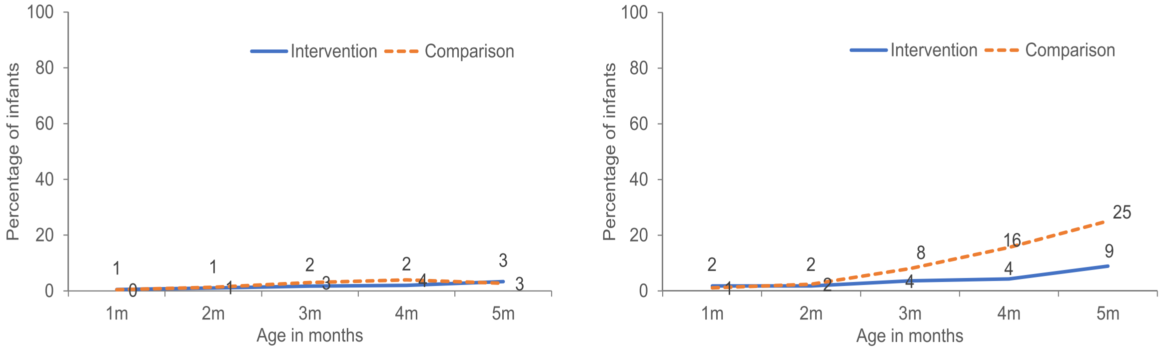
Initial Breastfeeding	Intervention % (N=902)	Comparison % (N=453)	RR (95% CI)	p-value
Early initiation of breastfeeding (EIBF)∞	74.7	75.2	1.00 (0.93, 1.07)	0.929
Colostrum feeding∞	97.8	96.9	1.01 (1.00, 1.02)	0.196
Prelacteal feeding∞	6.2	11.0	0.54 (0.39, 0.76)	0.001

FIGURE 2 Effect of nutrition counselling and practical demonstration on initial breastfeeding practices. EIBF, initiation of breastfeeding within 1 h of birth; ∞, information missing: EIBF (*n* = 13), colostrum feeding (*n* = 5), prelacteal feeding (*n* = 5); relative risk (RR) > 1 is favourable intervention effect for EIBF and colostrum feeding, and RR < 1 is favourable intervention effect for prelacteal feeding.



(a) Exclusive breastfeeding

(b) Predominant breastfeeding



(c) Breastfeeding and other milk

(d) Early introduction to complementary food

FIGURE 3 Infants aged 1-5 months were (a) exclusively breastfed, (b) predominantly breastfed (breastfeeding with other non-milk liquids), (c) Breastfed and received other milk, (d) introduced to complementary food, by study arm. Breastfeeding categories (a,b,c) and introduction to complementary food (d) are mutually exclusive.

intervention arm, infants who had a normal vaginal delivery and assisted vaginal birth were 1.25 times (95% CI: 1.14, 1.37) and 1.50 times (95% CI: 1.06, 2.14) more likely to be exclusively breastfed, compared with those in the comparison arm. In contrast, there was no statistically significant difference in EBF between intervention and comparison for caesarean births (RR: 1.04, 95% CI: 0.89, 1.21). A sensitivity analysis of the intervention effect according to the original randomization demonstrated a similar effect on EBF across all intervention arms individually and in the four intervention arms combined (Table S4).

4 | DISCUSSION

Our study showed that home-based counselling and practical demonstration by CHWs using an electronic job aid improves EBF by preventing the early introduction of complementary food before 6 months of children's age. Although several studies in LMICs have shown a positive effect of breastfeeding counselling provided by peer counsellors and community- and facility-based health care providers, evidence of an intervention using an electronic job aid in

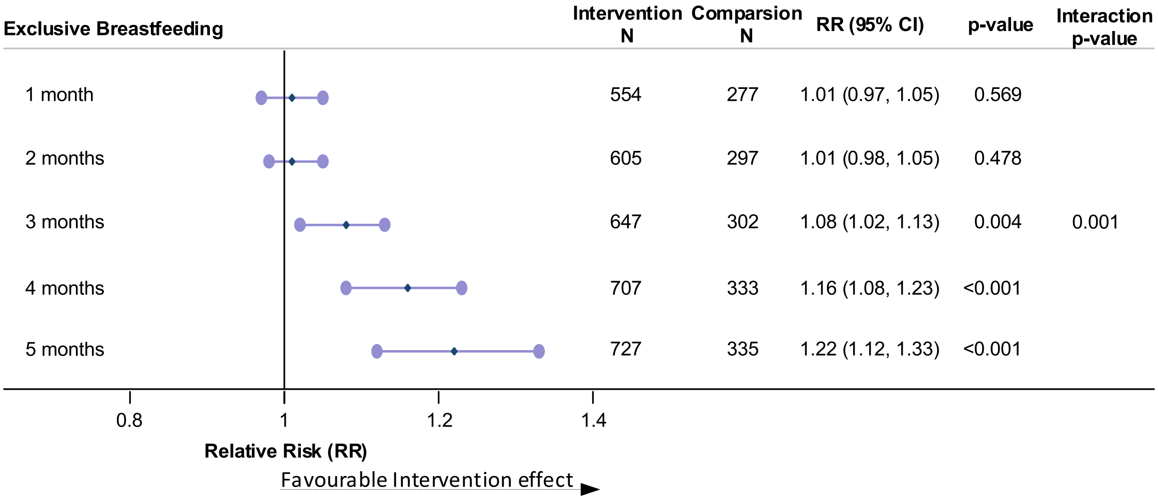


FIGURE 4 Effect of nutrition counselling and practical demonstration on exclusive breastfeeding among infants aged 1–5 months.

breastfeeding counselling is limited (Lassi et al., 2020). A systematic review of digital technology in breastfeeding promotion identified some web platform-based interventions for health care providers' knowledge improvement. However, none used an electronic job aid to support health care providers during breastfeeding counselling on-site and none were from LMICs (Tang et al., 2019). Our study adds important evidence of the effect of an intervention promoting breastfeeding in Bangladesh, where EBF is plateauing at the population level and where appropriate job aid for service providers is a logistics-related challenge in the health system (NIPORT & ICF, 2020). Nonetheless, the Government of Bangladesh has taken initiatives to digitalize health service delivery and record keeping by primary healthcare providers and frontline health workers (MEASURE Evaluation, 2019). The digital job aid tool can be adopted in the existing digital health service initiative to support the healthcare providers offering breastfeeding counselling in prenatal and postpartum health service contacts.

High coverage of colostrum feeding and EIBF reported in the study population are consistent with current national reports, with steady increases of these practices over the last decade in Bangladesh (Ara et al., 2018; Haider et al., 2010; NIPORT & ICF, 2020). Like several other studies, we found a negative association between caesarean section births and EIBF (Kavle et al., 2017; Prior et al., 2012). However, caesarean section births among our study participants were lower (17% in both arms) than the national rate (33%; NIPORT & ICF, 2020), which may explain the high proportion of EIBF in both study groups. The prevalence of prelacteal feeding in the comparison arm was low, similar to a recent estimate from the region (NIPORT & ICF, 2020). Counselling on this topic during the facility-based ANC visits may explain the lower prelacteal feeding in the intervention arm (Ara et al., 2018; Kushwaha et al., 2014).

Our study showed that a counselling and practical demonstration intervention effectively improved EBF, consistent with findings from nutrition education interventions promoting breastfeeding in LMICs (Keats et al., 2021). Although we found a 16–22% higher prevalence of EBF among intervention children at 4–5 months of age, Lassi et al.'s (2020) meta-analysis of nutrition education interventions from LMICs found a 53% increase in EBF at six months of age. However, most studies in the meta-analysis had a lower prevalence of EBF (<30%) among the control participants than in our study (Aksu et al., 2011; Bhandari et al., 2003; Gu et al., 2016; Ochola et al., 2013; Tylleskär et al., 2011). EBF prevalence at 5 months in our comparison arm (68%) was higher than the national EBF prevalence of 40% at 4–5 months (NIPORT & ICF, 2020). However, the effect of our intervention was similar to other community-based nutrition education studies conducted in rural Bangladesh and other LMICs (Abdulahi et al., 2021; Aidam et al., 2005; Arifeen et al., 2009; Azad et al., 2010; Flax et al., 2014; Khan et al., 2017; Younes et al., 2015).

In contrast to some previous studies, we found only a small difference in EBF between the intervention and comparison arms in the first 3 months (Aidam et al., 2005; Aksu et al., 2011; Ara et al., 2018; Bhandari et al., 2003; Flax et al., 2014; Gu et al., 2016; Ochola et al., 2013; Tahir & Al-Sadat, 2013). The high prevalence of EBF (85%) in the comparison arm up to 3 months of age helps explain this finding, which is consistent with the trend of high EBF in the first 2 months followed by a steep decline found in LMICs (NIPORT & ICF, 2020; Ochola et al., 2013). Reduction of EBF in our comparison arm was primarily due to the early introduction of complementary food, which is unlikely to occur during the first 3 months of life (Abiyu & Belachew, 2020; NIPORT & ICF, 2020; Przyrembel, 2012). A qualitative assessment from Bangladesh reported that mothers thought all foods should be introduced to infants from 3 months to familiarize the infants with eating (Haider et al., 2010). Previous studies have identified several breastfeeding-related knowledge gaps, misperceptions, and incorrect beliefs among mothers. These include mothers producing inadequate milk, mothers not having enough food to produce milk, children not getting enough milk, infants showing hunger cues, lack of confidence among mothers to continue EBF, lack of support for troubleshooting breastfeeding problems and knowledge of the duration of EBF, which result in early

TABLE 3 Effect of nutrition counselling and practical demonstration

Characteristics	Int. N	Com. N	Int. %	Com. %	RR (95% CI)	Interaction *p*
Maternal age (in years)						
<24	382	152	84.6	64.5	1.32 (1.16, 1.51)	0.144
25–29	218	115	79.8	71.3	1.11 (0.97, 1.27)	
30+	127	68	82.7	70.6	1.17 (0.99, 1.38)	
Maternal education						
Primary	385	187	80.8	64.2	1.26 (1.12, 1.42)	0.097
Secondary	293	135	86.1	71.1	1.20 (1.08, 1.35)	
Tertiary	49	13	79.6	92.3	0.95 (0.76, 1.19)	
Parity						
Nulliparous	328	134	85.1	67.2	1.28 (1.14, 1.45)	0.269
Multiparous	399	201	81.0	68.7	1.17 (1.05, 1.31)	
Maternal knowledge of IYCF						
Low	420	166	82.6	69.3	1.21 (1.09, 1.34)	0.883
Medium	159	73	83.7	63.0	1.27 (1.05, 1.52)	
High	148	96	82.4	69.8	1.20 (1.04, 1.40)	
Number of ANC visits						
None	161	112	83.9	71.4	1.19 (1.02, 1.39)	0.912
1–3	365	155	83.9	66.5	1.24 (1.12, 1.38)	
4 or more	187	66	79.7	65.2	1.23 (1.01, 1.51)	
Mode of birth						
Normal vaginal	556	258	82.0	68.3	1.25 (1.14, 1.37)	0.012
Assisted vaginal	48	23	85.4	56.5	1.50 (1.06, 2.14)	
Caesarean section	123	54	85.4	81.5	1.04 (0.89, 1.21)	
Household food security						
Secure	332	145	86.7	75.9	1.14 (1.02, 1.27)	0.421
Mild insecurity	81	25	76.5	56.0	1.42 (1.04, 1.94)	
Moderate insecurity	242	126	80.6	61.9	1.30 (1.09, 1.55)	
Severe insecurity	81	39	81.5	66.7	1.24 (0.94, 1.63)	
Socioeconomic status						
Lowest	148	62	82.3	62.9	1.34 (1.13, 1.59)	0.219
Second	137	76	81.8	59.2	1.37 (1.11, 1.71)	
Middle	140	73	87.1	76.7	1.12 (0.98, 1.28)	
Fourth	141	68	77.3	67.7	1.15 (0.95, 1.39)	
Highest	161	56	85.1	75.0	1.15 (0.99, 1.33)	

Note: Effect of nutrition counselling and practical demonstration on exclusive breastfeeding among infants aged 5 months by subgroups of maternal and household characteristics, healthcare-seeking and mode of birth.

Abbreviations: ANC, antenatal care; CI, confidence interval; Com., Comparison; Int., Intervention; IYCF, UNICEF's Infant and Young Child Feeding; RR, relative risk.

weaning (Haider et al., 2010; Hmone et al., 2016; Kavle et al., 2017; Nsiah-Asamoah et al., 2020; Rahman & Akter, 2019).

Consistent with findings from previous studies in Bangladesh, we found that relatives, friends and neighbours were the most reported source of information and advice on breastfeeding among the comparison arm participants (Haider et al., 2010; Kavle et al., 2017; Nsiah-Asamoah et al., 2020; Santacruz-Salas et al., 2020; Wanjohi et al., 2016). In-built into the counselling modules, we had prompts for the CHWs to clarify breastfeeding-related misconceptions to mothers and household members, which reduced negative influences like in other studies (Aksu et al., 2011; Younes et al., 2015). Our CHWs identified and addressed established problems against successful breastfeeding, such as suboptimal positioning and attachment practices, switching breasts and sitting positions (Haider et al., 2010). Such support enhances confidence and self-efficacy, and reduces mothers' frustrations and doubts about continuing EBF (McFadden et al., 2019; Santacruz-Salas et al., 2020; Shafaei et al., 2020).

We provided eight home-based counselling and practical demonstration visits between the third trimester of pregnancy and 6 months of infant's age. In previous studies, at least four counselling contacts showed a higher positive impact on EBF than less than four contacts (WHO, 2018). Ochola et al. (2013) also showed that seven home-based counselling visits positively impacted EBF at 3 and 6 months compared with no impact of health facility-based one-to-one counselling with a lower frequency. Similar high intensity and timely contacts effectively improved mothers' attitudes and prevalence of EBF among children below 6 months of age (Abdulahi et al., 2021).

Our study is among the few trials in LMICs that explored the effect of an electronic job aid-supported counselling and practical demonstration provided by CHWs to promote EBF among infants 0–5 months old. Although evidence is limited, previous studies reported that adoption of an electronic job aid improved health care providers' adherence to the recommended protocol for childhood illnesses and promotion of EBF (Borkum et al., 2015; Mitchell et al., 2013; Tang et al., 2019). Like a large-scale electronic job aid-supported community-based intervention in India, our counselling application with colour coded schedule reminders and electronic performance tracking might have ensured on-schedule completion of home visits by CHWs (Borkum et al., 2015). Counselling on maternal and child health and nutrition interventions by front-line workers in India supported by audio-visual job aids influenced their credibility and acceptance among the study participants (Chamberlain, 2014; Gopalakrishnan et al., 2020). We think there is likely a similar effect of counselling by our CHWs using our study's electronic device and application. Practical demonstration of appropriate breastfeeding technique and duration with context-relevant visual illustrations in the electronic application may have also enhanced the mothers' engagement and internalization of messages provided by the CHWs (Rahman et al., 2012). However, we cannot disentangle the effect of the electronic job aid alone on improved EBF, as we did not have an arm with counselling provided by CHWs without the electronic job aid. Nevertheless, the consistent, structured counselling visits multiple times by trained CHWs using the electronic job aid may have improved EBF among intervention children compared with the comparison group receiving infrequent infant feeding advice mostly from relatives and neighbours.

Several studies from high, middle and low-income countries have demonstrated a consistent negative association between caesarean birth and exclusive breastfeeding up to 6 months (Kavle et al., 2017; Khatun et al., 2018; Santacruz-Salas et al., 2020). However, our study found no statistical difference in EBF between infants with caesarean births in intervention and comparison arms, as the proportion of EBF in comparison arm was much higher than the proportions among normal and assisted vaginal delivery. Regarding prenatal LNS, a previous study in rural Bangladesh reports no difference in EBF practices between mothers who received LNS and those who did not, similar to our findings (Khan et al., 2017).

The main strength of our study is the C-RCT design and we found similar background characteristics between intervention and comparison arms, which is likely to reduce bias on the trial outcome. Secondly, adherence to the intervention schedule was high and, overall, lost to follow-up at 5 months of age was low (<15%) with no substantial difference between intervention and comparison arms. Thirdly, we used a locally adapted IYCF assessment tool used extensively in similar trials and nationwide surveys and implemented an independent assessment of outcomes (NIPORT et al., 2016).

Our study had some limitations. Firstly, we assessed breastfeeding practice outcomes based on mothers' self-reporting. We used a validated structured questionnaire with questions for consistency checking to minimise the bias. Data collectors were independent of the CHWs, unaware of outcome indicator definitions, and the same data collectors interviewed participants in both intervention and comparison arms. Secondly, we did not include assessment of breastfeeding self-efficacy among intervention and comparison arm mothers and in-depth process evaluation involving qualitative data collection techniques that could explain the effect pathway. Thirdly, the trial lacked an arm with CHWs providing counselling and practical demonstration in a conventional way without the electronic job aid. Therefore, assessing the effect of the electronic job aid on CHWs' skills and performance in delivering counselling and on EBF was not discernible. All these could be the focus of future research involving electronic job aid-based breastfeeding promotion interventions. Fourthly, we combined all four intervention arms into a single intervention arm, which had the intervention of interest of this analysis, that is, nutrition counselling using an electronic job aid. Combining the intervention arms is unlikely to have introduced any bias as neither the LNS provided during 0–5 months of children's age nor prenatal LNS would impact breastfeeding of the infants. Further, we have done an intention to treat analysis according to the original randomization and found the intervention effect consistent across all intervention arms.

5 | CONCLUSION

Promoting and supporting exclusive breastfeeding is the most important nutrition intervention during the first 6 months of a child's life. Our study provides evidence that counselling and practical demonstration provided by CHWs using an electronic job aid results in higher retention of EBF in a low resourced rural area in Bangladesh. Our findings also indicate that repeated counselling and demonstration visits by CHWs can prevent the critical faltering point of EBF at 3 months of age due to the early introduction of complementary food and can sustain EBF up to 6 months.

AUTHOR CONTRIBUTIONS

Shams El Arifeen, Sk Masum Billah, Purnima Menon, Tahmeed Ahmed, Stuart Gillespie, John Hoddinott and Michael J. Dibley designed the trial. Sk Masum Billah and Tarana E. Ferdous coordinated the field implementation. Nuzhat Choudhury and Tarana E. Ferdous developed the data collection tools. Rukhsana Haider coordinated the training of CHW to provide nutrition counselling. Abu Bakkar Siddique supported in data curation. Sk Masum Billah conducted the data analysis with inputs from Patrick Kelly. Sk Masum Billah drafted the manuscript with inputs from Michael J. Dibley, Camille Raynes-Greenow, Tarana E. Ferdous and Patrick Kelly. All authors reviewed, provided necessary edits and approved the final manuscript.

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CONFLICT OF INTEREST

The author declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

Abdulahi, M., Fretheim, A., Argaw, A., & Magnus, J. H. (2021). Breastfeeding education and support to improve early initiation and exclusive breastfeeding practices and infant growth: A cluster randomized controlled trial from a rural Ethiopian setting. *Nutrients*, *13*(4), 1204. https://doi.org/10.3390/nu13041204

Abiyu, C., & Belachew, T. (2020). Effect of complementary feeding behavior change communication delivered through community-level actors on the time of initiation of complementary foods in rural communities of West Gojjam zone, Northwest Ethiopia: A cluster-randomized controlled trial. *BMC Pediatrics*, *20*(1), 1–13. https://doi.org/10.1186/s12887-020-02396-z

Aidam, B. A., Perez-Escamilla, R., & Lartey, A. (2005). Lactation counseling increases exclusive breast-feeding rates in Ghana. *The Journal of Nutrition*, *135*(7), 1691–1695. https://doi.org/10.1093/jn/135.7.1691

Aksu, H., Küçük, M., & Düzgün, G. (2011). The effect of postnatal breastfeeding education/support offered at home 3 days after delivery on breastfeeding duration and knowledge: A randomized trial. *The Journal of Maternal-Fetal & Neonatal Medicine*, *24*(2), 354–361. https://doi.org/10.3109/14767058.2010.497569

Ara, G., Khanam, M., Papri, N., Nahar, B., Haque, M. A., Kabir, I., & Dibley, M. J. (2018). Peer counselling improves breastfeeding practices: A cluster randomized controlled trial in urban Bangladesh. *Maternal & Child Nutrition*, *14*(3), e12605. https://doi.org/10.1111/mcn.12605

Aranda-Jan, C. B., Mohutsiwa-Dibe, N., & Loukanova, S. (2014). Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa. *BMC Public Health*, *14*(1), 1–15. https://doi.org/10.1186/1471-2458-14-188

Arifeen, S. E., Hoque, D. E., Akter, T., Rahman, M., Hoque, M. E., Begum, K., & Ahmed, S. (2009). Effect of the integrated management of childhood illness strategy on childhood mortality and nutrition in a rural area in Bangladesh: A cluster randomised trial. *The Lancet*, *374*(9687), 393–403. https://doi.org/10.1016/s0140-6736(09)60828-x

Azad, K., Barnett, S., Banerjee, B., Shaha, S., Khan, K., Rego, A. R., & Prost, A. (2010). Effect of scaling up women's groups on birth outcomes in three rural districts in Bangladesh: A cluster-randomised controlled trial. *The Lancet*, *375*(9721), 1193–1202. https://doi.org/10.1016/s0140-6736(10)60142-0

BBS. (2013). *Bangladesh population and housing census 2011, community report, zila: Habiganj*.

Bhandari, N., Bahl, R., Mazumdar, S., Martines, J., Black, R. E., & Bhan, M. K., Infant Feeding Study Group. (2003). Effect of community-based promotion of exclusive breastfeeding on diarrhoeal illness and growth: A cluster randomised controlled trial. *The Lancet*, *361*(9367), 1418–1423. https://doi.org/10.1016/s0140-6736(03)13134-0

Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., Webb, P., Lartey, A., Black, R. E., & Lancet Nutrition Interventions Review Group, the Maternal and Child Nutrition Study Group. (2013). Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *The Lancet*, *382*(9890), 452–477. https://doi.org/10.1016/S0140-6736(13)60996-4

Billah, S. M., Ali, N. B., Khan, A., Raynes-Greenow, C., Kelly, P. J., Siraj, M. S., Askari, S., Menon, P., Arifeen, S. E., Dibley, M. J., & Nguyen, P. H. (2022). Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh. *PLoS One*, *17*(1), e0262867.

Billah, S. M., Ferdous, T. E., Karim, M. A., Dibley, M. J., Raihana, S., Moinuddin, M., Choudhury, N., Ahmed, T., Hoque, D., Menon, P., & Arifeen, S. E. (2017). A community-based cluster randomised controlled trial to evaluate the effectiveness of different bundles of nutrition-specific interventions in improving mean length-for-age z score among children at 24 months of age in rural Bangladesh:

study protocol. *BMC Public Health*, *17*(1), 375. https://doi.org/10.1186/s12889-017-4281-0

Billah, S. M., Ferdous, T. E., Kelly, P., Raynes-Greenow, C., Siddique, A. B., Choudhury, N., Ahmed, T., Gillespie, S., Hoddinott, J., Menon, P., Dibley, M. J., & Arifeen, S. E. (2021). Effect of nutrition counselling with a digital job aid on child dietary diversity: Analysis of secondary outcomes from a cluster randomised controlled trial in rural Bangladesh. *Maternal & child nutrition*, *18*, e13267. https://doi.org/10.1111/mcn.13267

Borkum, E., Sivasankaran, A., Sridharan, S., Rotz, D., Sethi, S., Manoranjini, M., & Rangarajan, A. (2015). *Evaluation of the Information and Communication Technology (ICT) Continuum of Care Services (CCS) Intervention in Bihar*. Mathematica Policy Research.

Brockway, M., Benzies, K., & Hayden, K. A. (2017). Interventions to improve breastfeeding self-efficacy and resultant breastfeeding rates: A systematic review and meta-analysis. *Journal of Human Lactation*, *33*(3), 486–499. https://doi.org/10.1177/0890334417707957

Cai, X., Wardlaw, T., & Brown, D. W. (2012). Global trends in exclusive breastfeeding. *International Breastfeeding Journal*, *7*(1), 1–5. https://doi.org/10.1186/1746-4358-7-12

Chamberlain, S. (2014). A mobile guide toward better health: How mobile kunji is improving birth outcomes in Bihar, India (Innovations Case Narrative: Mobile Kunji (Mobile Guide). *Innovations: Technology, Governance, Globalization*, *9*(3-4), 43–52. https://doi.org/10.1162/inov_a_00215

Flax, V. L., Negerie, M., Ibrahim, A. U., Leatherman, S., Daza, E. J., & Bentley, M. E. (2014). Integrating group counseling, cell phone messaging, and participant-generated songs and dramas into a microcredit program increases Nigerian women's adherence to international breastfeeding recommendations. *The Journal of Nutrition*, *144*(7), 1120–1124. https://doi.org/10.3945/jn.113.190124

Gopalakrishnan, L., Buback, L., Fernald, L., Walker, D., & Diamond-Smith, N., The CAS Evaluation Consortium. (2020). Using mHealth to improve health care delivery in India: A qualitative examination of the perspectives of community health workers and beneficiaries. *PLoS One*, *15*(1), e0227451. https://doi.org/10.1371/journal.pone.0227451

Gu, Y., Zhu, Y., Zhang, Z., & Wan, H. (2016). Effectiveness of a theory-based breastfeeding promotion intervention on exclusive breastfeeding in China: A randomised controlled trial. *Midwifery*, *42*, 93–99. https://doi.org/10.1016/j.midw.2016.09.010

Haider, R., Rasheed, S., Sanghvi, T. G., Hassan, N., Pachon, H., Islam, S., & Jalal, C. S. (2010). Breastfeeding in infancy: Identifying the program-relevant issues in Bangladesh. *International Breastfeeding Journal*, *5*(1), 1–12. https://doi.org/10.1186/1746-4358-5-21

Hmone, M. P., Dibley, M. J., Li, M., & Alam, A. (2016). A formative study to inform mHealth based randomized controlled trial intervention to promote exclusive breastfeeding practices in Myanmar: Incorporating qualitative study findings. *BMC Medical Informatics and Decision Making*, *16*(1), 1–10. https://doi.org/10.1186/s12911-016-0301-8

Ho, N. T., Li, F., Lee-Sarwar, K. A., Tun, H. M., Brown, B. P., Pannaraj, P. S., Bender, J. M., Azad, M. B., Thompson, A. L., Weiss, S. T., Azcarate-Peril, M. A., Litonjua, A. A., Kozyrskyj, A. L., Jaspan, H. B., Aldrovandi, G. M., & Kuhn, L. (2018). Meta-analysis of effects of exclusive breastfeeding on infant gut microbiota across populations. *Nature Communications*, *9*(1), 1–13. https://doi.org/10.1038/s41467-018-06473-x

Jones, G., Steketee, R. W., Black, R. E., Bhutta, Z. A., Morris, S. S., & Group, B. C. S. S. (2003). How many child deaths can we prevent this year? *The Lancet*, *362*(9377), 65–71. https://doi.org/10.1016/s0140-6736(03)13811-1

Källander, K., Tibenderana, J. K., Akpogheneta, O. J., Strachan, D. L., Hill, Z., ten Asbroek, A. H., Conteh, L., Kirkwood, B. R., & Meek, S. R. (2013). Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low-and middle-income countries: A review. *Journal of Medical Internet Research*, *15*(1), e17. https://doi.org/10.2196/jmir.2130

Kavle, J. A., LaCroix, E., Dau, H., & Engmann, C. (2017). Addressing barriers to exclusive breast-feeding in low-and middle-income countries: A systematic review and programmatic implications. *Public Health Nutrition*, *20*(17), 3120–3134. https://doi.org/10.1017/s1368980017002531

Keats, E. C., Das, J. K., Salam, R. A., Lassi, Z. S., Imdad, A., Black, R. E., & Bhutta, Z. A. (2021). Effective interventions to address maternal and child malnutrition: An update of the evidence. *The Lancet Child & Adolescent Health*, *5*, 367–384. https://doi.org/10.1016/S2352-4642(20)30274-1

Khan, A. I., Kabir, I., Eneroth, H., El Arifeen, S., Ekström, E. C., Frongillo, E. A., & Persson, L. A. (2017). Effect of a randomised exclusive breastfeeding counselling intervention nested into the MINIMat prenatal nutrition trial in Bangladesh. *Acta Paediatrica*, *106*(1), 49–54. https://doi.org/10.1111/apa.13601

Khatun, H., Comins, C. A., Shah, R., Islam, M. M., Choudhury, N., & Ahmed, T. (2018). Uncovering the barriers to exclusive breastfeeding for mothers living in Dhaka's slums: A mixed method study. *International Breastfeeding Journal*, *13*(1), 1–11. https://doi.org/10.1186/s13006-018-0186-5

Kushwaha, K. P., Sankar, J., Sankar, M. J., Gupta, A., Dadhich, J. P., Gupta, Y. P., Bhatt, G. C., Ansari, D. A., & Sharma, B. (2014). Effect of peer counselling by mother support groups on infant and young child feeding practices: The Lalitpur experience. *PLoS One*, *9*(11), e109181. https://doi.org/10.1371/journal.pone.0109181

Lassi, Z. S., Rind, F., Irfan, O., Hadi, R., Das, J. K., & Bhutta, Z. A. (2020). Impact of infant and young child feeding (iycf) nutrition interventions on breastfeeding practices, growth and mortality in low-and middle-income countries: Systematic review. *Nutrients*, *12*(3), 722. https://doi.org/10.3390/nu12030722

Lau, Y., Htun, T. P., Tam, W. S., & Klainin-Yobas, P. (2016). Efficacy of e-technologies in improving breastfeeding outcomes among perinatal women: A meta-analysis. *Maternal & Child Nutrition*, *12*(3), 381–401. https://doi.org/10.1111/mcn.12202

Local Burden of Disease Child Growth Failure Collaborators. (2020). Mapping child growth failure across low-and middle-income countries. *Nature*, *577*(7789), 231–234. https://doi.org/10.1038/s41586-019-1878-8

McFadden, A., Siebelt, L., Marshall, J. L., Gavine, A., Girard, L.-C., Symon, A., & MacGillivray, S. (2019). Counselling interventions to enable women to initiate and continue breastfeeding: A systematic review and meta-analysis. *International Breastfeeding Journal*, *14*(1), 1–19. https://doi.org/10.1186/s13006-019-0235-8

MEASURE Evaluation. (2019). *Implementation of the electronic management information system in Bangladesh: experience and lessons learned*.

Micha, R., Mannar, V., Afshin, A., Allemandi, L., Baker, P., Battersby, J., & Di Cesare, M. (2020). *2020 Global nutrition report: Action on equity to end malnutrition*. OCHA.

Mitchell, M., Hedt-Gauthier, B. L., Msellemu, D., Nkaka, M., & Lesh, N. (2013). Using electronic technology to improve clinical care–results from a before-after cluster trial to evaluate assessment and classification of sick children according to Integrated Management of Childhood Illness (IMCI) protocol in Tanzania. *BMC Medical Informatics and Decision Making*, *13*(1), 1–8. https://doi.org/10.1186/1472-6947-13-95

Modi, D., Dholakia, N., Gopalan, R., Venkatraman, S., Dave, K., Shah, S., Desai, G., Qazi, S. A., Sinha, A., Pandey, R. M., Anand, A., Desai, S., & Shah, P. (2019). mHealth intervention "ImTeCHO" to improve delivery of maternal, neonatal, and child care services—A cluster-randomized trial in tribal areas of Gujarat, India. *PLoS Medicine*, *16*(10), e1002939. https://doi.org/10.1371/journal.pmed.1002939

MOH&FW. (2013). *Infant and young child feeding training manual*.

NIPORT, & ICF. (2020). *Bangladesh demographic and health survey 2017–18*.

NIPORT, Mitra and Associates, & ICF International. (2016). *Bangladesh demographic and health survey 2014*.

NIPORT, Mitra and Associates, & ICF International. (2019). *Bangladesh demographic and health survey 2017-18: Key indicators*.

Nsiah-Asamoah, C., Doku, D. T., & Agblorti, S. (2020). Mothers' and grandmothers' misconceptions and socio-cultural factors as barriers to exclusive breastfeeding: A qualitative study involving Health Workers in two rural districts of Ghana. *PLoS One*, *15*(9), e0239278. https://doi.org/10.1371/journal.pone.0239278

Ochola, S. A., Labadarios, D., & Nduati, R. W. (2013). Impact of counselling on exclusive breast-feeding practices in a poor urban setting in Kenya: A randomized controlled trial. *Public Health Nutrition*, *16*(10), 1732–1740. https://doi.org/10.1017/s1368980012004405

Perri-Moore, S., Routen, T., Shao, A. F., Rambaud-Althaus, C., Swai, N., Kahama-Maro, J., D'acremont, V., Genton, B., & Mitchell, M. (2015). Using an eIMCI-derived decision support protocol to improve provider–caretaker communication for treatment of children under 5 in Tanzania. *Global Health Communication*, *1*(1), 41–47. https://doi.org/10.1080/23762004.2016.1181486

Prior, E., Santhakumaran, S., Gale, C., Philipps, L. H., Modi, N., & Hyde, M. J. (2012). Breastfeeding after cesarean delivery: A systematic review and meta-analysis of world literature. *The American Journal of Clinical Nutrition*, *95*(5), 1113–1135. https://doi.org/10.3945/ajcn.111.030254

Przyrembel, H. (2012). Timing of introduction of complementary food: Short- and long-term health consequences. *Annals of Nutrition and Metabolism*, *60*(Suppl. 2), 8–20. https://doi.org/10.1159/000336287

Rahman, A., & Akter, F. (2019). Reasons for formula feeding among rural Bangladeshi mothers: A qualitative exploration. *PLoS One*, *14*(2), e0211761. https://doi.org/10.1371/journal.pone.0211761

Rahman, A., Haq, Z., Sikander, S., Ahmad, I., Ahmad, M., & Hafeez, A. (2012). Using cognitive-behavioural techniques to improve exclusive breastfeeding in a low-literacy disadvantaged population. *Maternal & Child Nutrition*, *8*(1), 57–71. https://doi.org/10.1111/j.1740-8709.2011.00362.x

Saha, K. K., Billah, M., Menon, P., El Arifeen, S., & Mbuya, N. V. (2015). *Bangladesh national nutrition services: Assessment of implementation status*. World Bank.

Santacruz-Salas, E., Aranda-Reneo, I., Segura-Fragoso, A., Cobo-Cuenca, A. I., Laredo-Aguilera, J. A., & Carmona-Torres, J. M. (2020). Mothers' expectations and factors influencing exclusive breastfeeding during the first 6 months. *International Journal of Environmental Research and Public Health*, *17*(1), 77. https://doi.org/10.3390/ijerph17010077

Schmied, V., Beake, S., Sheehan, A., McCourt, C., & Dykes, F. (2011). Women's perceptions and experiences of breastfeeding support: A metasynthesis. *Birth*, *38*(1), 49–60. https://doi.org/10.1111/j.1523-536x.2010.00446.x

Shafaei, F. S., Mirghafourvand, M., & Havizari, S. (2020). The effect of prenatal counseling on breastfeeding self-efficacy and frequency of breastfeeding problems in mothers with previous unsuccessful breastfeeding: A randomized controlled clinical trial. *BMC Women's Health*, *20*, 1–10. https://doi.org/10.1186/s12905-020-00947-1

Shakya, P., Kunieda, M. K., Koyama, M., Rai, S. S., Miyaguchi, M., Dhakal, S., Sandy, S., Sunguya, B. F., & Jimba, M. (2017). Effectiveness of community-based peer support for mothers to improve their breastfeeding practices: A systematic review and meta-analysis. *PLoS One*, *12*(5), e0177434. https://doi.org/10.1371/journal.pone.0177434

Tahir, N. M., & Al-Sadat, N. (2013). Does telephone lactation counselling improve breastfeeding practices? A randomised controlled trial. *International Journal of Nursing Studies*, *50*(1), 16–25. https://doi.org/10.1016/j.ijnurstu.2012.09.006

Tang, K., Gerling, K., Chen, W., & Geurts, L. (2019). Information and communication systems to tackle barriers to breastfeeding: Systematic search and review. *Journal of Medical Internet Research*, *21*(9), e13947. https://doi.org/10.2196/13947

Tylleskär, T., Jackson, D., Meda, N., Engebretsen, I. M. S., Chopra, M., Diallo, A. H., & Goga, A. (2011). Exclusive breastfeeding promotion by peer counsellors in sub-Saharan Africa (PROMISE-EBF): A cluster-randomised trial. *The Lancet*, *378*(9789), 420–427. https://doi.org/10.1016/s0140-6736(11)60738-1

UNICEF. (2012). *The community infant and young child feeding counselling package: Key messages booklet*. Retrieved from New York: https://www.unicef.org/nutrition/files/Key_Message_Booklet_2012_small.pdf

Victora, C. G., Bahl, R., Barros, A. J., França, G. V., Horton, S., Krasevec, J., Murch, S., Sankar, M. J., Walker, N., Rollins, N. C., & Lancet Breastfeeding Series Group. (2016). Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. *The Lancet*, *387*(10017), 475–490. https://doi.org/10.1016/S0140-6736(15)01024-7

Vyas, S., & Kumaranayake, L. (2006). Constructing socio-economic status indices: How to use principal components analysis. *Health Policy and Planning*, *21*(6), 459–468. https://doi.org/10.1093/heapol/czl029

Wang, Y., Xue, H., Huang, Y., Huang, L., & Zhang, D. (2017). A systematic review of application and effectiveness of mHealth interventions for obesity and diabetes treatment and self-management. *Advances in Nutrition*, *8*(3), 449–462. https://doi.org/10.3945/an.116.014100

Wanjohi, M., Griffiths, P., Wekesah, F., Muriuki, P., Muhia, N., Musoke, R. N., Fouts, H. N., Madise, N. J., & Kimani-Murage, E. W. (2016). Sociocultural factors influencing breastfeeding practices in two slums in Nairobi, Kenya. *International Breastfeeding Journal*, *12*(1), 1–8. https://doi.org/10.1186/s13006-016-0092-7

WHO. (2008). *Indicators for assessing infant and young child feeding practices: Part1 definitions*.

WHO. (2018). *Guideline: counselling of women to improve breastfeeding practices*.

Wisnieski, L., Kerver, J., Holzman, C., Todem, D., & Margerison-Zilko, C. (2018). Breastfeeding and risk of metabolic syndrome in children and adolescents: A systematic review. *Journal of Human Lactation*, *34*(3), 515–525.

World Health Organization. (2000). *Obesity: preventing and managing the global epidemic*.

Younes, L., Houweling, T. A., Azad, K., Kuddus, A., Shaha, S., Haq, B., Nahar, T., Hossen, M., Beard, J., Copas, A., Prost, A., Costello, A., & Fottrell, E. (2015). The effect of participatory women's groups on infant feeding and child health knowledge, behaviour and outcomes in rural Bangladesh: A controlled before-and-after study. *Journal of Epidemiology and Community Health*, *69*(4), 374–381. https://doi.org/10.1136/jech-2014-204271

Zou, G. (2004). A modified poisson regression approach to prospective studies with binary data. *American Journal of Epidemiology*, *159*(7), 702–706. https://doi.org/10.1093/aje/kwh090

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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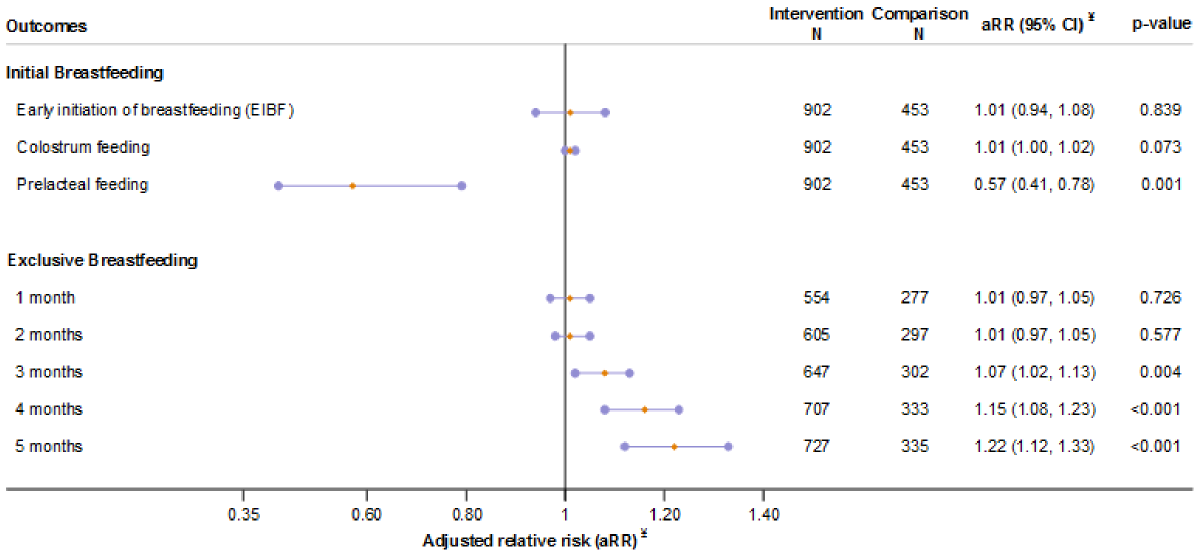
Supporting information

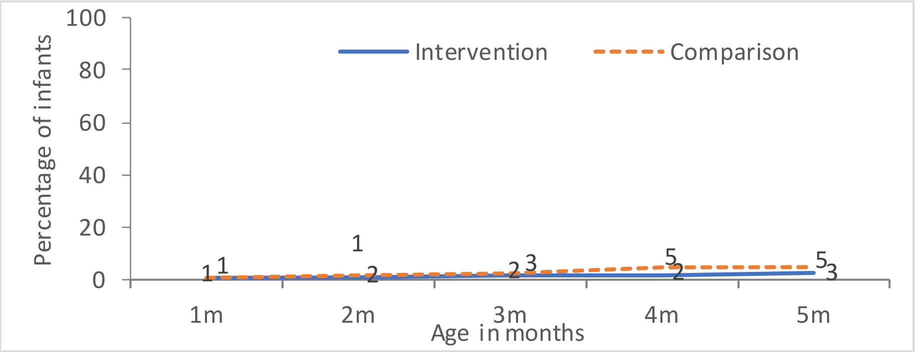
Appendix Table S1: Number and percentage of available samples and average cluster size at 1-5 months visits

Characteristics	Intervention		Comparison	
	% (n)	Cluster size Mean(±SD)	% (n)	Cluster size Mean(±SD)
Live births	902	9.24 (±1.49)	453	18.23 (±1.40)
Monthly follow-ups	N=847		N=403	
1 month	65.4 (554)	6.32 (±1.80)	68.7 (277)	12.97 (±2.93)
2 months	71.4 (605)	6.71 (±1.89)	73.7 (297)	12.81 (±2.94)
3 months	76.4 (647)	7.25 (±2.03)	74.9 (302)	12.71 (±2.57)
4 months	83.5 (707)	7.63 (±1.94)	82.6 (333)	14.05 (±2.57)
5 months	85.8 (727)	7.78 (±1.94)	83.1 (335)	13.97 (±2.64)



Outcomes	Intervention N	Comparison N	aRR (95% CI) ¥	p-value
Initial Breastfeeding				
Early initiation of breastfeeding (EIBF)	902	453	1.01 (0.94, 1.08)	0.839
Colostrum feeding	902	453	1.01 (1.00, 1.02)	0.073
Prelacteal feeding	902	453	0.57 (0.41, 0.78)	0.001
Exclusive Breastfeeding				
1 month	554	277	1.01 (0.97, 1.05)	0.726
2 months	605	297	1.01 (0.97, 1.05)	0.577
3 months	647	302	1.07 (1.02, 1.13)	0.004
4 months	707	333	1.15 (1.08, 1.23)	<0.001
5 months	727	335	1.22 (1.12, 1.33)	<0.001

Appendix Figure S2: Effect of nutrition counselling and practical demonstration on initial breastfeeding and exclusive breastfeeding among children aged 1-5 months adjusted for covariates; ¥adjusted for maternal age, education, knowledge on IYCF, sex of the child, household wealth, food insecurity, number of antenatal care visits and mode of birth; RR > 1 is favourable intervention effect for EIBF, colostrum feeding and exclusive breastfeeding, and RR<1 favours the intervention effect for prelacteal feeding



Appendix Figure S3: Percentage of children aged 1-5 months fed with bottle and nipple in the intervention and comparison arm

Appendix Table S4: Effect of nutrition counselling and practical demonstration with and without nutrient supplements on exclusive breastfeeding among children aged 1-5 months

Age[1]	**BCC+PNS+CFS (arm1)**	**BCC+PNS (arm2)**	**BCC+CFS (arm3)**	**BCC only (arm4)**	**Intervention combined (arms 1-4)**	**Comparison (arm5)**	**BCC+PNS +CNS vs. Comparison (arm1 vs. arm5)**	**BCC+PNS vs. Comparison (arm2 vs. arm5)**	**BCC+CFS vs. Comparison (arm3 vs. arm5)**	**BCC vs. Comparison (arm4 vs. arm5)**	**Intervention combined vs. Comparison (arms 1-4 vs arm5)**
	%	%	%	%	%	%	**aRR (95% CI)**	**aRR (95% CI)**	**aRR (95% CI)**	**aRR (95% CI)**	**aRR (95% CI)**
1mo	96.4	94.0	98.6	92.8	95.5	94.6	1.02 (0.96, 1.08)	1.00 (0.94, 1.05)	1.04 (0.98, 1.09)	0.98 (0.92, 1.04)	1.01 (0.97, 1.05)
2mo	95.5	94.3	94.6	90.9	93.9	92.9	1.03 (0.98, 1.07)	1.01 (0.96, 1.07)	1.02 (0.96, 1.08)	0.98 (0.93, 1.04)	1.01 (0.97, 1.05)
3mo	91.7	92.9	92.4	89.0	91.5	85.4	1.08 (1.01, 1.15)*	1.09 (1.03, 1.14)*	1.07 (1.02, 1.13)*	1.06 (0.98, 1.13)	1.07 (1.02, 1.13)**
4mo	86.9	90.9	90.7	91.5	89.9	77.8	1.11 (1.02, 1.21)*	1.16 (1.08, 1.25)***	1.16 (1.08, 1.25)***	1.18 (1.10, 1.27)***	1.15 (1.08, 1.23)***
5mo	86.0	79.6	82.1	83.7	82.8	68.1	1.26 (1.15, 1.39)***	1.17 (1.04, 1.32)***	1.20 (1.08, 1.34)***	1.24 (1.12, 1.38)***	1.22 (1.12, 1.33)***

[1] Age in months (mo), BCC: Behaviour change communication (nutrition counselling and practical demonstration with electronic job aid), PNS: Lipid-based prenatal nutrient supplement, CFS: Lipid-based complementary nutrient supplement during 6-23 months of age, aRR: relative risk-adjusted for maternal age, education, knowledge on IYCF, sex of child, household wealth, food insecurity, number of antenatal care visits and mode of birth, *p<0.05, **p<0.01, *** p<0.001

Chapter 6: Promotion of child dietary diversity

Paper 4: Effect of nutrition counselling with a digital job aid on child dietary diversity: Analysis of secondary outcomes from a cluster randomised controlled trial in rural Bangladesh

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Effect of nutrition counselling with a digital job aid on child dietary diversity: Analysis of secondary outcomes from a cluster randomised controlled trial in rural Bangladesh

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Abstract

Adequate dietary diversity among infants is often suboptimal in developing countries. We assessed the impact of nutrition counselling using a digital job aid on dietary diversity of children aged 6–23 months using data from a cluster randomised controlled trial in Bangladesh. The trial had five arms, each with 25 clusters. The four intervention arms provided counselling using a digital job aid and different prenatal and post-natal combinations of lipid-based supplements and the comparison arm with usual practice. We enrolled 1500 pregnant women and followed them until the children reached their second birthday. We developed a tablet-based system for intervention delivery, data collection and project supervision. We combined the four intervention arms ($n = 855$), in which community health workers (CHWs) provided age-appropriate complementary feeding counselling, to compare against the comparison arm ($n = 403$). We calculated the outcome indicators from the children's 24-h dietary recalls. Overall, the intervention increased the mean dietary diversity score by 0.09 (95% confidence interval [CI]: 0.2–0.16) and odds of minimum dietary diversity by 18% (95% CI: 0.99–1.40). However, there was a significant interaction on the effect of the intervention on dietary diversity by age. The mean dietary diversity score was 0.24 (95% CI: 0.11–0.37) higher in the intervention than in the comparison arm at 9 months and 0.14 (95% CI: 0.01–27) at 12 months of age. The intervention effect was non-significant at an older age. Overall, consumption of flesh food was 1.32 times higher in the intervention arm (odds ratio [OR] 1.32, 95% CI: 1.11–1.57) in 6–23 months of age. The intervention significantly improved child dietary diversity score in households with mild and moderate food insecurity by 0.27 (95% CI: 0.06–0.49) and 0.16 (0.05–27), respectively, but not with food-secure and severely food-insecure households. Although the study did not evaluate the impact of digital job aid alone, the findings indicate the utility of nutrition counselling by CHWs using a digital job aid to improve child feeding practices in broader programmes.

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1 | INTRODUCTION

Childhood undernutrition remains a significant global challenge and is at the core of the Sustainable Development Goals. A recent analysis of data from low- and middle-income countries (LMICs) suggested a moderate reduction in childhood stunting but slow progress in wasting between 2000 and 2015 with high socio-economic inequity, especially in low-income countries (Victora et al., 2021). About 22% of the world's under-five children remains stunted, mostly (54%) from South Asia (Micha et al., 2020). Infant and young child feeding (IYCF) practices, including dietary diversity during 6 to 23 months of life, are critical for a child's growth and development (World Health Organization [WHO], 2003). Inadequate dietary patterns have been linked to acute and chronic childhood undernutrition and can result in long-term adverse consequences (Bhutta et al., 2013; Victora et al., 2021). Promoting appropriate IYCF is a recommended priority intervention to reduce childhood undernutrition (Keats et al., 2021). Evidence from Bangladesh has also shown a positive impact of appropriate IYCF practices, including adequate dietary diversity on better growth outcomes (K. K. Saha et al., 2008). In addition to promoting appropriate IYCF practices, small-quantity lipid-based complementary nutrient supplementation (SQ-LNS) effectively reduced childhood stunting, wasting and anaemia (Dewey et al., 2021; Keats et al., 2021).

The WHO recommends that children between 6 and 23 months eat a minimum of four out of seven standard food groups daily to meet nutritional demand for optimal growth (WHO, 2010). Further, WHO recommends children consume animal-sourced foods from 6 months of age because of the high bioavailability of protein, iron and other essential nutrients in these foods (Shapiro et al., 2019). There are reports from resource-poor settings like Bangladesh of suboptimal nutrition due to a low protein intake in children's daily diet (Choudhury et al., 2019; Islam et al., 2018).

Despite Bangladesh having one of the fastest declining rates of chronic childhood undernutrition in the last two decades, it was still among the 27 high burden countries with more than 20% of children stunted in 2017–2018 (Fanzo et al., 2018; Headey, 2013). Further, there is heterogeneity across geographic and socio-economic groups (U. R. Saha et al., 2019). Notably, health sector nutrition interventions contributed to 16% of the change in childhood stunting over recent decades (Headey et al., 2015). Nutrition-specific interventions like promoting of appropriate IYCF practices have not led to consistent improvements in child feeding indicators (NIPORT et al., 2016). The minimum acceptable dietary practices, including continued breastfeeding, consumption from four or more food groups and appropriate meal frequency, stagnated at ∼21%–23% between 2011 and 2014 and only improved to 34% in the latest 2017–2018 national survey (Manikam et al., 2018; NIPORT et al., 2019). Dietary diversity remained low, with only 39% of children aged 6–23 months consuming from ≥4 food groups in the last 24 h (NIPORT et al., 2019).

Ensuring adequate dietary diversity among 6- to 23-month-old children in resource-poor settings like Bangladesh appears to depend on a variety of background characteristics including socio-economic status, paternal education, maternal knowledge on child feeding, household food security, engagement in agriculture and location of residence (Choudhury et al., 2019; Dangura & Gebremedhin, 2017; Issaka et al., 2015; Manikam et al., 2018; Solomon et al., 2017). Improved dietary practices are associated with receiving routine maternal care services throughout pregnancy and the post-partum period and receiving IYCF messages during health care contacts or through targeted counselling demonstration visits (Blackstone & Sanghvi, 2018; Iqbal et al., 2017). Introduction and regular provision of different groups of complementary foods, especially animal-sourced protein, often rely on the caregiver's perception and knowledge about appropriate feeding practices (Rasheed et al., 2011).

The positive impact of face-to-face nutrition counselling of caregivers, either delivered alone or with other behaviour change interventions to improve children's feeding practices, is well documented (Kim et al., 2020). Multiple studies in Bangladesh have demonstrated that nutrition counselling, either one-to-one or in small groups of mothers, improved feeding practices among children aged <2 years (Menon et al., 2016; Mistry et al., 2019; Owais et al., 2017). Another study found that group counselling intervention leads to 'spill-over' impact on dietary diversity among children of neighbouring women (Hoddinott et al., 2017).

Key messages

- Nutrition counselling of mothers by community health workers using a digital job aid can improve dietary diversity and consumption of animal-sourced protein among 6- to 23-month-old children.
- Household food insecurity is an important modifying factor for the impact of nutrition counselling on a child's dietary diversity.
- Nutrition counselling can result in the early introduction of multiple food groups but may have less effect at older ages.
- Policymakers should consider wider programmatic use of digital device-aided nutrition counselling for community-based programmes.

In Bangladesh, frontline workers at community-based contacts or primary health care centres are the primary providers of nutrition interventions like IYCF counselling (Menon et al., 2016; K. K. Saha et al., 2015). These services are often of substandard quality due to gaps in service providers' knowledge and skills, high workloads and lack of proper logistics and job aids (Billah et al., 2017). In similar settings, the use of mobile devices (called mHealth) has improved health worker's knowledge and skills, quality of child health services and caretaker's recall of counselling messages (Källander et al., 2013; Perri-Moore et al., 2015). A recent review of grey literature and a survey of experts identified that 53 digital tools had been implemented in different countries at a pilot or large scale to improve quality nutrition service delivery. Thirty-six of these tools provided decision support to service providers on nutrition service protocols, and 25 tools supported IYCF counselling (USAID Advancing Nutrition, 2020). However, documented evidence about the likely effects of counselling of mothers using digital job aids on children's dietary practices is scarce.

We implemented a community-based cluster randomised controlled trial (cRCT) in Bangladesh to explore the effect of four bundles of selected nutrition-specific interventions on the children's linear growth at 2 years of age (Billah et al., 2017). Individual counselling by community health workers (CHWs) using a custom-designed electronic application to mothers of children aged 6–23 months old on appropriate IYCF practices was the common component in all four intervention bundles. In this manuscript, we present the findings on the effect of this nutrition counselling of mothers using a digital job aid on the dietary diversity of their 6- to 23-month-old children, a secondary outcome of the trial.

2 | METHODS

2.1 | Study design and setting

We conducted a parallel five-arm cRCT between 2015 and 2019. The trial's primary objective was to assess the impact of four maternal and child nutrition-specific intervention bundles on children's length-for-age *Z*-score at 2 years of age. The intervention bundles consisted of three basic nutrition-specific interventions in four different combinations, delivered during the 'first 1000 days' of the child's life. These interventions were (1) counselling using a digital job aid on maternal nutrition during pregnancy, and child nutrition through exclusive breastfeeding up to 6 months and appropriate complementary feeding from 6 to 23 completed months; (2) lipid-based prenatal nutrient supplement; and (3) lipid-based complementary nutrient supplement during 6–23 months of age. Arm-wise intervention combinations included nutrition counselling, prenatal nutrient supplement and complementary nutrient supplement (arm1); nutrition counselling and perinatal nutrient supplement (arm2); nutrition counselling and complementary nutrient supplement (arm3); nutrition counselling alone (arm4); and a natural practice comparison arm (arm5) (Figure 1). We identified women within 125 days of gestation in the intervention and comparison clusters and followed them until the children were 2 years of age. A detailed description of the study design, interventions and data collection methods has been previously published (Billah et al., 2017).

This paper focuses on nutrition counselling using digital job aids provided in all four intervention arms to improve child feeding practices. To assess counselling's effect on dietary diversity among 6- to 23-month-old children, we combined the intervention arms and compared this with the comparison arm. Previous studies showed no impact of lipid-based complementary nutrient supplement (LNS) on infants' dietary diversity (Arimond et al., 2017). Nonetheless, before combing the intervention arms, we examined the intervention's effect on dietary diversity in each intervention arm compared with the comparison arm. We combined the intervention arms to increase the statistical power for subgroup analysis of the impact of nutrition counselling using a digital job aid. Figure 1 shows the original trial design, the arms we combined for this analysis and the number of study participants available at follow-up visits. We conducted the study in two rural subdistricts, Bahubal and Nabiganj of Habiganj district, a north-east district in Bangladesh with a high level of childhood undernutrition (NIPORT et al., 2016). We selected 12 unions, the lowest administrative unit, each comprising ~25,000 people. We defined 125 study clusters each with ~2000 people. Using Stata software, we randomly allocated 25 clusters to each of the five study arms using a block randomisation process with block sizes of 5–15. We had allocation concealment at the cluster level. A statistician assigned deidentified clusters into study arms before starting enrolment of participants. A field manager unmasked cluster identity and disclosed to the CHWs about the interventions to be provided to participants in each cluster according to the assigned study arm. Blinding of CHWs and the participants was not possible due to the type of interventions, that is, counselling and LNS.

We implemented a monthly house-to-house surveillance of married women of reproductive age by community-based surveillance workers to prospectively identify and enrol new pregnancies in the study, 10 in each intervention and 20 in each comparison cluster. We enrolled 1500 pregnant women between November 2015 and May 2016, 250 in each intervention and 500 in the comparison arm. The enrolled pregnant women had 1355 live births (902 in the intervention arms and 453 in the comparison arm), and we followed the newborns for 2 years (Figure 1). This paper included 1258 children (855 in intervention and 403 in comparison) who were alive at 6 months of age and followed up to 2 years between August 2016 and January 2019. The sample size was determined to detect an effect size of 0.4 difference of mean length-for-age *Z*-score, the primary trial outcome (Billah et al., 2017).

2.2 | Intervention description

We adapted maternal and child nutrition counselling messages recommended by WHO-UNICEF (UNICEF, 2012). We consulted the National IYCF training package for health workers to ensure convergence with locally customised messages and appropriate

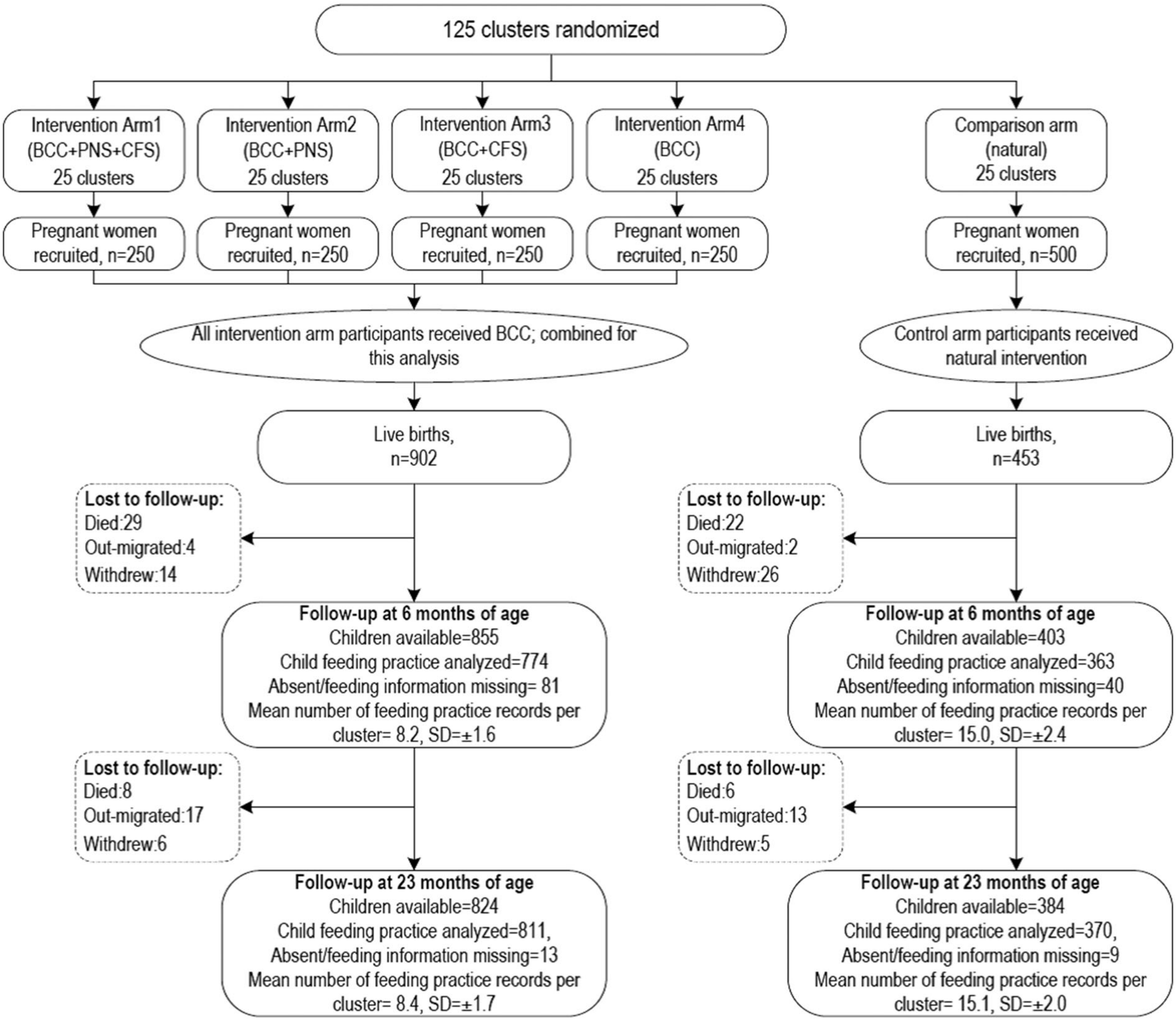


FIGURE 1 CONSORT diagram showing study arms and the number of participants available at follow-up visits. BCC, behaviour change communication refers digital platform-aided nutrition counselling; CNS, lipid-based complementary nutrient supplement during 6–23 months of age; PNS, lipid-based prenatal nutrient supplement

terminologies in the native language Bangla. Nutrition counselling messages for children 6–23 months included the importance and techniques of timely initiation of complementary feeding, age-appropriate thickness, quantity, frequency and diversity in complementary feeding, continued breastfeeding, responsive feeding, feeding sick children and picky eaters and basic hygiene practices. We introduced the participants to the concept of different food groups, which they would remember easily, without burdening them with excessive information. We highlighted the importance of animal-sourced protein (meat, fish, organ meat and egg) and fresh fruits and vegetables in daily complementary feeding. The health workers showed participants the relevant pictorial illustrations of food groups and 'recommended to avoid' practices included in the counselling application to facilitate communications. Each counselling session continued for about an hour but varied according to the mothers' situation. Half of the intervention children also received LNS consisting of selected micronutrients (~70%–75% of recommended dietary allowance) in peanut-and-oil paste. Participants in the natural practice comparison arm received no intervention from the study but had access to routine care and nutrition counselling for children from local paediatric outpatient health service contacts. However, previous literature reported that current curative service platforms have very low coverage and quality in providing preventive nutrition service like nutrition counselling (K. K. Saha et al., 2015).

We developed an android-based software application to aid in scheduling and providing nutrition counselling by CHWs. The counselling app had built-in age-appropriate messages on feeding practices, to guide the CHWs. The messages provided focused guidance to the CHWs during their counselling sessions aiding them in the challenges of recalling a broad spectrum of age-wise IYCF messages. The digital tool also helped them navigate across the topics as required. During children's 6–23 months of age, each mother–child pair received up to seven counselling visits at 3-month intervals starting from six completed months. After notification and entry of a live birth into the system, the counselling app synchronised the birthdate and auto-generated post-partum intervention visit plans. The CHWs conducted home visits within ±7 days of the scheduled date for intervention delivery. They made one repeat visit to attempt within the month of the visit schedule if the caregiver was absent.

All CHWs and their immediate supervisors were female, locally recruited and spoke the local dialects of Bangla. We trained the CHWs for 6 days in two phases (3 days each) on the content, counselling techniques and use of the counselling app on the mobile device. The training emphasised the importance and ways of introducing complementary food, multiple food groups, age-appropriate meal consistency, frequency and quantity. A content expert initially observed each CHW to ensure that they provided appropriate nutrition messages using suitable techniques. Further, we conducted monthly supervision-monitoring meetings and periodic refresher training throughout the study.

We established a web-based Project Management Information System (MIS) in which we linked intervention delivery through an android-based tablet to a central database. The application recorded the completion status in different colour codes of all visits made by CHWs to provide nutrition counselling. The CHWs synced the visit status and relevant information from the application with the central server every day. Field supervisors and the central team regularly used the web-based desktop dashboard system to monitor activities/performance and provide appropriate feedback. We have reported a detailed description of this system elsewhere (Billah et al., 2017).

2.3 | Outcome variables

This paper's outcome variable of interest is the dietary diversity score, a secondary outcome of the trial. We calculated the score using the WHO definition of the number of food groups consumed by a child in the 24 h preceding the interview from seven food groups (WHO, 2008). These food groups include grains, roots and tubers; legumes and nuts; dairy products (milk, yoghurt and cheese); flesh foods (meat, fish, poultry and organ meats); eggs; vitamin-A-rich fruits and vegetables; and other fruits and vegetables. We assigned 1 point to a food group if the child consumed any food of that group in the previous 24 h. For composite meals, we assigned each food component separately to its associated food group. Thus, the dietary diversity score for each child could have values from 0 to 7. We calculated the minimum dietary diversity indicator from the dietary diversity scores, defined as ‘children aged 6–23 months fed foods from four or more food groups in the 24 h before the interview’ (WHO, 2008). We also considered the consumption of each of the seven food groups as outcome indicators.

2.4 | Data collection

We conducted structured interviews with the study participants (pregnant women) at enrolment to collect their background characteristics, reproductive history, household asset and food security. We conducted structured interviews within 10 days of childbirth to collect the birth outcome, mode and type of birth from the current pregnancy and health care seeking. We collected information on feeding practices for children aged 6–23 months by 24-h recall method using a structured questionnaire. We adapted the IYCF module of the Bangladesh Demographic and Health Survey for contextualisation of the common food items and local terms (NIPORT et al., 2016). Interviewers asked the mothers if they had fed the child each of the food items listed in the questionnaire in the 24 h preceding the interview. We collected children's feeding practice information at a maximum of seven time points at 6, 9, 12, 15, 18, 21 and 23 completed months of age. An electronic app, which included all questionnaire modules, was developed for conducting interviews using internet-connected tablets. The app had options for conducting the interview offline and uploaded stored information to a central server when the tablet had internet connectivity. Data collectors, independent from the intervention implementation team, were recruited and trained in interviewing skills, questionnaires and using the app for data collection. The evaluation team supervisors monitored the completion of scheduled visits and quality of interviews by spot checks.

2.5 | Statistical analysis

We followed the intention-to-treat principle in data analysis. Child feeding practices evaluated by a 24-h recall interview differ by the child's age (NIPORT et al., 2019). We excluded the data collected more than ±1 month from the scheduled visit except for the 6-month visit. We included the interviews conducted between 6 and 7 months as 6-month visit data in the analysis.

We compared the distribution of household socio-economic status and food security, maternal background characteristics and health care practices at birth across the intervention and comparison arms. We applied principal component analysis to data on household assets to construct a wealth index and divided participants into wealth quintiles based on the index (Vyas & Kumaranayake, 2006). We analysed the intervention effect on the continuous outcome variable, that is, dietary diversity score and binary outcome variables, including minimum dietary diversity and consumption from each food group by linear and logistic mixed models. We included the intervention, that is, receiving nutrition counselling as a binary variable and adjusted for follow-up visits at different age and randomisation blocks as categorical explanatory variables (fixed effect) in the models. We included two random effects: one for the cluster randomisation and another for repeated measurements of children nested within the clusters. We also assessed whether the intervention effect varied by child's age, maternal education, socio-economic status and household food security by fitting additional models that included an interaction term between intervention and those variables. We tested statistical significance for the interactions and summarised the estimated intervention effects as mean differences and odds ratios (ORs) for continuous and categorical outcomes, respectively. We calculated 95% confidence intervals (CIs) and *p*-values for point estimates of the intervention effect. The difference in outcome between the intervention and comparison arms was considered statistically significant at a level of *p*-value < 0.05. We conducted all analyses using Stata Version 14.

2.6 | Ethical consideration

This study was registered with ClinicalTrials.gov and approved by the Ethical Review Committee of icddr,b. We completed trial registration in May 2016 after the start of participant recruitment but before completion of enrolment and any of the outcome assessments. However, we did not deviate from the original ethics approved protocol, which we published in 2017 (Billah et al., 2017). We analysed the entire cohort of recruited trial participants. We obtained written informed consent from study participants at two enrolment points. The first was during enrolment, and the second was at the first follow-up visit after birth. At each follow-up visit, we obtained verbal consent and confirmed voluntary participation.

3 | RESULTS

This analysis included complementary feeding practice data from 1258 children: 855 in the intervention and 403 in the comparison arm. We followed up 1013 children to a maximum of seven scheduled visits between 6 and 23 months of age (Figure 1) with 689 in the intervention and 324 in the comparison arm. Data availability from each visit ranged from ~90% at the 6-month visit (lowest availability) to ~95% at the 9-month visit (highest availability). Data were missing mainly due to the absence of the mother at the scheduled household visits. Nonetheless, there were also some refusals, permanent relocations out of the study area and child deaths (Figure 1 and Table S1). The mean age at the follow-up visits was close to the targeted age in the planned schedule and had small standard deviations (Table S1). The study implementation monitoring reports suggested >90% completion of scheduled counselling visits by CHWs between 6 and 23 months of child's age (data not shown). Exposure to nutrition counselling from existing government and NGO providers was low, 11% and 13% in the intervention and comparison arms at 12 months of child's age, respectively.

Overall, maternal background, household characteristics and health care-seeking practices at birth were similar in the intervention and comparison arms, except for the distribution of the sex of the child (female 53% vs. 46% in intervention and comparison, respectively) (Table 1). Analyses of dietary diversity score showed a significant interaction of the effect of the intervention by age and household food security status (Figure 2). The mean dietary diversity scores (out of 7) were significantly higher at 9 months (mean difference 0.24, 95% CI: 0.11–0.37) and at 12 months (mean difference 0.14, 95% CI: 0.01–0.27) among children in the intervention arm than in the comparison arm. Counselling interventions had no effect on the dietary diversity score among children in the two extreme groups of food insecurity, that is, participants with no household food insecurity and severe food insecurity. However, we observed a larger impact of the intervention on diet diversity score among participants with mild food insecurity (mean difference between intervention and comparison participants: 0.27, 95% CI: 0.06–0.49) and moderate food insecurity (mean difference 0.16, 95% CI: 0.05–0.27) (Figure 2).

There was a similar pattern of effect of nutrition counselling on minimum dietary diversity by child's age and food security status (Figure 3). The minimum dietary diversity was 2.13 times (95% CI: 1.18–3.82) higher among intervention children at 9 months of age and 1.49 times (95% CI: 1.16–1.90) higher among moderately food-insecure children in the intervention arm than those in the comparison arm. Among children from households with mild food insecurity, 21% of the intervention children had minimum dietary diversity compared with 15% in comparison children, although statistical significance was marginal (OR 1.54, 95% CI: 0.98–98.03). We found very similar effects for mean dietary diversity score and minimum dietary diversity in each of the four original intervention arms compared with the comparison (Table S2).

The nutrition counselling intervention showed a significant overall effect during 6–23 months on intake of flesh food and eggs (Table 2). Consumption of animal-sourced protein (eggs, meat, organ meat or fish) was 1.33 times higher in the intervention arm (intervention 60% vs. comparison 56%, OR 1.33, 95% CI: 1.11–1.60). However, the intervention effect on these food groups was higher at younger ages. Consumption of egg was 68% higher among intervention children than the comparison arm at 9 months of age (OR 1.68, 95% CI: 1.14–2.48); but the differences were not detectable at older ages (Table S3). Nutrition counselling had a consistently positive impact on the flesh food intake throughout 6 to 15 months of age (Table S3). Children in the intervention arm were more likely to start the consumption of flesh foods early, at 9 months (intervention 22% vs. comparison 17%, OR 13.16, 95% CI: 1.77–98.03) and continued to have a higher intake of meat, fish or organ meat till 15 months of age (intervention 62% vs. comparison 56%, OR 1.36, 95% CI: 1.02–1.83). Nutrition counselling intervention resulted in increased egg consumption among intervention children with moderate household food insecurity only (intervention 17% vs. comparison 12%, OR 1.46, 95% CI: 1.11–1.92) (Table S4). However, the intervention was effective in boosting flesh food consumption among both mild and moderate food-insecure participants, 52% in the intervention versus 45% in the comparison, OR 1.41 (95% CI: 1.02–1.95), and 52% in the intervention versus 45% in the comparison group, OR 1.29 (95% CI: 1.10–1.53), respectively (Table S4).

Although a lower proportion of intervention participants consumed grains, roots and tubers at 6 months age (OR 0.70, 95% CI: 0.51–0.96), they were 1.70 (95% CI: 1.15–2.52) times more likely to consume grains than comparison participants at 9 months of age (Table S3). Consumption of dairy products was low in both groups across all ages. Consumption of legumes and nuts was similar in the intervention and comparison arms at different ages. However, intervention children were 1.60 times (95% CI: 1.03–2.48) and 1.32 times (95% CI: 1.05–1.67) more likely to consume legumes and nuts in mild

TABLE 1 Maternal background and household characteristics at enrolment and health care-seeking behaviour at birth among mothers with live births

Characteristics	Intervention[a] *N* = 902 % (*n*) or mean (±SD)	Comparison *N* = 453 % (*n*) or mean (±SD)
Maternal age		
<24	53.1 (479)	48.8 (221)
25–29	30.3 (273)	30.2 (137)
30+	16.6 (150)	21.0 (95)
Maternal education		
Mean (±SD) years of schooling	5.93 (±2.9)	6.13 (±2.9)
Maternal occupation		
Engaged in income-generating activities	4.2 (38)	4.4 (20)
Homemaker	95.8 (864)	95.6 (433)
Mother's exposure to mass media	25.5 (230)	24.7 (112)
Parity[b]		
Nulliparous	46.2 (417)	43.5 (197)
Multiparous	53.8 (485)	56.5 (256)
Gestational age at birth (weeks)		
≥37	83.7 (755)	79.0 (358)
32–36	15.0 (135)	18.5 (84)
≤31	1.3 (12)	2.4 (11)
Sex of the child*		
Male	47.2 (426)	53.9 (244)
Female	52.8 (476)	46.1 (209)
Type of birth		
Singleton	98.7 (890)	98.0 (444)
Multiple	1.3 (12)	2.0 (9)
Mode of childbirth		
Normal vaginal birth	76.3 (688)	75.3 (341)
Assisted birth	6.1 (55)	7.5 (34)
Caesarean section	17.6 (159)	17.2 (78)
Place of birth		
Home	59.7 (538)	60.5 (274)
Health facility	39.9 (360)	39.3 (178)
Other	0.4 (4)	0.2 (1)
Attendance at birth[c]		
Skilled birth attendant	46.8 (422)	42.6 (193)
Unskilled/traditional health care provider	48.8 (440)	53.6 (243)
Other	4.0 (36)	3.3 (15)
Household wealth quintile[d]		
Lowest	20.7 (187)	17.6 (80)
Second	18.1 (163)	22.5 (102)
Middle	20.7 (187)	20.8 (94)
Fourth	20.0 (180)	20.8 (94)
Highest	20.5 (185)	18.3 (83)
Household food security[e]		
Secure	43.2 (390)	44.8 (203)
Mildly food insecure	10.8 (97)	8.4 (38)

(Continues)

TABLE 1 (Continued)

Characteristics	Intervention[a] *N* = 902 % (*n*) or mean (±SD)	Comparison *N* = 453 % (*n*) or mean (±SD)
Moderately food insecure	33.6 (303)	36.0 (163)
Severely food insecure	12.2 (110)	10.8 (49)

[a] All intervention arms combined.
[b] Included multiple births in the count of firstborns.
[c] Information missing for six participants.
[d] The household wealth quintile was calculated from a composite asset score estimated by principal component analysis of roof, wall and floor materials, toilet facility, electricity, ownership of television, mobile phone, refrigerator, almirah/wardrobe, table, chair, electric fan, water pump, motorcycle/three-wheelers, livestock and poultry, homestead and farmland.
[e] Information missing for two participants.
*p-value < 0.05.

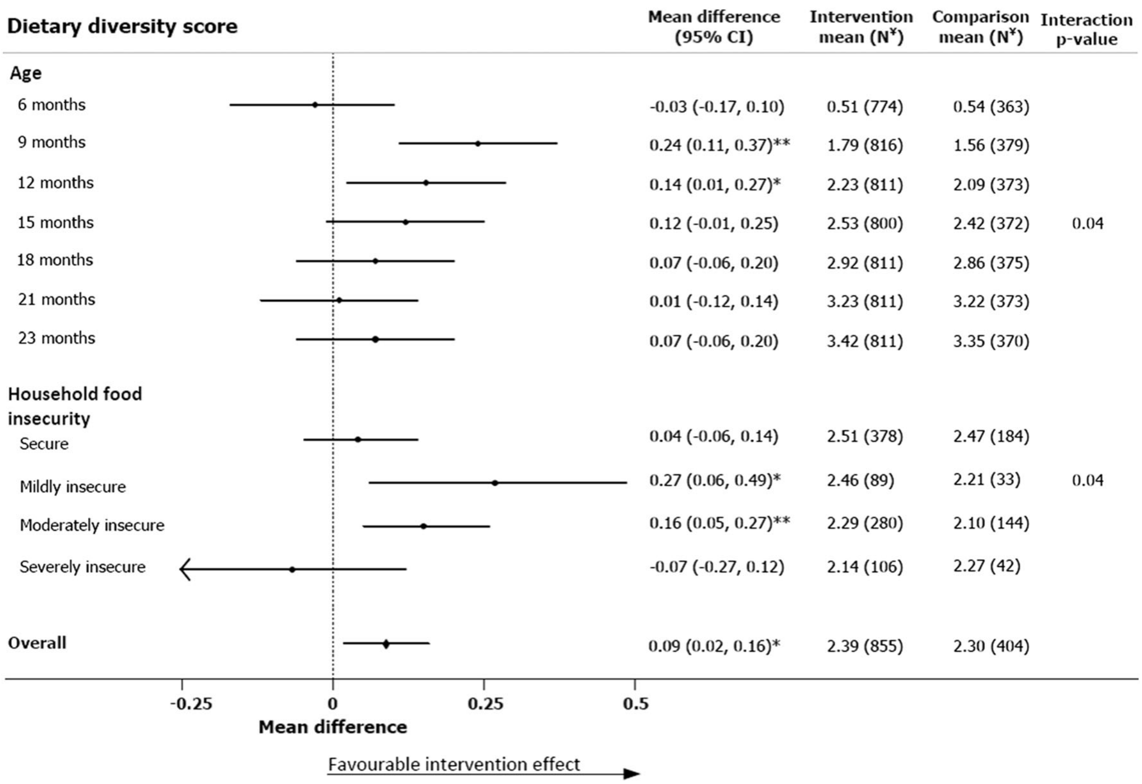
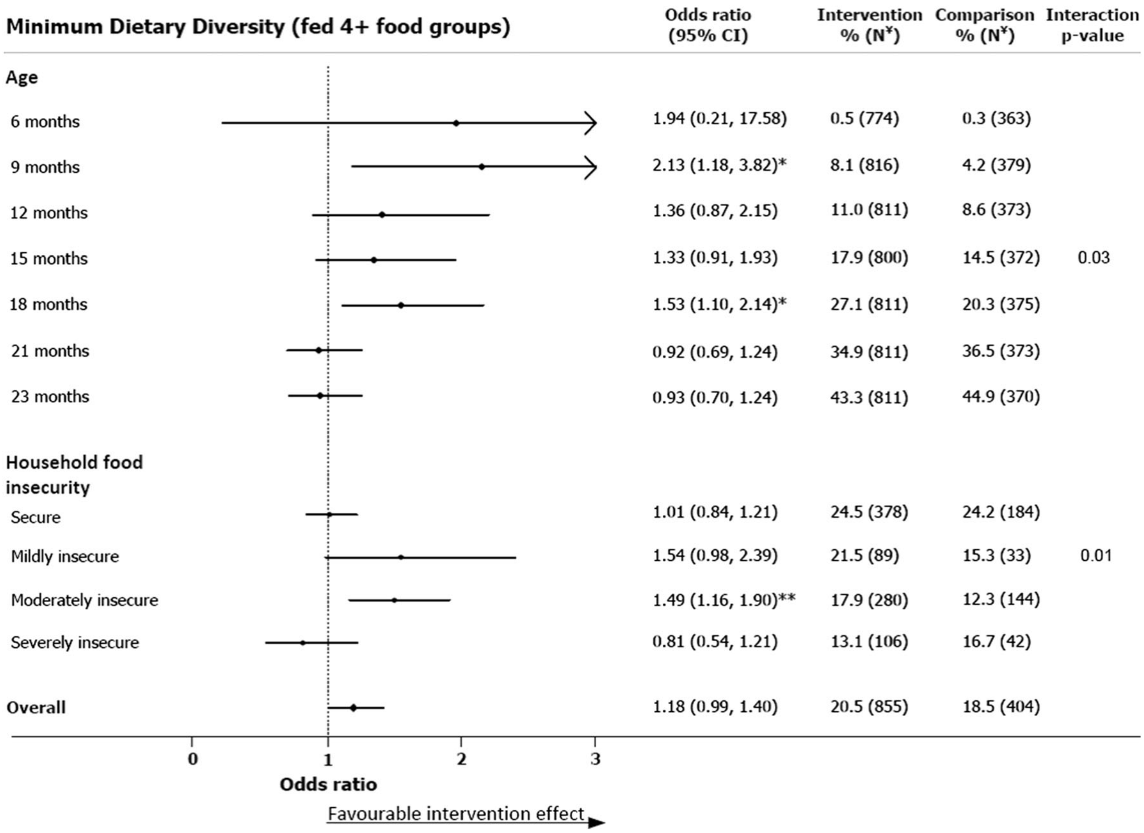


FIGURE 2 Effect of nutrition counselling using a digital job aid on dietary diversity score at different follow-up visits between children 6 and 23 months of age and by household food security. *p-value < 0.05, **p-value < 0.01 indicate that the intervention effect is significant; interaction p-value tests the null hypothesis that the effect of intervention is the same across all subgroups; $^{\Psi}$*N*s in household food insecurity subgroups represent number of children had feeding practice data for at least one follow-up visit. CI, confidence interval

and moderate food-insecure groups, respectively (Table S4). The intervention effect was also non-significant for consumption of dairy products, vitamin-A-rich fruits and vegetables and other fruits and vegetables in any food security status subgroups (Table S4). Subgroup analysis by the participants' socio-economic status and maternal education status did not show any critical differences in intervention effects on the dietary practices among 6- to 23-month-old children (data not shown).

4 | DISCUSSION

We found that individual nutrition counselling of mothers by CHWs using a customised, mobile application improved feeding practices among 6- to 23-month-old children in rural Bangladesh. We showed that seven counselling visits between 6 and 23 months of age could improve the mean number of food groups fed to 6- to 23-month-old children. We also showed that nutrition counselling could improve the



Minimum Dietary Diversity (fed 4+ food groups)	Odds ratio (95% CI)	Intervention % (N$^{\Psi}$)	Comparison % (N$^{\Psi}$)	Interaction p-value
Age				
6 months	1.94 (0.21, 17.58)	0.5 (774)	0.3 (363)	
9 months	2.13 (1.18, 3.82)*	8.1 (816)	4.2 (379)	
12 months	1.36 (0.87, 2.15)	11.0 (811)	8.6 (373)	
15 months	1.33 (0.91, 1.93)	17.9 (800)	14.5 (372)	0.03
18 months	1.53 (1.10, 2.14)*	27.1 (811)	20.3 (375)	
21 months	0.92 (0.69, 1.24)	34.9 (811)	36.5 (373)	
23 months	0.93 (0.70, 1.24)	43.3 (811)	44.9 (370)	
Household food insecurity				
Secure	1.01 (0.84, 1.21)	24.5 (378)	24.2 (184)	
Mildly insecure	1.54 (0.98, 2.39)	21.5 (89)	15.3 (33)	0.01
Moderately insecure	1.49 (1.16, 1.90)**	17.9 (280)	12.3 (144)	
Severely insecure	0.81 (0.54, 1.21)	13.1 (106)	16.7 (42)	
Overall	1.18 (0.99, 1.40)	20.5 (855)	18.5 (404)	

FIGURE 3 Effect of nutrition counselling using a digital job aid on minimum dietary diversity at different follow-up visits between children 6 and 23 months of age and by household food security. **p*-value < 0.05, ***p*-value < 0.01 indicate that the intervention effect is significant; interaction *p*-value tests the null hypothesis that the effect of intervention is the same across all subgroups; $^{\Psi}$Ns in household food insecurity subgroups represent number of children had feeding practice data for at least one follow-up visit

early introduction of egg, flesh food and grains in the diet of 6- to 23-month-old children. We observed improved dietary diversity among intervention children up to 12 months of age and for flesh food for up to 15 months. We also found that nutrition counselling improved children's feeding practices in mild and moderately food-insecure households but not in food-secure or severely food-insecure households. Our findings also identified household food security to be an important contextual consideration when designing nutrition education programmes.

The original study had four intervention arms. Combining these arms to explore nutrition counselling's impact on dietary diversity among children 6–23 months is valid. Counselling on appropriate IYCF practices was the same in all intervention arms by the same staff. Furthermore, we saw that the effects were similar across the four intervention arms including the arm with nutrition counselling alone (Table S2). Previous studies reported that the provision of LNS had no impact on children's dietary diversity (Arimond et al., 2017). Consistent with these findings, we did not see any difference in dietary diversity across the intervention arms with or without LNS.

Our findings of a positive impact of nutrition counselling on improved dietary diversity and higher consumption of egg, flesh food and grains are consistent with similar community-based studies in LMICs. Most other studies assessed the impact of nutrition education up to 18 months of children (Bhandari et al., 2004; Guldan et al., 2000; Penny et al., 2005; Shi et al., 2010; Vazir et al., 2013), whereas we evaluated the effect until 23 completed months. We found that nutrition counselling had its greatest impact on flesh flood consumption up to 15 months of the children's age. Considering the suboptimal consumption of animal-sourced protein in rural 6- to 23-month-old children, we included relevant messages on animal-sourced protein in children's diet in our nutrition counselling module. The CHWs emphasised this issue while counselling. A study in China also showed that prioritising messages on animal-sourced protein during nutrition counselling doubled its consumption among intervention children compared with the controls (Shi et al., 2010). Higher consumption of flesh foods among the intervention children between 6 and 15 months of age was mainly from increased fish consumption (data not presented). Consumption of dairy food was low among both intervention and comparison children, consistent with general child feeding practice in Bangladesh (NIPORT et al., 2019).

We did not find an intervention impact on dietary diversity and individual food groups beyond 15 months of age, which can be

TABLE 2 Overall effect of nutrition counselling using a digital job aid on dietary practices among 6- to 23-month-old children

Indicator	Intervention [$N = 855$]	Comparison [$N = 404$]	OR[a]	95% CI
Dietary diversity score (mean [±SD])	2.39 [±1.39]	2.30 [±1.38]	0.09*	0.02–0.16
MDD (% of children)	20.5	18.5	1.18	0.99–1.40
Individual food groups (%)				
Egg	19.2	16.6	1.22*	1.03–1.45
Flesh food	53.7	49.6	1.32**	1.11–1.57
Dairy products	7.2	7.4	0.95	0.77–1.19
Grains, roots and tubers	87.5	86.7	1.11	0.88–1.40
Vitamin-A-rich fruits and vegetables	23.5	22.3	1.10	0.97–1.24
Legumes and nuts	20.2	19.4	1.05	0.91–1.20
Other fruits and vegetables[b]	31.7	32.1	0.96	0.85–1.10

Note: Overall effect of intervention was estimated including visits at all ages and levels of food insecurity.
Abbreviations: CI, confidence interval; MDD, minimum dietary diversity (consumption of 4+ food groups).
[a] Odds ratio (OR) from a logistic mixed-effect model with randomisation block and individual-level (child) clustering; OR represents the ratio of odds of having reported consuming a food group in past 24 h.
[b] Analysed excluding 6 months of observations as comparison samples had zero value resulting estimate of OR to infinity.
*p-value < 0.05. **p-value < 0.01.

explained by the gradual improvement of dietary diversity with age and a reduced intervention effect in older children. The positive impact of counselling on earlier introduction and continuation of diverse and specific food groups was followed by a plateauing of dietary diversity, a finding that is consistent with other studies. In India, a study showed higher rice, milk and vegetable consumption in children at 9 months but no difference at 18 months between intervention and control arms (Bhandari et al., 2004). Another intervention study in Peru found a higher egg, chicken liver or fish consumption at 6 and 8 months in the intervention arm but no statistically significant difference from 9 months onwards (Penny et al., 2005).

In contrast to a study in China (Shi et al., 2010), we found no difference in the mean dietary diversity score between intervention and control arms at 6 months of age. The WHO-UNICEF IYCF guideline recommends the initiation of complementary feeding at six completed months (UNICEF, 2012). We assessed feeding practice at the beginning of the seventh month of age; the mean age at the visit was 6.2 and 6.1 months for the intervention and comparison arms, respectively (Table S1). It is reasonable to assume that dietary diversity would not be noticeable at the earliest stage of initiating complementary food. Nonetheless, we observed a higher proportion of children in the comparison arm, consuming grains and dairy products at 6 months. We assume that these children were introduced to complementary food before 6 months, despite the recommendation to breastfeed exclusively until this age. In future analyses, we will test this hypothesis and analyse exclusive breastfeeding practice in the cohort.

The minimum dietary diversity was 18% higher in the intervention arm irrespective of the child's age and household food insecurity, although the finding was not statistically significant ($p = 0.07$). One explanation is that the nutrition counselling intervention could improve consumption of some of the food groups, but not all, in the study population where poor dietary diversity among children 6–23 months is common (NIPORT et al., 2019). The findings on the overall effect of nutrition counselling on dietary diversity should be interpreted with caution. The substantial effect modification by age and limited effect beyond 12 months have resulted in an overall low effect size on dietary diversity. A recent study from urban Bangladesh reported 1.95-fold increase in minimum dietary diversity among 7- to 12-month-old children whose mothers received peer counselling, consistent with the intervention effect observed at 9 months of children's age in our study (Ara et al., 2019). A meta-analysis of three studies that involved nutrition counselling, including one from rural Bangladesh, showed 1.64-fold increase (95% CI: 0.92–2.03) in minimum dietary diversity among 6- to 23-month-old children (Janmohamed et al., 2020). However, it is difficult to compare these studies with our findings directly as none of these studies reported the effect by age groups or any effect modification by age. These earlier studies did not use digital job aids and are too diverse to easily compare with our trial to elucidate any added impact from the use of digital technology.

Household food security has played a role too, because about 45% of our study children belonged to food-insecure households. Our subgroup analysis suggested that nutrition counselling had a statistically significant effect on improving minimum dietary diversity (OR 1.49, 95% CI: 1.16–1.90) among children from moderately food-insecure households. We observed a similar effect on minimum dietary diversity (OR 1.59, 95% CI: 0.99–2.39) in participants from mildly food-insecure households. But this effect was marginally significant ($p = 0.06$) with a wide CI due to the small sample. Studies from similar settings suggest that household food security is strongly associated with dietary diversity among 6- to 23-month-old children

(Agbadi et al., 2017; Chandrasekhar et al., 2017). High levels of food insecurity may also explain greater consumption of grains and low consumption of dairy products, legumes and nuts, vitamin-A-rich food and fruits and vegetables in both intervention and comparison children resulting in no significant intervention effect on these food groups. A Malawian nutrition education study in a high food-insecure population also found no effect of the intervention on these outcomes (Kuchenbecker et al., 2017). Adding nutrition-sensitive interventions like cash transfers with nutrition counselling might have a better outcome for all food groups and minimum dietary diversity in food-insecure settings, as was found in a social safety net study in Bangladesh (Ahmed et al., 2016).

Our study's strength is the longitudinal follow-up of intervention and comparison children, which let us explore the impact of counselling on feeding practices from 6 months to 2 years of age, including early introduction of different food groups. The balance in the maternal background and health care characteristics and low loss to follow-up in both arms are likely to ensure the study's internal validity. The cluster randomised design and provision of individual counselling of enrolled mothers at home by CHWs reduced the likelihood of contamination of our intervention. The digital data collection with consistency, logic and range checks reduced the chance of errors in data entry and ensured timely visits by evaluation data collectors.

Our study has some limitations. First, our findings are generalisable to populations similar to our resource-poor study area with household food insecurity and where suboptimal child feeding practices are common. Second, blinding of the participants and interviewers who collected feeding practice information about the intervention was not possible due to the nature of the intervention. However, we expect a very low or no information bias. The evaluation team was independent of the intervention delivery team and collected data on feeding practices using structured and validated tools. Third, we did not collect information on quantities of the food consumed and therefore are unable to report the intervention impact on the nutrient content of complementary foods. However, dietary diversity is much easier to collect and is reliable in terms of data quality on food intake and is considered a good proxy for understanding diet quality. We did not collect data on the cost of nutrition counselling with digital job aid intervention and therefore did not conduct an economic analysis in the study. Fourth, although contamination was unlikely, it was not impossible. Mothers in the comparison arm may have received nutrition messages at routine childcare contacts. We did not assess if providing small-quantity lipid-based complementary nutrient supplements in two intervention arms influenced the child's dietary diversity. A previous study reported an equal or greater minimum dietary diversity in complementary food supplemented arms compared with a child feeding counselling only arm (Campbell et al., 2016). The authors speculated that food supplements might have improved appetite among children and influenced mothers' active and responsive child feeding behaviours. Nonetheless, we found a similar effect size for each of the intervention arms with or without complementary nutrient supplement compared with the comparison arm.

In our study, CHWs delivered nutrition counselling using a digital job aid. However, we cannot conclude that improved practices in dietary diversity among intervention children are attributable to the application of the digital job aid as we did not have an arm with nutrition counselling without a digital job aid. Limited evidence is available in LMICs of the impact on digital job aid supported nutrition education interventions on complementary feeding practices and dietary diversity outcomes (Mildon & Sellen, 2019). One study in India used a digital job aid tool for nutrition counselling, which reported significant improvements in solid and semi-solid food consumption among children aged 6 months or older (Borkum et al., 2015). However, our findings reinforce the benefits of nutrition counselling interventions for improving optimal dietary diversity among infants and young children and support integration of digital job aids in nutrition service delivery in settings like Bangladesh, where the quality of nutrition services is poor (Billah et al., 2017).

Further research to explore the consistency of the findings in similar settings would be useful. Although other studies have reported the effect of nutrition education on child growth outcomes in food-insecure settings (Lassi et al., 2020), there is little evidence about whether or not educational interventions alone can improve dietary diversity in food-insecure environments. We found that nutrition counselling was effective for children from mild or moderate food-insecure households in subgroup analyses. Integration of social protection interventions with nutrition counselling (Ahmed et al., 2016) should be tested to improve early and sustained dietary diversity among 6- to 23-month-old children in food-insecure settings.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

CONTRIBUTIONS

SEA, PM, TA, SG, JH, SMB and MJD conceptualised and designed the study; SMB and TF implemented the study under the supervision of SEA and TA; NC guided the counselling package and evaluation tools development; ABS managed and cleaned the data; SMB analysed data under the guidance of PK, MJD and CRG; SMB prepared the first draft. MJD, CRG, TF and PK reviewed multiple drafts and guided revisions. All authors read and approved the final manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

Agbadi, P., Urke, H. B., & Mittelmark, M. B. (2017). Household food security and adequacy of child diet in the food insecure region north in Ghana. *PLoS ONE*, *12*(5), e0177377. https://doi.org/10.1371/journal.pone.0177377

Ahmed, A. U., Hoddinott, J. F., Roy, S., Sraboni, E., Quabili, W. R., & Margolies, A. (2016). Which kinds of social safety net transfers work best for the ultra poor in Bangladesh?: Operation and impacts of the transfer modality research initiative. Retrieved from Dhaka.

Ara, G., Khanam, M., Papri, N., Nahar, B., Kabir, I., Sanin, K. I., Khan, S. S., Sarker, M. S. A., & Dibley, M. J. (2019). Peer counseling promotes appropriate infant feeding practices and improves infant growth and development in an urban slum in Bangladesh: A community-based cluster randomized controlled trial. *Current Developments in Nutrition*, *3*(7), nzz072.

Arimond, M., Abbeddou, S., Kumwenda, C., Okronipa, H., Hemsworth, J., Jimenez, E. Y., Ocansey, E., Lartey, A., Ashorn, U., Adu-Afarwuah, S., Vosti, S. A., Hess, S. Y., & Dewey, K. G. (2017). Impact of small quantity lipid-based nutrient supplements on infant and young child feeding practices at 18 months of age: Results from four randomized controlled trials in Africa. *Maternal & Child Nutrition*, *13*(3), e12377. https://doi.org/10.1111/mcn.12377

Bhandari, N., Mazumder, S., Bahl, R., Martines, J., Black, R. E., Bhan, M. K., & Infant Feeding Study Group. (2004). An educational intervention to promote appropriate complementary feeding practices and physical growth in infants and young children in rural Haryana, India. *The Journal of Nutrition*, *134*(9), 2342–2348. https://doi.org/10.1093/jn/134.9.2342

Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., Webb, P., Lartey, A., & Black, R. E. (2013). Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *The Lancet*, *382*(9890), 452–477. https://doi.org/10.1016/S0140-6736(13)60996-4

Billah, S. M., Saha, K. K., Khan, A. N. S., Chowdhury, A. H., Garnett, S. P., El Arifeen, S., & Menon, P. (2017). Quality of nutrition services in primary health care facilities: Implications for integrating nutrition into the health system in Bangladesh. *PLoS ONE*, *12*(5), e0178121. https://doi.org/10.1371/journal.pone.0178121

Blackstone, S., & Sanghvi, T. (2018). A comparison of minimum dietary diversity in Bangladesh in 2011 and 2014. *Maternal & Child Nutrition*, *14*(4), e12609. https://doi.org/10.1111/mcn.12609

Borkum, E., Sivasankaran, A., Sridharan, S., Rotz, D., Sethi, S., Manoranjini, M., Ramakrishnan, L., & Rangarajan, A. (2015). Evaluation of the information and communication technology (ICT) continuum of care services (CCS) intervention in Bihar. *Mathematica Policy Research*.

Campbell, R. K., Hurley, K. M., Shamim, A. A., Shaikh, S., Chowdhury, Z. T., Mehra, S., de Pee, S., Ahmed, T., West, K. P. Jr., & Christian, P. (2016). Effect of complementary food supplementation on breastfeeding and home diet in rural Bangladeshi children. *The American Journal of Clinical Nutrition*, *104*(5), 1450–1458. https://doi.org/10.3945/ajcn.116.135509

Chandrasekhar, S., Aguayo, V. M., Krishna, V., & Nair, R. (2017). Household food insecurity and children's dietary diversity and nutrition in India. Evidence from the comprehensive nutrition survey in Maharashtra. *Maternal & Child Nutrition*, *13*, e12447. https://doi.org/10.1111/mcn.12447

Choudhury, S., Headey, D. D., & Masters, W. A. (2019). First foods: Diet quality among infants aged 6–23 months in 42 countries. *Food Policy*, *88*, 101762. https://doi.org/10.1016/j.foodpol.2019.101762

Dangura, D., & Gebremedhin, S. (2017). Dietary diversity and associated factors among children 6–23 months of age in Gorche district, Southern Ethiopia: Cross-sectional study. *BMC Pediatrics*, *17*(1), 6. https://doi.org/10.1186/s12887-016-0764-x

Dewey, K. G., Wessells, K. R., Arnold, C. D., Prado, E. L., Abbeddou, S., Adu-Afarwuah, S., Ali, H., Arnold, B. F., Ashorn, P., Ashorn, U., Ashraf, S., Becquey, E., Bendabenda, J., Brown, K. H., Christian, P., Colford, J. M. Jr., Dulience, S. J. L., Fernald, L. C. H., Galasso, E., … Stewart, C. P. (2021). Characteristics that modify the effect of small-quantity lipid-based nutrient supplementation on child growth: an individual participant data meta-analysis of randomized controlled trials. *MedRxiv*. https://doi.org/10.1101/2021.02.05.21251105

Fanzo, J., Hawkes, C., Udomkesmalee, E., Afshin, A., Allemandi, L., Assery, O. Baker, P., Battersby, J., Bhutta, Z., Chen, K., Corvalan, C., Di Cesare, M., Dolan, C., Fonseca, J., Grummer-Strawn, L., Hayashi, C., McArthur, J., Rao, A., Rosenzweig, C., & Schofield, D. (2018) 2018 Global Nutrition Report: Shining a light to spur action on nutrition. *Technical Report*. Bristol, UK: Development Initiatives. [Monograph]

Guldan, G. S., Fan, H.-C., Ma, X., Ni, Z.-Z., Xiang, X., & Tang, M.-Z. (2000). Culturally appropriate nutrition education improves infant feeding and growth in rural Sichuan, China. *The Journal of Nutrition*, *130*(5), 1204–1211. https://doi.org/10.1093/jn/130.5.1204

Headey, D., Hoddinott, J., Ali, D., Tesfaye, R., & Dereje, M. (2015). The other Asian enigma: Explaining the rapid reduction of undernutrition in Bangladesh. *World Development*, *66*, 749–761. https://doi.org/10.1016/j.worlddev.2014.09.022

Headey, D. D. (2013). Developmental drivers of nutritional change: A cross-country analysis. *World Development*, *42*, 76–88. https://doi.org/10.1016/j.worlddev.2012.07.002

Hoddinott, J., Ahmed, I., Ahmed, A., & Roy, S. (2017). Behavior change communication activities improve infant and young child nutrition knowledge and practice of neighboring non-participants in a cluster-randomized trial in rural Bangladesh. *PLoS ONE*, *12*(6), e0179866. https://doi.org/10.1371/journal.pone.0179866

Iqbal, S., Zakar, R., Zakar, M. Z., & Fischer, F. (2017). Factors associated with infants' and young children's (6–23 months) dietary diversity in Pakistan: Evidence from the demographic and health survey 2012–13. *Nutrition Journal*, *16*(1), 78. https://doi.org/10.1186/s12937-017-0297-7

Islam, M. M., Sanin, K. I., Mahfuz, M., Ahmed, A. S., Mondal, D., Haque, R., & Ahmed, T. (2018). Risk factors of stunting among children living in an urban slum of Bangladesh: Findings of a prospective cohort study. *BMC Public Health*, *18*(1), 197. https://doi.org/10.1186/s12889-018-5101-x

Issaka, A. I., Agho, K. E. N., Page, A. L., Burns, P., Stevens, G. J., & Dibley, M. J. (2015). The problem of suboptimal complementary feeding practices in West Africa: What is the way forward? *Maternal & Child Nutrition*, *11*, 53–60. https://doi.org/10.1111/mcn.12195

Janmohamed, A., Sohani, N., Lassi, Z. S., & Bhutta, Z. A. (2020). The effects of community home visit and peer group nutrition intervention delivery platforms on nutrition outcomes in low and middle-income countries: A systematic review and meta-analysis. *Nutrients*, *12*(2), 440. https://doi.org/10.3390/nu12020440

Källander, K., Tibenderana, J. K., Akpogheneta, O. J., Strachan, D. L., Hill, Z., ten Asbroek, A. H., Conteh, L., Kirkwood, B. R., & Meek, S. R.

(2013). Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low-and middle-income countries: A review. *Journal of Medical Internet Research*, *15*(1), e17. https://doi.org/10.2196/jmir.2130

Keats, E. C., Das, J. K., Salam, R. A., Lassi, Z. S., Imdad, A., Black, R. E., & Bhutta, Z. A. (2021). Effective interventions to address maternal and child malnutrition: An update of the evidence. *The Lancet Child & Adolescent Health*.

Kim, S., Phuong, N. H., Lan, T. M., & Menon, P. (2020). Different combinations of behavior change interventions and frequencies of interpersonal contacts are associated with infant and young child feeding practices in Bangladesh, Ethiopia, and Vietnam. *Current Developments in Nutrition.*, *4*. https://doi.org/10.1093/cdn/nzz140

Kuchenbecker, J., Reinbott, A., Mtimuni, B., Krawinkel, M. B., & Jordan, I. (2017). Nutrition education improves dietary diversity of children 6–23 months at community-level: Results from a cluster randomized controlled trial in Malawi. *PLoS ONE*, *12*(4), e0175216. https://doi.org/10.1371/journal.pone.0175216

Lassi, Z. S., Rind, F., Irfan, O., Hadi, R., Das, J. K., & Bhutta, Z. A. (2020). Impact of infant and young child feeding (IYCF) nutrition interventions on breastfeeding practices, growth and mortality in low-and middle-income countries: Systematic review. *Nutrients*, *12*(3), 722. https://doi.org/10.3390/nu12030722

Manikam, L., Prasad, A., Dharmaratnam, A., Moen, C., Robinson, A., Light, A., Ahmed, S., Lingam, R., & Lakhanpaul, M. (2018). Systematic review of infant and young child complementary feeding practices in South Asian families: The India perspective. *Public Health Nutrition*, *21*(4), 637–654. https://doi.org/10.1017/S136898001700297X

Menon, P., Nguyen, P. H., Saha, K. K., Khaled, A., Sanghvi, T., Baker, J., Afsana, K., Haque, R., Frongillo, E. A., Ruel, M. T., & Rawat, R. (2016). Combining intensive counseling by frontline workers with a nationwide mass media campaign has large differential impacts on complementary feeding practices but not on child growth: Results of a cluster-randomized program evaluation in Bangladesh. *The Journal of Nutrition*, *146*(10), 2075–2084. https://doi.org/10.3945/jn.116.232314

Micha, R., Mannar, V., Afshin, A., Allemandi, L., Baker, P., & Battersby, J. (2020). Global nutrition report: Action on equity to end malnutrition 2020.

Mildon, A., & Sellen, D. (2019). Use of mobile phones for behavior change communication to improve maternal, newborn and child health: A scoping review. *Journal of Global Health*, *9*(2). https://doi.org/10.7189/jogh.09.020425

Mistry, S. K., Hossain, M. B., & Arora, A. (2019). Maternal nutrition counselling is associated with reduced stunting prevalence and improved feeding practices in early childhood: A post-program comparison study. *Nutrition Journal*, *18*(1), 47. https://doi.org/10.1186/s12937-019-0473-z

NIPORT, Mitra and Associates, & ICF International. (2016). Bangladesh Demographic and Health Survey 2014. Retrieved from Dhaka, Bangladesh, and Rockville, Maryland, USA:

NIPORT, Mitra and Associates, & ICF International. (2019). Bangladesh Demographic and Health Survey 2017–18: Key indicators. Retrieved from Dhaka, Bangladesh, and Rockville, Maryland, USA:

Owais, A., Schwartz, B., Kleinbaum, D. G., Suchdev, P. S., Faruque, A. S. G., Das, S. K., Rahman, S., & Stein, A. D. (2017). A nutrition education program in rural Bangladesh was associated with improved feeding practices but not with child growth. *The Journal of Nutrition*, *147*(5), 948–954. https://doi.org/10.3945/jn.116.243956

Penny, M. E., Creed-Kanashiro, H. M., Robert, R. C., Narro, M. R., Caulfield, L. E., & Black, R. E. (2005). Effectiveness of an educational intervention delivered through the health services to improve nutrition in young children: A cluster-randomised controlled trial. *The Lancet*, *365*(9474), 1863–1872. https://doi.org/10.1016/S0140-6736(05)66426-4

Perri-Moore, S., Routen, T., Shao, A. F., Rambaud-Althaus, C., Swai, N., Kahama-Maro, J., D'Acremont, V., Genton, B., & Mitchell, M. (2015). Using an eIMCI-derived decision support protocol to improve provider–caretaker communication for treatment of children under 5 in Tanzania. *Global Health Communication*, *1*(1), 41–47. https://doi.org/10.1080/23762004.2016.1181486

Rasheed, S., Haider, R., Hassan, N., Pachón, H., Islam, S., Jalal, C. S., & Sanghvi, T. G. (2011). Why does nutrition deteriorate rapidly among children under 2 years of age? Using qualitative methods to understand community perspectives on complementary feeding practices in Bangladesh. *Food and Nutrition Bulletin*, *32*(3), 192–200. https://doi.org/10.1177/156482651103200302

Saha, K. K., Billah, M., Menon, P., El Arifeen, S., & Mbuya, N. V. (2015). *Bangladesh National Nutrition Services: Assessment of implementation status*. The World Bank. https://doi.org/10.1596/978-1-4648-0640-7

Saha, K. K., Frongillo, E. A., Alam, D. S., Arifeen, S. E., Persson, L. Å., & Rasmussen, K. M. (2008). Appropriate infant feeding practices result in better growth of infants and young children in rural Bangladesh. *The American Journal of Clinical Nutrition*, *87*(6), 1852–1859. https://doi.org/10.1093/ajcn/87.6.1852

Saha, U. R., Chattapadhayay, A., & Richardus, J. H. (2019). Trends, prevalence and determinants of childhood chronic undernutrition in regional divisions of Bangladesh: Evidence from demographic health surveys, 2011 and 2014. *PloS One*, *14*(8), e0229677. https://doi.org/10.1371/journal.pone.0229677

Shapiro, M. J., Downs, S. M., Swartz, H. J., Parker, M., Quelhas, D., Kreis, K., Kraemer, K., West, K. P. Jr., & Fanzo, J. (2019). A systematic review investigating the relation between animal-source food consumption and stunting in children aged 6–60 months in low and middle-income countries. *Advances in Nutrition*, *10*(5), 827–847. https://doi.org/10.1093/advances/nmz018

Shi, L., Zhang, J., Wang, Y., Caulfield, L. E., & Guyer, B. (2010). Effectiveness of an educational intervention on complementary feeding practices and growth in rural China: A cluster randomised controlled trial. *Public Health Nutrition*, *13*(4), 556–565. https://doi.org/10.1017/S1368980009991364

Solomon, D., Aderaw, Z., & Tegegne, T. K. (2017). Minimum dietary diversity and associated factors among children aged 6–23 months in Addis Ababa, Ethiopia. *International Journal for Equity in Health*, *16*(1), 181. https://doi.org/10.1186/s12939-017-0680-1

UNICEF. (2012). The community infant and young child feeding counselling package: Key messages booklet. Retrieved from New York: https://www.unicef.org/nutrition/files/Key_Message_Booklet_2012_small.pdf

USAID Advancing Nutrition. (2020). Using digital tools to strengthen nutrition service delivery: An overview. Retrieved from Arlington, VA.

Vazir, S., Engle, P., Balakrishna, N., Griffiths, P. L., Johnson, S. L., Creed-Kanashiro, H., Fernandez Rao, S., Shroff, M. R., & Bentley, M. E. (2013). Cluster-randomized trial on complementary and responsive feeding education to caregivers found improved dietary intake, growth and development among rural Indian toddlers. *Maternal & Child Nutrition*, *9*(1), 99–117. https://doi.org/10.1111/j.1740-8709.2012.00413.x

Victora, C. G., Christian, P., Vidaletti, L. P., Gatica-Domínguez, G., Menon, P., & Black, R. E. (2021). Revisiting maternal and child undernutrition in low-income and middle-income countries: Variable progress towards an unfinished agenda. *The Lancet*.

Vyas, S., & Kumaranayake, L. (2006). Constructing socio-economic status indices: How to use principal components analysis. *Health Policy and Planning*, *21*(6), 459–468. https://doi.org/10.1093/heapol/czl029

WHO. (2003). Global strategy for infant and young child feeding. Retrieved from Geneva.

WHO. (2008). Indicators for assessing infant and young child feeding practices: Part1 Definitions (9241599294). Retrieved from Geneva, Switzerland.

WHO. (2010). Indicators for assessing infant and young child feeding practices: Part 2: Measurement. Retrieved from

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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Supporting information

Appendix Table S1: Data availability and age at follow up visits for assessing dietary intake of 6-23 months old children

Age at follow-up visits	**Number (%) of children feeding data available at each follow-up visit**		**Number of lost to follow-ups**						**Number of absent/refusals at follow-up visits**		**Mean age in months (±SD) at the follow-up visits**	
			Died		**Out-migrated**		**Withdrew**					
	Int. N=855	Comp. N=403	Int. N=855	Comp. N=403	Int. N=855	Comp. N=403	Int. N=855	Comp. N=403	Int. N=855	Comp. N=403	Int. N=855	Comp. N=403
6 months	774 (90.5)	363 (90.0)	-	-	-	-	-	-	81	40	6.2 (±0.44)	6.1 (±0.41)
9 months	816 (95.4)	379 (94.0)	2	1	1	2	4	4	32	17	9.0 (±0.33)	9.1 (±0.35)
12 months	811 (94.9)	373 (92.6)	2	2	6	3	1	1	28	17	12.0 (±0.26)	12.1 (±0.33)
15 months	800 (93.6)	372 (92.3)	0	0	3	1	0	0	36	17	14.9 (±0.25)	14.9 (±0.22)
18 months	811 (94.9)	375 (93.1)	0	0	2	2	1	0	22	12	17.8 (±0.22)	17.8 (±0.19)
21 months	811 (94.9)	373 (92.6)	2	1	5	5	0	0	15	8	20.8 (±0.21)	20.8 (±0.16)
23 months	811 (94.9)	370 (91.8)	2	2	0	0	0	0	13	9	23.7 (±0.24)	23.7 (±0.16)

Int.=intervention , Comp.=Comparison

Appendix Table S2: effect of nutrition counselling using a digital job aid on dietary practices among 6-23 months old children in each of the four intervention arms

Indicator	Intervention N	Comparison N	Intervention Mean[±SD]/%	Comparison Mean/%	Mean difference/OR (95% CI)†
Dietary diversity score (mean[±SD])					
All intervention arm vs comparison	855	403	2.39 [±1.39]	2.30 [±1.38]	0.09(0.02, 0.16)*
Arm1 vs comparison	217	403	2.39 [±1.39]	2.30 [±1.38]	0.10(0.02, 0.18)*
Arm2 vs comparison	213	403	2.37 [±1.37]	2.30 [±1.38]	0.08(0.00, 0.15)
Arm3 vs comparison	211	403	2.39 [±1.39]	2.30 [±1.38]	0.09(0.01, 0.16)*
Arm4 vs comparison	214	403	2.39 [±1.39]	2.30 [±1.38]	0.09(0.01, 0.17)*
Minimum dietary diversity (% of children)					
All intervention arm vs comparison	855	403	20.5	18.5	1.18(0.99, 1.40)
Arm1 vs comparison	217	403	20.7	18.5	1.21(0.98, 1.48)
Arm2 vs comparison	213	403	20.1	18.5	1.18(0.95, 1.44)
Arm3 vs comparison	211	403	20.6	18.5	1.16(0.94, 1.42)
Arm4 vs comparison	214	403	20.7	18.5	1.18(0.94, 1.47)

N=Number of observations, %= percentage of infants received the minimum dietary diversity; †mean difference/Odds ratio (OR) from mixed-effect models with randomisation block and individual level (child) clustering; Arm 1: nutrition counselling, prenatal nutrient supplement and complementary nutrient supplement; Arm 2: nutrition counselling and prenatal nutrient supplement; Arm 3: nutrition counselling and complementary nutrient supplement, Arm 4: nutrition counselling alone; Arm 5: comparison; *p-value<0.05

Appendix Table S3: Effect of nutrition counselling using a digital job aid on the consumption of seven individual food groups at different follow-up visits between children 6-23 months of age

Indicator	**Intervention**		**Comparison**		**OR (95% CI)** $^{\rho}$	**Interaction p-value**†
	N$^{¥}$	**%**	**N**$^{¥}$	**%**		
Eggs						
6 months	774	3.5	363	1.7	2.19 (0.88, 5.42)	0.29
9 months	816	17.9	379	11.9	1.68 (1.14, 2.48)**	
12 months	811	17.3	373	16.6	1.05 (0.73, 1.50)	
15 months	800	18.9	372	14.8	1.37 (0.95, 1.98)	
18 months	811	24.5	375	21.1	1.24 (0.89, 1.72)	
21 months	811	26.3	373	24.7	1.09 (0.80, 1.50)	
23 months	811	25.5	370	24.9	1.04 (0.76, 1.43)	
Flesh food						
6 months	774	3.5	363	0.3	13.16 (1.77, 98.00)*	0.27
9 months	816	22.3	379	16.9	1.45 (1.02, 2.06)*	
12 months	811	43.7	373	37.0	1.37 (1.02, 1.85)*	
15 months	800	62.1	372	55.9	1.36 (1.02, 1.83)*	
18 months	811	74.2	375	71.2	1.20 (0.88, 1.65)	
21 months	811	81.3	373	80.4	1.07 (0.75, 1.52)	
23 months	811	86.7	370	84.9	1.19 (0.81, 1.75)	
Dairy products						
6 months	774	3.8	363	6.3	0.53 (0.30, 0.96)*	0.22
9 months	816	4.3	379	5.0	0.83 (0.46, 1.51)	
12 months	811	4.7	373	3.8	1.26 (0.66, 2.41)	
15 months	800	6.6	372	7.3	0.88 (0.53, 1.47)	
18 months	811	7.9	375	6.7	1.20 (0.72, 2.01)	
21 months	811	10.1	373	12.1	0.79 (0.52, 1.21)	
23 months	811	12.8	370	10.5	1.26 (0.82, 1.93)	
Grains roots tubers						
6 months	774	35.1	363	42.4	0.70 (0.51, 0.96)*	<0.01
9 months	816	88.7	379	82.9	1.70 (1.15, 2.52)**	
12 months	811	95.1	373	92.2	1.66 (0.97, 2.82)	
15 months	800	95.9	372	93.6	1.63 (0.92, 2.89)	
18 months	811	98.0	375	97.6	1.21 (0.52, 2.84)	
21 months	811	98.5	373	98.1	1.26 (0.48, 3.30)	
23 months	811	99.1	370	98.9	1.24 (0.36, 4.35)	
Vitamin-A rich fruits and vegetables						
6 months	774	1.7	363	1.4	1.26 (0.44, 3.56)	0.02
9 months	816	20.2	379	16.4	1.34 (0.96, 1.86)	
12 months	811	24.9	373	23.1	1.14 (0.85, 1.53)	
15 months	800	23.0	372	20.7	1.18 (0.87, 1.60)	
18 months	811	24.9	375	22.9	1.14 (0.85, 1.53)	
21 months	811	28.6	373	37.0	0.69 (0.53, 0.90)**	
23 months	811	39.8	370	34.3	1.31 (1.01, 1.71)*	
Legumes and nuts						
6 months	774	2.1	363	1.9	1.06 (0.43, 2.61)	0.32
9 months	816	16.4	379	15.8	1.04 (0.73, 1.47)	
12 months	811	24.2	373	27.1	0.84 (0.63, 1.14)	
15 months	800	25.8	372	28.0	0.88 (0.66, 1.18)	
18 months	811	24.3	375	19.2	1.38 (1.00, 1.89)	
21 months	811	23.1	373	21.5	1.10 (0.80, 1.51)	
23 months	811	24.8	370	22.2	1.17 (0.86, 1.59)	

Indicator	Intervention		Comparison		OR (95% CI) $^{\rho}$	Interaction p-value[†]
	N[¥]	%	N[¥]	%		
Other fruits and vegetables						
6 months	774	1.0	363	0.0	-	<0.001
9 months	816	9.4	379	6.9	1.42 (0.89, 2.26)	
12 months	811	13.1	373	9.1	1.50 (0.99, 2.27)	
15 months	800	20.8	372	21.5	0.95 (0.70, 1.29)	
18 months	811	38.6	375	47.5	0.68 (0.53, 0.88)**	
21 months	811	55.1	373	48.5	1.31 (1.01, 1.69)*	
23 months	811	53.0	370	59.7	0.75 (0.58, 0.97)*	

[¥] Ns represent the number of children for whom feeding practice data was available, %= percentage of infants received the food group; $^{\rho}$Odds ratio (OR) from logistic mixed-effect models with randomisation cluster and individual level (child) clustering, *p-value<0.05, **p-value<0.01 indicate that the intervention effect is significant within the subgroup; [†] Interaction p-value tests the null hypothesis that the effect of the intervention is the same across all subgroups.

Appendix Table S4: Effect of nutrition counselling using a digital job aid on the consumption of seven individual food groups among 6-23 months old children by household food insecurity status

Indicator	**Intervention**		**Comparison**		**OR (95% CI)** [ρ]	**Interaction p-value**[†]
	N[¥]	**%**	**N**[¥]	**%**		
Eggs						
Food secure	378	23.0	184	20.6	1.18 (0.95-1.46)	0.03
Mildly food insecure	89	20.0	33	15.7	1.38 (0.85-2.23)	
Moderately food insecure	280	17.2	144	12.3	1.46 (1.11-1.92)**	
Severely food insecure	106	10.1	42	14.9	0.64 (0.04-1.03)	
Flesh food						
Food secure	378	57.7	184	54.9	1.12 (0.96-1.29)	0.18
Mildly food insecure	89	52.2	33	44.9	1.41 (1.02-1.95)*	
Moderately food insecure	280	50.0	144	42.9	1.30 (1.10-1.53)**	
Severely food insecure	106	50.2	42	53.8	0.96 (0.79-1.28)	
Dairy products						
Food secure	378	6.9	184	6.6	1.04 (0.75-1.45)	0.39
Mildly food insecure	89	9.0	33	12.5	0.59 (0.32-1.09)	
Moderately food insecure	280	7.7	144	7.4	1.03 (0.72-1.47)	
Severely food insecure	106	5.5	42	6.6	0.82 (0.41-1.62)	
Grains roots and tubers						
Food secure	378	87.4	184	86.2	1.10 (0.89-1.34)	0.28
Mildly food insecure	89	89.1	33	83.8	1.61 (1.02-2.25)*	
Moderately food insecure	280	87.5	144	87.3	1.00 (0.79-1.27)	
Severely food insecure	106	86.9	42	88.7	0.92 (0.59-1.43)	
Vitamin-A rich fruits and vegetables						
Food secure	378	26.1	184	26.6	1.03 (0.88-1.21)	0.77
Mildly food insecure	89	23.7	33	19.9	1.25 (0.84-1.84)	
Moderately food insecure	280	20.9	144	18.4	1.13 (0.92-1.39)	
Severely food insecure	106	20.3	42	19.3	1.12 (0.78-1.61)	
Legumes and nuts						
Food secure	378	21.7	184	23.4	0.88 (0.73-1.06)	<0.01
Mildly food insecure	89	24.2	33	18.1	1.60 (1.03-2.48)*	
Moderately food insecure	280	19.0	144	15.0	1.32 (1.05-1.67)*	
Severely food insecure	106	14.7	42	18.9	0.73 (0.49-1.10)	
Other fruits and vegetables						
Food secure	378	28.0	184	28.9	0.95 (0.81-1.11)	0.80
Mildly food insecure	89	27.8	33	25.9	1.10 (0.77-1.57)	
Moderately food insecure	280	26.9	144	27.2	0.97 (0.81-1.16)	
Severely food insecure	106	26.6	42	25.1	1.10 (0.80-1.52)	

[¥]Ns represent the number of children in the subgroup for whom feeding practice data was available at least at one follow-up visit; [ρ]Odds ratio (OR) from logistic mixed-effect models with randomisation cluster and individual level (child) clustering, *p-value<0.05, **p-value<0.01 indicate that the intervention effect is significant within the subgroup; [†]Interaction p-value tests the null hypothesis that the effect of the intervention is the same across all subgroups.

Chapter 7: General discussion

7.1 Summary of findings

Despite the considerable improvements in child nutrition over the last two decades in LMICs, many African and South Asian children are still undernourished and fail to thrive to their full potential[1, 2]. Progress in reducing child undernutrition has been slow in recent years and is feared to have been worsened by COVID-19[3, 4]. Few LMICs are likely to attain the SDG targets for child undernutrition by 2030[4]. Coverage of key nutrition-specific interventions to address child undernutrition is improving. However, it shows large regional, intra-country and socio-economic disparity[5]. In Bangladesh, large gaps remain in achieving universal coverage of key nutrition-specific interventions for mothers and children[6]. Geographic and socio-economic inequities in coverage of the interventions are also widespread (section 2.2.5)[6, 7]. Moreover, the slow progress in improving the coverage of nutrition-specific interventions accounts for the low contribution of the health sector (16%) to total child stunting reduction between 2004 and 2014 in Bangladesh[8]. This thesis includes four studies that explored how to improve coverage and quality of selected priority nutrition-specific interventions to be delivered during the first 1000 days of life in Bangladesh.

With the growing shift towards integrating nutrition services into the health systems, the quality of nutrition services remains a major concern. It influences the effective coverage and impact of the interventions[5, 9]. This thesis explored the quality of nutrition services provided during ANC (Chapter 3), the first formal contact for receiving preventive nutrition interventions in pregnancy[10]. Consistent with the evidence from LMICs, the thesis found poor coverage and quality of nutrition interventions such as weight assessment, anaemia assessment, nutrition counselling, and IFA supplementation during ANC[11, 12]. This research also explored health facility readiness, healthcare provider and client characteristics, and process of care (client-provider interaction) factors to improve nutrition service provision at ANC. Maternal weight assessment relied on logistical readiness, while healthcare providers' knowledge of nutrition services improved anaemia assessment and nutrition counselling. The provision of nutrition services was positively associated with healthcare providers using a visual aid or an ANC card. Similar to previous research, this research also demonstrated that better healthcare providers' interpersonal communication during ANC improved IFA distribution and nutrition counselling[13, 14]. Nonetheless, lower-level providers (paramedics and CHWs) provided better quality nutrition services than physicians and nurses, indicating selectivity and self-prioritisation of curative over preventive nutrition services by higher-level providers performing multiple responsibilities[15]. Further, women in early pregnancy were less likely to receive IFA supplements and weight measurements, as was found in previous studies[16, 17]. In contrast, basic nutrition training and external supervision of healthcare providers did not impact the nutrition service provision questioning the quality, acceptance, and relevance of the training and supervision to nutrition-specific service provision during ANC.

Antenatal IFA supplementation is a critical nutrition-specific intervention and has multifaced impacts such as reducing maternal anaemia, and improving birth weight and children's linear growth[18, 19]. In Chapter 4, the implementation of the WHO recommendation of blanket supplementation of at least 180 IFA tablets in pregnancy in Bangladesh was explored[20, 21]. Using a household survey of 2572 women who gave birth to a live-born infant in the six months preceding the interview, this research identified poor coverage of the recommended adequate dose of consuming ≥180 IFA tablets in pregnancy (user adherence-adjusted effective coverage). Similar to previous findings, the highest decline in IFA coverage occurred between receiving and consuming IFA in any quantity and the adequate dose[22]. However, the gap between the total number of tablets received and the number consumed was low. This research also identified programmatically critical areas to intervene to improve the user adherence-adjusted effective coverage of IFA supplementation. Consistent with previous findings, the number of ANC contacts during pregnancy had a strong linear relationship with the number of IFA tablets received and user adherence-adjusted coverage, reinforcing the importance of the ANC platform for nutrition service delivery[23]. However, this relationship was highly influenced by the timing of the first ANC contact. Women who started receiving ANC after four months of gestational age were less likely to have user adherence-adjusted coverage of IFA even with four or more ANC visits. Receiving advice on IFA positively impacted effective coverage of IFA, emphasising the importance of adequate nutrition counselling during ANC. Nonetheless, relying only on ANC for IFA resulted in lower effective coverage, highlighting the likely gaps in readiness and quality of IFA distribution in ANC, no provision of free IFA at private facilities, and an inadequate number of ANC visits received by mothers[22, 24].

The promotion of optimal breastfeeding has been recommended as a priority nutrition-specific intervention for its multifaced benefits on a child's survival, health, nutrition, and development[25, 26]. Chapter 5 explored evidence from a cluster randomised controlled trial in Bangladesh investigating the application of a digital job aid for counselling pregnant and post-partum women to improve coverage of nutrition education and initial and exclusive breastfeeding up to six months of age[27]. This research showed that an electronic job aid supported counselling and practical demonstration of breastfeeding techniques by CHWs prevented prelacteal feeding and improved exclusive breastfeeding up to six months. This finding is consistent with previous nutrition education research[28, 29]. The nutrition education intervention sustained high coverage of exclusive breastfeeding by preventing the introduction of other foods in the intervention group before six months of age. Multiple home-based time-tailored structured counselling, context-relevant visual illustration built into the job aid, and practical demonstration and problem-solving on breastfeeding by CHWs may have addressed the existing misconceptions, doubts, stress, frustrations, lack of confidence about breastfeeding among mothers[30-33]. Moreover, the intervention was equally effective among different, educational, and other socio-economic characteristics of the mothers indicating that a digital job aid can promote equity in exclusive breastfeeding practice. This research also demonstrated that coverage of nutrition counselling by trained healthcare providers was significantly higher among the mothers in the job aid-supported nutrition counselling group compared to the usual practice arm.

Similar to exclusive breastfeeding practices, age-appropriate complementary feeding practices also remain suboptimal in LMICs[34]. Among the complementary feeding indicators, consumption of the minimally diverse diet has been the poorest and the main hurdle for improving the coverage of minimum acceptable diet among 6-23 months old children in LMICs[34, 35]. Chapter 6 presented an analysis of the effect of digital job aid-supported nutrition counselling on improving dietary diversity among children aged 6-23 months[36]. There was high coverage (>90%) of infant and young child feeding counselling which resulted in improved dietary diversity in young children such as 9 and 12 months. Similar to previous evidence, this research demonstrated that prioritising messages on animal-sourced protein can consistently improve consumption in children up to 15 months of age[37]. A key finding of the study is the effect modification of household food security on the relationship between nutrition education intervention and the child's dietary diversity. Consistent with the previous findings of the limited effect of nutrition education in food-insecure settings[38, 39], this research showed that nutrition education intervention was effective in improving the child's diet diversity only among mild and moderately food insecure households and demonstrated the importance of complex contextual drivers of infant feeding and nutrition.

7.2 Strengths and limitations

This research has several strengths. The thesis had a wide scope. Considering the evidence-based recommendations for nutrition-specific interventions effective in addressing child undernutrition[40, 41], this thesis focused on improving coverage and quality of selected interventions delivered during the first 1000 days of life relevant for LMIC settings. The evaluated, priority nutrition-specific preventive interventions were all aligned with the priorities of the National Nutrition Services programme in Bangladesh[42]. As the effectiveness of these interventions was already established, this research explored the gaps and factors influencing quality nutrition service provision and identified the coverage gaps and areas to intervene for improving coverage.

One key strength of this research was using a wide mix of data from multiple relevant sources, including a cross-sectional household survey, health facility readiness assessment, healthcare provider interviews, observation of nutrition service provision, and data from a cluster randomised controlled trial for corroborating evidence to improve coverage and quality of nutrition interventions. This research also included community, primary, and secondary-level health facilities in sampling from different areas of

Bangladesh, where appropriate, which increased the generalizability of the findings. The randomised trial data had excellent internal and external validity, with good follow-up completion (>85%).

Another strength of this research was the application of theoretical frameworks for the cross-sectional study designs adopted in Chapters 3 and 4. Chapter 3 adopted the Donabedian framework for assessing healthcare quality[43]. Likewise, Chapter 4 adopted a modified version of Fiedler et al.'s framework to identify the falter points in adequate IFA coverage in pregnancy and applied the effective coverage measurement cascade and Anderson's health-seeking behaviour model for exploring the factors influencing effective coverage. Using these theoretical frameworks enabled a robust analysis of factors affecting the quality and coverage of nutrition interventions.

This research's methodological strength lies in the tools and methods used for data collection and analysis. Contextually adapted structured tools were used for health facility assessment, observation of ANC consultations, and interviews with healthcare providers[11, 15, 44](Chapter 3), and the household survey of mothers with a recent birth (Chapter 4) used an adapted version of the Bangladesh Demographic and Health Survey questionnaire[35]. Similarly, assessments of breastfeeding (Chapter 5) and age-appropriate complementary feeding (Chapter 6) in the CRCT were conducted using a 24-hour recall-based infant and young child feeding questionnaire modelled from the Bangladesh Demographic and Health Survey child nutrition questionnaire[45]. The analysis employed mixed linear, logistic, and Poisson regression models, including clustering variables as random effects and explanatory variables as fixed effects. This allowed a more robust estimate of standard errors, confidence intervals, and statistical significance. Where appropriate, the analyses were adjusted for the multi-level cluster sampling. Data from the CRCT were analysed using the intention-to-treat principle. Relevant sensitivity and sub-group analyses were also conducted.

This research has some limitations. Firstly, it explored the quality and coverage of only four preventive nutrition-specific interventions. However, except for calcium supplementation during ANC contacts, none of the non-selected interventions is universally provided to mothers and children in Bangladesh[42]. Moreover, calcium supplementation mainly targets the prevention of hypertension and the risk of pre-eclampsia in pregnancy which is not the focus of this research. Vitamin-A supplements are provided to 6-59 months old children mostly through national campaigns every six months[42]. Secondly, the research did not use any qualitative research methods to explore supply and demand side barriers and challenges for improving quality and coverage of interventions. Nonetheless, some previous studies have identified existing programmatic and systems-level challenges in nutrition service delivery in Bangladesh[15]. Thirdly, the research had limited exploration of the quality of nutrition services delivered by the private sector. Understanding pathways to leverage this fast-growing source of healthcare is needed. Nonetheless, the research is highly relevant to the existing modalities of community-based nutrition service delivery in Bangladesh's public and private sectors[15, 46]. Fourthly, this research needed data on the coverage of all priority preventive nutrition-specific interventions in a cohort of mother-child dyads during the first 1000 days of life. Without this continuum of care data, it was not possible to examine the composite coverage of priority nutrition-specific interventions during this critical period. Also, the research could not identify the interventions with larger gaps in achieving >90% coverage and the underlying factors influencing the coverage differences among interventions. Finally, the cross-sectional survey for assessing the coverage of antenatal IFA supplementation was conducted within 6 months after birth to minimise reporting bias but cannot grantee validity of dose of IFA consumption. The estimates of number of IFA tablets received and consumed during pregnancy should be interpreted with caution.

7.3 Implications for policy, programmes, and areas for future research

This research highlights the gaps in the quality and coverage of key preventive nutrition-specific interventions. It demonstrates some critical policy and programmatic opportunities for improving the coverage of quality nutrition interventions in the first 1000 days of life in LMICs such as Bangladesh.

The findings demonstrated the importance of the readiness of the health facilities to provide a quality service (Chapter 3). The national health facility assessments showed consistently poor readiness and functionality of health facilities at all levels to provide maternal health services, including ANC and child health and nutrition services[47]. Strengthening the implementation of the National Nutrition Services Operational Plan inputs[42] is essential to improve the readiness of public sector health facilities to provide nutrition services at all maternal and child healthcare contacts. A recent study also reported poor readiness of private sector health facilities and suggested the importance of regulatory measures and monitoring of private health facilities by the Government of Bangladesh[48]. In the future, implementation research for leveraging the government’s stewardship role to improve the quality of care in private facilities is important in such settings with the growing contribution of the private sector in health and nutrition service provision[49]. Additionally, future research should explore population level coverage of quality nutrition services during pregnancy and the direct health and indirect non-health sector determinants of quality adjusted effective coverage.

This research also highlighted the inadequacy of routine supervision and the basic nutrition training of service providers in improving the quality of nutrition service provision at ANC. Previous literature suggests that the current supervisory practice in public health service is highly focused on administration, and that supervisors often lack the technical competence to provide supportive supervision[15, 50]. Harnessing the benefits of supervision necessitates policy and systems-level changes to embed quality-focused supportive supervision by engaging technical supervisors. Improving the capacity of the existing supervisors to provide quality supervision is also important. Future implementation research should also focus on developing a supporting supervision toolkit to improve the quality of nutrition services delivered on health service platforms. Similarly, a rigorous evaluation of the competency-based knowledge and skill improvement training of healthcare providers on nutrition services introduced in the current National Nutrition Services Operational Plan[42], after the data for this research was collected, is warranted to explore the effect on improving the healthcare providers' competence and quality of nutrition service provision.

Client-provider communication is an important aspect that improves the quality of nutrition services in ANC. Also, women receiving advice on the importance of IFA increased the number of IFA consumed and user adherence-adjusted coverage of antenatal IFA supplementation. However, currently, counselling is inadequate, and healthcare providers often tend to prioritise curative over preventive services[15]. Both facility and community-based programmes should emphasise the role clarification of healthcare providers and improve their counselling and communication skills with the clients to improve the quality of the services. Future research should explore health systems and motivational factors influencing the provider's preferences and practices and consider those findings in designing the provider's capacity-building and mentoring interventions.

Although IFA supplementation during pregnancy to address iron deficiency anaemia among mothers is recommended by the WHO[20] and the National Nutrition Programme[42] and IFA is freely available at public health facilities, receiving and consuming an adequate dose of IFA depends on the timing and frequency of ANC. In the last ten years, receiving ANC from medically trained providers has increased in Bangladesh; however, receiving four or more visits and starting the first ANC in early gestation is still inadequate[7, 51]. The national programme should emphasise community engagement and mobilisation interventions to increase ANC utilisation. The national maternal health programme should adopt the WHO-recommended eight ANC contacts[20].

This research also highlighted that women in early pregnancy are less likely to receive IFA at ANC consultations. The National Guideline on Prevention and Treatment of Iron Deficiency Anaemia 2001 recommended starting IFA supplementation as soon as pregnancy is detected[52]. But the National Maternal Health Standard Operating Procedure in 2015 preferred starting IFA supplementation after 12 weeks of pregnancy[53]. The Antenatal Care Guideline in 2020 also recommended starting antenatal IFA supplementation from 12 weeks onwards[54]. Inconsistencies between different guidelines on the timing of IFA supplementation may have created a misconception among the providers and resulted in the lower provision of IFA supplements in the first trimester. Pregnant women also often perceive and associate early pregnancy complications with IFA side effects. Making the guidelines consistent and providing healthcare providers with information on timing, dose, and potential side effects of IFA based on the recent evidence are imperative to promote IFA supplementation in early pregnancy. This thesis could not validate the IFA consumption and coverage estimated by mother's recall. Future research should assess antenatal IFA consumption among currently pregnant women and validate the IFA coverage by assessing the anaemia status of the IFA recipients.

One of the key findings of this research is on the usefulness of job aids in providing nutrition-specific interventions during pregnancy and in the first two years of a child's life. The National Nutrition Services Programme should ensure the availability of job aids and promote their use by healthcare providers to improve the quality of nutrition services. Formative and implementation research should review the existing ANC job aids and propose necessary adaptions, including the number of IFA tablets provided to mothers on the ANC card, to improve their relevance to quality nutrition service provision.

This research also established the considerable benefits of electronic job aid-supported nutrition counselling on infant and young child feeding practices. Both facility and community-based programmes should adopt an electronic job aid-supported nutrition education intervention. Furthermore, the recent provision of digital devices to primary healthcare providers for their business automation under the digital health initiative[55] leverages an opportunity to integrate the electronic job aid tool providing time-relevant nutrition counselling. Future implementation research should focus on contextualising the job aid for healthcare providers. Considering the previous successful examples of the mass campaign such as promoting oral rehydration solution and zinc for childhood diarrhoea[56], future research should also explore how multi-modal mass-scale behaviour change strategies can complement the one-to-one counselling of mothers in addressing the community misconceptions and societal normative barriers and creating an enabling environment for appropriate infant feeding practices. Future research should explore the specific benefits of adding electronic job aid in nutrition counselling from both health systems and beneficiary perspectives by comparing the job aid supported counselling with the traditional counselling method without such job aids. Nonetheless, the cost-effectiveness of the digital job aid supported counselling intervention package should be assessed before implementing the intervention at scale.

The finding of the effect of household food insecurity on dietary diversity and animal-sourced protein intake among infants highlighted the importance of multisectoral nutrition programming. Providing only counselling on dietary diversity and consumption of relatively costlier food such as animal protein to food insecure households also raises an ethical concern as the caregivers may not be able to transform the knowledge into practice. Providing only the nutrition education intervention may have failed to address barriers to optimal feeding practices in severely food insecure households[57, 58]. The mean dietary score was also lower than the recommended minimum dietary score of 4+ food groups both in the intervention and control arms. Limited effects of the nutrition counselling intervention on improving the consumption of dairy products, vitamin-A rich foods, and other fruits and vegetables explain the lower than recommended mean dietary diversity in the intervention arm. Combining the nutrition-sensitive interventions such as social safety net interventions including conditional or conditional cash transfers during this critical window of opportunity would support the caregivers to improve infant feeding practices[59, 60]. The Ministry of Women and Children Affairs (MoWCA) of the Government of Bangladesh is implementing social safety net programs for poor pregnant and lactating mothers to support maternal nutrition and infant feeding practices and health[61]. The National Nutrition Services programme should collaborate with these government and non-government programmes consisting of nutrition-sensitive livelihood promotion and social safety net interventions to complement nutrition education interventions in food-insecure populations. Nonetheless, deciding how to best bundle nutrition education and context-relevant nutrition-sensitive interventions during the first 1000 days of life requires comprehensive implementation research and multi-sectoral coordination at the policy and programme levels.

Monitoring effective coverage and composite coverage of key nutrition-specific interventions is an important next step to identify the progress in the implementation and coverage of all priority interventions during the first 1000 days of life. This would also enable the identification of the slow-progressing interventions and highlight the quality gaps. At the policy level, an initiative to provide inputs for the adaptation of existing population-level coverage measures, such as the Demographic and Health Survey and Multiple Indicator Cluster Survey, is necessary to include relevant nutrition intervention coverage measurements. At the health systems level, strengthening routine health information systems to document the readiness and provision of care with quality parameters is important for measuring and improving the quality and coverage of nutrition-specific interventions delivered through health system platforms.

7.4 Conclusion

This research highlights the importance of and demonstrates where and how to intervene to improve the coverage and quality of selected nutrition-specific interventions during the first 1000 days of life in an LMIC setting such as Bangladesh. This research reports suboptimal quality of nutrition services delivered at antenatal care contacts and demonstrates the importance of health facility readiness, good provider-client interaction, and using job aids for better quality nutrition service delivery. The research also emphasises the need to restructure healthcare providers' training in nutrition and supportive supervision to improve nutrition service provision. The research identifies a low user adherence-adjusted effective coverage of antenatal IFA supplementation. Consistent guidelines and orientation of the healthcare providers on IFA initiation in early pregnancy and appropriate counselling on the side effects of IFA, promotion of WHO recommendation on receiving ANC early and eight or more times in pregnancy are important health systems strengthening actions to improve adherence to IFA supplementation. This research adds to the emerging knowledge of integrating digital technology as a decision and guiding tool in delivering health and nutrition services. Considering the positive effect of exclusive breastfeeding and dietary diversity among children, this research recommends adopting electronic job aid-supported nutrition counselling into wider programmes and health systems platforms. Integrating nutrition-sensitive social protection interventions to complement nutrition counselling is also warranted to address underlying drivers of child undernutrition such as household food insecurity. In summary, adopting the lessons learnt and policy recommendations from this research would improve the coverage and quality of key nutrition-specific interventions and promote optimal growth of children in LMICs.

7.5 References

1. Victora CG, Christian P, Vidaletti LP, Gatica-Domínguez G, Menon P, Black RE. Revisiting maternal and child undernutrition in low-income and middle-income countries: variable progress towards an unfinished agenda. The Lancet. 2021.
2. Development Initiatives. 2021 Global Nutrition Report: The state of global nutrition. Bristol, UK: Development Initiatives; 2021.
3. Osendarp S, Akuoku JK, Black RE, Headey D, Ruel M, Scott N, et al. The COVID-19 crisis will exacerbate maternal and child undernutrition and child mortality in low-and middle-income countries. Nature Food. 2021;2(7):476-84.
4. United Nations Children's Fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and Trends in Child Malnutrition: Key Findings of the 2021 Edition of the Joint Child Malnutrition Estimates. Geneva: World Health Organization; 2021. Report No.: 9240025251.
5. Heidkamp RA, Piwoz E, Gillespie S, Keats EC, D'Alimonte MR, Menon P, et al. Mobilising evidence, data, and resources to achieve global maternal and child undernutrition targets and the Sustainable Development Goals: an agenda for action. The Lancet. 2021;397(10282):1400-18.
6. Nguyen PH, Khương LQ, Pramanik P, Billah SM, Menon P, Piwoz E, et al. Effective coverage of nutrition interventions across the continuum of care in Bangladesh: insights from nationwide cross-sectional household and health facility surveys. BMJ Open. 2021;11(1):e040109.
7. Bangladesh Bureau of Statistics (BBS), UNICEF Bangladesh. Progotir Pathey, Bangladesh Multiple Indicator Cluster Survey 2019, Survey Findings Report. Dhaka, Bangladesh: Bangladesh Bureau of Statistics (BBS); 2019.
8. Headey D, Hoddinott J, Ali D, Tesfaye R, Dereje M. The other Asian enigma: explaining the rapid reduction of undernutrition in Bangladesh. World Development. 2015;66:749-61.
9. Amouzou A, Leslie HH, Ram M, Fox M, Jiwani SS, Requejo J, et al. Advances in the measurement of coverage for RMNCH and nutrition: from contact to effective coverage. BMJ Global Health. 2019;4(Suppl 4):e001297.
10. Billah SM, Ali NB, Khan ANS, Raynes-Greenow C, Kelly PJ, Siraj MS, et al. Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh. PloS one. 2022;17(1):e0262867.
11. Billah SM, Saha KK, Khan ANS, Chowdhury AH, Garnett SP, Arifeen SE, et al. Quality of nutrition services in primary health care facilities: Implications for integrating nutrition into the health system in Bangladesh. PloS one. 2017;12(5):e0178121-e.
12. Islam MM, Masud MS. Determinants of frequency and contents of antenatal care visits in Bangladesh: Assessing the extent of compliance with the WHO recommendations. PloS one. 2018;13(9):e0204752.
13. Phommachanh S, Essink DR, Jansen M, Broerse JE, Wright P, Mayxay M. Improvement of Quality of Antenatal Care (ANC) Service Provision at the Public Health Facilities in Lao PDR: Perspective and Experiences of Supply and Demand Sides. BMC pregnancy and childbirth. 2019;19(1):1-13.
14. Emiru AA, Alene G, Debelew GT. Women's satisfaction with the quality of antenatal care services rendered at public health facilities in Northwest Ethiopia: the application of partial proportional odds model. BMJ open. 2020;10(9):e037085.
15. Saha KK, Billah M, Menon P, El Arifeen S, Mbuya NV. Bangladesh National Nutrition Services: assessment of implementation status: The World Bank; 2015.
16. Alam A, Rasheed S, Khan NU, Sharmin T, Huda TM, Arifeen SE, et al. How can formative research inform the design of an iron-folic acid supplementation intervention starting in first trimester of pregnancy in Bangladesh? BMC Public Health. 2015;15(1):374.
17. Amoakoh-Coleman M, Agyepong IA, Zuithoff NP, Kayode GA, Grobbee DE, Klipstein-Grobusch K, et al. Client factors affect provider adherence to clinical guidelines during first antenatal care. PLoS One. 2016;11(6):e0157542.

18. Oh C, Keats EC, Bhutta ZA. Vitamin and mineral supplementation during pregnancy on maternal, birth, child health and development outcomes in low-and middle-income countries: a systematic review and meta-analysis. Nutrients. 2020;12(2):491.

19. Nisar YB, Aguayo VM, Billah SM, Dibley MJ. Antenatal Iron-Folic Acid Supplementation Is Associated with Improved Linear Growth and Reduced Risk of Stunting or Severe Stunting in South Asian Children Less than Two Years of Age: A Pooled Analysis from Seven Countries. Nutrients. 2020;12(9):2632.

20. World Health Organization. WHO Antenatal Care Recommendations for a Positive Pregnancy Experience: Nutritional Interventions Update: Multiple Micronutrient Supplements During Pregnancy. Geneva, Switzerland: World Health Organization (WHO); 2020. Report No.: 9240007784.

21. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International. Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International; 2012.

22. Sununtnasuk C, D'Agostino A, Fiedler JL. Iron+ folic acid distribution and consumption through antenatal care: identifying barriers across countries. Public Health Nutrition. 2016;19(4):732-42.

23. Nguyen PH, Sanghvi T, Kim SS, Tran LM, Afsana K, Mahmud Z, et al. Factors influencing maternal nutrition practices in a large scale maternal, newborn and child health program in Bangladesh. PloS One. 2017;12(7):e0179873.

24. Siekmans K, Roche M, Kung'u JK, Desrochers RE, De-Regil LMJM, nutrition c. Barriers and enablers for iron folic acid (IFA) supplementation in pregnant women. 2018;14:e12532.

25. Ho NT, Li F, Lee-Sarwar KA, Tun HM, Brown BP, Pannaraj PS, et al. Meta-analysis of effects of exclusive breastfeeding on infant gut microbiota across populations. Nature communications. 2018;9(1):1-13.

26. Victora CG, Bahl R, Barros AJ, França GV, Horton S, Krasevec J, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. The Lancet. 2016;387(10017):475-90.

27. Billah SM, Ferdous TE, Siddique AB, Raynes-Greenow C, Kelly P, Choudhury N, et al. The effect of electronic job aid assisted one-to-one counselling to support exclusive breastfeeding among 0–5-month-old infants in rural Bangladesh. Maternal & Child Nutrition. 2022:e13377.

28. Lassi ZS, Rind F, Irfan O, Hadi R, Das JK, Bhutta ZA. Impact of infant and young child feeding (iycf) nutrition interventions on breastfeeding practices, growth and mortality in low-and middle-income countries: systematic review. Nutrients. 2020;12(3):722.

29. McFadden A, Siebelt L, Marshall JL, Gavine A, Girard L-C, Symon A, et al. Counselling interventions to enable women to initiate and continue breastfeeding: a systematic review and meta-analysis. International breastfeeding journal. 2019;14(1):1-19.

30. Aksu H, Küçük M, Düzgün G. The effect of postnatal breastfeeding education/support offered at home 3 days after delivery on breastfeeding duration and knowledge: a randomized trial. The Journal of Maternal-Fetal & Neonatal Medicine. 2011;24(2):354-61.

31. Haider R, Rasheed S, Sanghvi TG, Hassan N, Pachon H, Islam S, et al. Breastfeeding in infancy: identifying the program-relevant issues in Bangladesh. International Breastfeeding Journal. 2010;5(1):1-12.

32. Kavle JA, LaCroix E, Dau H, Engmann C. Addressing barriers to exclusive breast-feeding in low- and middle-income countries: a systematic review and programmatic implications. Public Health Nutrition. 2017;20(17):3120-34.

33. Shafaei FS, Mirghafourvand M, Havizari S. The effect of prenatal counseling on breastfeeding self-efficacy and frequency of breastfeeding problems in mothers with previous unsuccessful breastfeeding: a randomized controlled clinical trial. BMC women's health. 2020;20:1-10.

34. White JM, Bégin F, Kumapley R, Murray C, Krasevec J. Complementary feeding practices: Current global and regional estimates. Maternal & Child Nutrition. 2017;13:e12505.

35. National Institute of Population Research and Training (NIPORT), ICF International. Bangladesh Demographic and Health Survey 2017-18. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT and ICF; 2020.

36. Billah SM, Ferdous TE, Kelly PJk, Greenow CR, Siddique AB, Choudhury N, et al. Effect of nutrition counselling with a digital job aid on child dietary diversity: Analysis of secondary outcomes from a cluster randomised controlled trial in rural Bangladesh. Maternal & Child Nutrition. 2021(e13267).
37. Shi L, Zhang J, Wang Y, Caulfield LE, Guyer B. Effectiveness of an educational intervention on complementary feeding practices and growth in rural China: a cluster randomised controlled trial. Public Health Nutrition. 2010;13(4):556-65.
38. Imdad A, Yakoob MY, Bhutta ZA. Impact of maternal education about complementary feeding and provision of complementary foods on child growth in developing countries. BMC Public Health. 2011;11(3):1-14.
39. Kuchenbecker J, Reinbott A, Mtimuni B, Krawinkel MB, Jordan I. Nutrition education improves dietary diversity of children 6-23 months at community-level: Results from a cluster randomized controlled trial in Malawi. PLoS One. 2017;12(4):e0175216.
40. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? The Lancet. 2013;382(9890):452-77.
41. Keats EC, Das JK, Salam RA, Lassi ZS, Imdad A, Black RE, et al. Effective interventions to address maternal and child malnutrition: an update of the evidence. The Lancet Child Adolescent Health. 2021.
42. Government of People's Republic of Bangladesh. 4th Health, Population and Nutrition Sector Programme (4th HPNSP), Operational Plan, National Nutrition Service (NNS) Dhaka: Institute of Public Health Nutrition, Directorate General of Health Service, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh; 2017.
43. Donabedian A. The quality of care: How can it be assessed? JAMA. 1988;260(12):1743-8.
44. National Institute of Population Research and Training (NIPORT), Associates for Community and Population Research (ACPR), ICF International. Bangladesh Health Facility Survey 2014. Dhaka, Bangladesh: NIPORT, ACPR and ICF International; 2016.
45. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International. Bangladesh Demographic and Health Survey 2014. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT, Mitra and Associates, and ICF International; 2016.
46. Nguyen PH, Kim SS, Tran LM, Menon P, Frongillo EA. Intervention design elements are associated with frontline health workers' performance to deliver infant and young child nutrition services in Bangladesh and Vietnam. Current Developments in Nutrition. 2019;3(8):nzz070.
47. National Institute of Population Research and Training (NIPORT), ICF International. Bangladesh Health Facility Survey 2017: Final Report. Dhaka, Bangladesh: NIPORT and ICF; 2019.
48. Billah SM, Islam S, Lotus SU, Rahman M, Hossain MJ, Sarker BK, et al. Assessment of licensing status, compliance with the basic licensing requirements, and MNH care readiness of the private inpatient healthcare facilities of Bangladesh. 2022.
49. Cross HE, Sayedi O, Irani L, Archer LC, Sears K, Sharma S. Government stewardship of the for-profit private health sector in Afghanistan. Health Policy and Planning. 2017;32(3):338-48.
50. World Health Organization. Bangladesh health system review: WHO Regional Office for the Western Pacific; 2015.
51. National Institute of Population Research and Training (NIPORT), International Centre for Diarrhoeal Disease Research Bi, b),, MEASURE Evaluation. Bangladesh District Level Socio-demographic and Health Care Utilization Indicators. Dhaka, Bangladesh, and Chapel Hill, NC, USA: NIPORT, icddr,b and MEASURE Evaluation; 2019.
52. Nutrition IoPH. National Guidelines: Prevention and Treatment of Iron Deficiency Anaemia. Dhaka: IPHN; 2001.
53. Ministry of Health and Family Welfare (MOH&FW). Maternal Health Standard Operating Procedure (SOP) Volume-1. Bangladesh: MOH&FW; 2015.
54. Directorate General Health Services (DGHS), World Health Organization (WHO) Bangladesh, Obstetrical and Gynaecological Society of Bangladesh (OGSB). Guideline on Antenatal Care (ANC). In: Services DGoH, editor. Dhaka: Ministry of Health and Family Welfare; 2020.

55. MEASURE Evaluation. Implementation of the Electronic Management Information System in Bangladesh: Experience and Lessons Learned. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina.; 2019.
56. Billah SM, Raihana S, Ali NB, Iqbal A, Rahman MM, Khan ANS, et al. Bangladesh: a success case in combating childhood diarrhoea. Journal of Global Health. 2019;9(2).
57. Ali IA, Shet A, Mascarenhas M, Galanti MR. Effect of a maternal counselling intervention delivered by community health workers on child nutrition: secondary analysis of a cluster randomised controlled trial in India. BMC public health. 2021;21(1):1-11.
58. Chandrasekhar S, Aguayo VM, Krishna V, Nair R. Household food insecurity and children's dietary diversity and nutrition in India. Evidence from the comprehensive nutrition survey in Maharashtra. Maternal & Child Nutrition. 2017;13:e12447.
59. Ahmed A, Hoddinott JF, Roy S, Sraboni E, Quabili WR, Margolies A. Which kinds of social safety net transfers work best for the ultra poor in Bangladesh? Operation and impacts of the transfer modality research initiative. 2022.
60. De Groot R, Palermo T, Handa S, Ragno LP, Peterman A. Cash transfers and child nutrition: pathways and impacts. Development Policy Review. 2017;35(5):621-43.
61. Nawaz MS, Masing Newar COC. Improving social protection programmes to support mothers and young children’s diets in Bangladesh: Combining cash transfers with behaviour change. Nutrition Exchange Asia 2. 2020:22.

Appendix A: Other relevant papers published during PhD candidature

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Reproductive Health

RESEARCH Open Access

Setting up a maternal and newborn registry applying electronic platform: an experience from the Bangladesh site of the global network for women's and children's health

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Abstract

Background: The Global Network for Women's and Children's Health Research (Global Network, GN) has established the Maternal Newborn Health Registry (MNHR) to assess MNH outcomes over time. Bangladesh is the newest country in the GN and has implemented a full electronic MNH registry system, from married women surveillance to pregnancy enrollment and subsequent follow ups.

Method: Like other GN sites, the Bangladesh MNHR is a prospective, population-based observational study that tracks pregnancies and MNH outcomes. The MNHR site is in the Ghatail and Kalihati sub-districts of the Tangail district. The study area consists of 12 registry clusters each of ~ 18,000–19,000 population. All pregnant women identified through a two-monthly house-to-house surveillance are enrolled in the registry upon consenting and followed up on scheduled visits until 42 days after pregnancy outcome. A comprehensive automated registry data capture system has been developed that allows for married women surveillance, pregnancy enrollment, and data collection during follow-up visits using a web-linked tablet-PC-based system.

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(Continued from previous page)

Result: During March–May 2019, a total of 56,064 households located were listed in the Bangladesh MNH registry site. Of the total 221,462 population covered, 49,269 were currently married women in reproductive age (CMWRA). About 13% CMWRA were less susceptible to pregnancy. Large variability was observed in selected contraceptive usage across clusters. Overall, 5% of the listed CMWRAs were reported as currently pregnant.

Conclusion: In comparison to paper-pen capturing system electronic data capturing system (EDC) has advantages of less error-prone data collection, real-time data collection progress monitoring, data quality check and sharing. But the implementation of EDC in a resource-poor setting depends on technical infrastructure, skilled staff, software development, community acceptance and a data security system. Our experience of pregnancy registration, intervention coverage, and outcome tracking provides important contextualized considerations for both design and implementation of individual-level health information capturing and sharing systems.

Keywords: Bangladesh, Maternal and newborn health, Global network, Registry, Electronic data capture

Plain English summary

In 2001, Global Network (GN), an international consortium dedicated to improving the health of women and children in resource-limited settings was developed. The GN has established an international multi-site population-based registry to quantify and understand the trends in pregnancy outcomes in defined low-resource geographic areas over time. Data from the registry is also used to guide/plan current and future GN studies as well as assessing the impact of the different interventions on maternal and newborn health.

Bangladesh is the most recent country to join the GN and has implemented a fully electronic registry system for married women surveillance, pregnancy identification and follow up until 42 days after birth. An electronic application is used by community-level registry administrators for enrollment of participants, preparation of follow-up visits plans, recording and transferring/sharing information collected at different follow-up visits. The application also provides real-time connectivity with a data display dashboard for progress monitoring and data use. The electronic registry system is better than paper-based methods for improved data quality and integrity, study productivity, preference of users, and reduced cost.

Background

In 2001, the National Institute for Child Health and Human Development established the Global Network for Women's and Children's Health Research (Global Network, GN) [1], an international consortium dedicated to improving the health of women and children in resource-limited areas. It has a goal to understand the morbidity and mortality surrounding childbirth and to identify the scalable low-cost interventions to improve maternal-child health. The GN has established an international multi-site population-based registry to assess pregnancy outcomes over time. The primary purpose of this prospective, population-based observational maternal newborn health registry (MNHR) is to quantify and understand the trends in pregnancy outcomes in defined low-resource geographic areas over time, in order to provide population-based statistics on stillbirths and neonatal and maternal mortality, including cause of death (COD). In addition, MNHR data will be used to guide/plan current and future GN studies as well as assess the impact of the interventions of GN protocols [2, 3].

Accurate data collection and management is an essential component of the MNHR which enrolls approximately 60,000 participants per year across 8 global sites (6). Bangladesh is the most recent country to join the GN and has implemented a full electronic MNH registry system, from married women surveillance to pregnancy enrollment and follow up. Application of electronic data collection (EDC) is an increasingly common tool for health research, especially in surveillance and registries due to improved data quality and integrity, study productivity, preference of users, and reduced cost relative to paper-based methods. Different GN sites of MNHR have adopted electronic data capturing and recoding systems in addition to existing paper-based data collection at service delivery points and home follow-ups. This article details the process of implementing EDC for the MNHR in a rural site in Bangladesh.

Methods

The MNHR is a prospective, population-based observational study that tracks pregnancies and outcomes in defined geographic communities. It provides stillbirth, neonatal and maternal mortality rates to inform research. The MNHR has been introduced in 7 low-middle income countries (DRC, Guatemala, India, Pakistan, Bangladesh, Zambia, and Kenya) [3]. The MNHR was initiated in 7 sites between 2008 and 2009. In Bangladesh, the MNHR was initiated in March 2019 and is funded to continue through 2023.

Study variables

The purpose of this observational study is to quantify and understand the trends in pregnancy outcomes in

journal of global health

Bangladesh: a success case in combating childhood diarrhoea

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Background Bangladesh had a large reduction in childhood deaths due to diarrhoeal disease in recent decades. This paper explores the preventive, promotive, curative and contextual drivers that helped Bangladesh achieve this exemplary success.

Methods Primary and secondary data collection approaches were used to document trends in reduction of Diarrhoea Specific Mortality Rate (DSMR) between 1980 and 2015, understand what policies and programmes played key roles, and estimate the contribution of specific interventions that were implemented during the period. Data acquisition involved relevant document reviews and in-depth interviews with key stake-holders. A systematic search of literature was undertaken to explore socio-economic, aetiological, behavioural, and nutritional drivers of diarrhoeal disease reduction in Bangladesh. Finally, we used LiST (Lives Saved Tool) to model the contributions of the relevant interventions during three time periods (1980-2015, 1980-2000 and 2000-2015), and to project the number of lives saved in 2030 (compared to 2015) if these interventions were implemented at near universal coverage (90%).

Results The factors which likely had the most impact on DSMR were the coordinated efforts of the Government of Bangladesh (GoB) with non-government organizations (NGOs) and the private sector that enabled swift implementation, at scale, of interventions like oral rehydration solution (ORS) and zinc, promotion of breastfeeding, handwashing and sanitary latrines (WASH), as well as improvements in female education and nutrition. Compared to 1980, we found ORS and reduction in stunting prevalence had the greatest impact on DSMR, saving roughly 70 000 lives combined in 2015. Until 2000, ORS had a higher contribution to DSMR reduction than reduction in stunting prevalence. This proportionate contribution was reversed during 2000-2015. At near universal coverage (90%) of combined direct diarrhoeal disease, nutrition and WASH interventions, we project that an additional 5356 deaths due to diarrhoea could be averted in 2030.

Conclusion Bangladesh's achievement in reduction of DSMR highlights the important role of an enabling policy environment that fostered coordinated efforts of the public and private sectors and NGOs for maximal impact. To maintain this momentum, evidence-based interventions should be scaled up at universal coverage.

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Diarrhoeal disease remains a leading global cause of childhood deaths despite a decline in the last three decades [1]. Developing countries make the largest contribution to the global burden of diarrhoea mortality with most deaths occurring in sub-Saharan Africa and South Asia. Diarrhoea has been one of the major

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U-Shaped Association between Maternal Hemoglobin and Low Birth Weight in Rural Bangladesh

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Abstract. Low birth weight (LBW) is associated with a higher risk of neonatal mortality and the development of adult-onset chronic disease. Understanding the ongoing contribution of maternal hemoglobin (Hgb) levels to the incidence of LBW in South Asia is crucial to achieve the World Health Assembly global nutrition target of a 30% reduction in LBW by 2025. We enrolled pregnant women from the rural Tangail District of Bangladesh in a Maternal Newborn Health Registry established under The Global Network for Women's and Children's Health Research. We measured the Hgb of pregnant women at enrollment and birth weights of all infants born after 20 weeks gestation. Using logistic regression to adjust for multiple potential confounders, we estimated the association between maternal Hgb and the risk of LBW. We obtained Hgb measurements and birth weights from 1,665 mother–child dyads between July 2019 and April 2020. Using trimester-specific cutoffs for anemia, 48.3% of the women were anemic and the mean (±SD) Hgb level was 10.6 (±1.24) g/dL. We identified a U-shaped relationship where the highest risk of LBW was seen at very low ($<$ 7.0 g/dL, OR = 2.00, 95% CI = 0.43–7.01, *P* = 0.31) and high ($>$ 13.0 g/dL, OR = 2.17, 95% CI = 1.01–4.38, *P* = 0.036) Hgb levels. The mechanisms underlying this U-shaped association may include decreased plasma expansion during pregnancy and/or iron dysregulation resulting in placental disease. Further research is needed to explain the observed U-shaped relationship, to guide iron supplementation in pregnancy and to minimize the risk of LBW outcomes.

INTRODUCTION

Low birth weight (LBW) continues to be a pressing global health concern as approximately 20 million babies are born each year with a weight of $<$ 2,500 grams.[1] This threshold for LBW was established by epidemiologic studies that demonstrated that babies with a birth weight of less than 2,500 grams were 20 times more likely to die in infancy.[2,3] LBW is associated with 80% of all neonatal deaths and has been linked to the development of stunting and adult-onset-non-communicable disease through malnutrition and fetal programming in utero.[1,4,5]

In 2012, the WHO set global nutrition targets under the Millennium Development Goals (MDGs) that include a 30% reduction in LBW by the year 2025.[1,6] These goals have brought attention to South Asia as about half of all LBW infants are born in India and Bangladesh. National LBW surveys conducted in Bangladesh in 2003–2004 and again in 2015 document significant progress in reducing the incidence of LBW in the region from 36% in 2003–2004 to 22.6% in 2015.[3] This progress has been attributed to improvement in socioeconomic conditions and widespread implementation of routine iron-folate supplementation.[3] Despite this progress, further work is needed to reduce LBW in South Asia to a rate comparable with the 6% of all births seen in many developed nations.[3,6]

Adequate iron stores are required during pregnancy for expansion of the maternal red cell mass that supports the growing placenta and fetus. Inadequate iron stores at the start of pregnancy place women at risk for the development of iron-deficiency anemia.[7,8] For this reason, universal preventative iron supplementation is routinely included in prenatal care.[9,10] This practice is supported by a positive correlation between iron supplementation and birth weight.[11,12] Anemia, however, which is often used as a proxy for iron deficiency, is inconsistently associated with LBW.[13] The national LBW survey in Bangladesh in 2015 found no association between hemoglobin (Hgb) and birth weight whereas a large systematic review and meta-analysis conducted in 2016 found the anemia-attributable proportion of LBW in low-income countries was 25%.[3,14,15] Some studies have found an association between only severe anemia ($<$ 7.0 g/dL) and LBW, whereas others document an increased risk of LBW at any Hgb level less than 11.0 g/dL, particularly when combined with a low maternal body mass index (BMI).[16,17]

Here, we report findings on the association of maternal Hgb with risk of LBW from an ongoing Maternal and Newborn Health Registry. It is important to further clarify the relationship between anemia and LBW in Bangladesh to bolster progress toward meeting the global nutrition target of a 30% reduction in LBW by the year 2025.

MATERIALS AND METHODS

Data sources and sampling procedure. This was a population-based study that is part of the National Institute of Child Health Global Network Maternal Newborn Health Registry (MNHR) (ClinicalTrials.gov Identifier: NCT01073475.) MNHR is a multisite, prospective, ongoing, and active surveillance system that is tracking pregnancies and births in defined geographic communities (clusters), each with approximately 300–400 deliveries per year. The Bangladesh site is located in the Tangail District of Bangladesh and is composed of 12 study clusters each with 17,500–19,500 people. Through a bimonthly house-to-house surveillance, pregnant women were identified and 99.7% of all eligible pregnant women were enrolled upon providing consent to participate. Mother–child dyads were followed up at birth (within 72 hours) and at 42 days postpartum for collection of maternal and newborn outcomes. Details of the registry are

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BMJ Open

Effective coverage of nutrition interventions across the continuum of care in Bangladesh: insights from nationwide cross-sectional household and health facility surveys

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ABSTRACT

Introduction Improving the impact of nutrition interventions requires adequate measurement of both reach and quality of interventions, but limited evidence exists on advancing coverage measurement. We adjusted contact-based coverage estimates, taking into consideration the inputs required to deliver quality nutrition services, to calculate input-adjusted coverage of nutrition interventions across the continuum of care from pregnancy through early childhood in Bangladesh.

Methods We used data from the 2014 Bangladesh Demographic and Health Surveys to assess use of maternal and child health services and the 2014 Service Provision Assessment to determine facility readiness to deliver nutrition interventions. Service readiness captured availability of nutrition-specific inputs (including human resources and training, equipment, diagnostics and medicines). Contact coverage was combined with service readiness to create a measure of input-adjusted coverage at the national and regional levels, across place of residence, and by maternal education and household socioeconomic quintiles.

Results Contact coverage varied from 28% for attending at least four ANC visits to 38% for institutional delivery, 35% for child growth monitoring and 81% for sick child care. Facilities demonstrated incomplete readiness for nutrition interventions, ranging from 48% to 51% across services. Nutrition input-adjusted coverage was suboptimal (18% for ANC, 23% for institutional delivery, 20% for child growth monitoring and 52% for sick child care) and varied between regions within the country. Inequalities in input-adjusted coverage were large during ANC and institutional delivery (14–17 percentage points (pp) between urban and rural areas, 15 pp between low and high education, and 28-34 pp between highest and lowest wealth quintiles) and less variable for sick child care (<2 pp).

Conclusion Nutrition input-adjusted coverage was suboptimal and varied subnationally and across the continuum of care in Bangladesh. Special efforts are needed to improve the reach as well as the quality of health and nutrition services to achieve the Sustainable Development Goals.

Strengths and limitations of this study

- Our study used nationally representative population and health system data to estimate input-adjusted coverage for nutrition interventions across the continuum of maternal and early childhood care.
- Our study quantified inequities in input-adjusted coverage within the population and indicated potential priorities for improvement, including special investment in reaching underserved populations with key services, while also ensuring adequate quality of services.
- Although the Service Provision Assessment survey was quite comprehensive, it did not capture every aspect to measure facility readiness to provide nutrition interventions or to calculate each step of care cascades from need for services through to health benefits.
- The exclusion of small private clinics hospitals with less than 20 beds could lead to an overestimation of quality for private sector users, as larger facilities tend to have higher readiness than smaller ones.

INTRODUCTION

Global evidence suggests that if high-quality health systems could effectively deliver a core subset of 19 maternal and child interventions, almost one quarter of the maternal deaths, neonatal deaths, and stillbirths would be prevented.[1] Access to 10 evidence-based nutrition interventions alone could reduce the mortality rate in children under 5 by 15%.[2] Despite this, coverage data for high-impact interventions along the continuum of care remain limited due to challenges in data collection and measurement.[3] Improving the impact of nutrition interventions requires adequate measurement of both reach and quality of interventions. Current global measurement mainly focuses on contact coverage indicators,[4] but does not adequately

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nutrients

Article

Antenatal Iron-Folic Acid Supplementation Is Associated with Improved Linear Growth and Reduced Risk of Stunting or Severe Stunting in South Asian Children Less than Two Years of Age: A Pooled Analysis from Seven Countries

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Abstract: In South Asia, an estimated 38% of preschool-age children have stunted growth. We aimed to assess the effect of WHO-recommended antenatal iron, and folic acid (IFA) supplements on smaller than average birth size and stunting in South Asian children <2 years old. The sample was 96,512 mothers with their most recent birth within two years, from nationally representative surveys between 2005 and 2016 in seven South Asian countries. Primary outcomes were stunting [length-for-age Z-score (LAZ) < –2], severe stunting [length-for-age Z-score (LAZ) < –3], length-for-age Z score, and perceived smaller than average birth size. Exposure was the use of IFA supplements. We conducted analyses with Poisson, linear and logistic multivariate regression adjusted for the cluster survey design, and 14 potential confounders covering the country of the survey, socio-demographic factors, household economic status, maternal characteristics, and duration of respondent recall. The prevalence of stunting was 33%, severe stunting was 14%, and perceived smaller than average birth size was 22%. Use of antenatal IFA was associated with a reduced adjusted risk of being stunted by 8% (aRR 0.92, 95% CI 0.89, 0.95), of being severely stunted by 9% (aRR 0.91, 95% CI 0.86, 0.96) and of being smaller than average birth size by 14% (aRR 0.86, 95% CI 0.80, 0.91). The adjusted mean LAZ was significantly higher in children whose mothers used IFA supplements. Maternal use of IFA in the first four months gestation and consuming 120 or more supplements throughout pregnancy was associated with the largest reduction in risk of child stunting. Antenatal IFA supplementation was associated with a significantly reduced risk of stunting, severe stunting, and smaller than average perceived birth size and improved LAZ in young South Asian children. The early and sustained use of antenatal IFA has the potential to improve child growth outcomes in South Asia and other low-and-middle-income countries with high levels of iron deficiency in pregnancy.

Keywords: iron and folic acid; antenatal supplements; birth size; length-for-age Z score; stunting; children under-two; South Asia

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1. Introduction

Undernutrition is responsible for 3.1 million child deaths/year or 45% of global child deaths [1]. Both low birth-weight (<2500 g) and stunting (height or length-for-age-Z score < –2) are major public health problems [1,2]. Child stunting reflects poor nutrition and frequent infections before and after

Appendix B: Trial protocol paper for Chapter 5 and 6

Billah *et al. BMC Public Health* (2017) 17:375
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BMC Public Health

STUDY PROTOCOL Open Access

A community-based cluster randomised controlled trial to evaluate the effectiveness of different bundles of nutrition-specific interventions in improving mean length-for-age z score among children at 24 months of age in rural Bangladesh: study protocol

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Abstract

Background: Prevalence of stunting among under-five children in Bangladesh is 36%, varying with geographic and socio-economic characteristics. Previously, research groups statistically modelled the effect of 10 individual nutrition-specific interventions targeting the critical first 1000 days of life from conception, on lives saved and costs incurred in countries with the highest burden of stunted children. However, primary research on the combined effects of these interventions is limited. Our study directly addresses this gap by examining the effect of combinations of 5 *preventive* interventions on length-for-age z-scores (LAZ) among 2-years old children.

Methods: This community-based cluster randomised trial (c-RCT) compares 4 intervention combinations against one comparison arm. Intervention combinations are: 1) Behaviour change communication (BCC) on maternal nutrition during pregnancy, exclusive breastfeeding, and complementary feeding, along with prenatal nutritional supplement (PNS) and complementary food supplement (CFS); 2) BCC with PNS; 3) BCC with CFS; and 4) BCC alone. The comparison arm receives only routine health and nutrition services. From a rural district, 125 clusters were selected and randomly assigned to any one of the five study arms by block randomisation. A bespoke automated tab-based system was developed linking data collection, intervention delivery and project supervision. Total sample size is 1500 pregnant women, with minimum 1050 resultant children expected to be retained, powered to detect a difference of at least 0.4 in the mean LAZ score of children at 24 months, the main outcome variable, between the comparison arm and each intervention arm. Length and other anthropometric measurements, nutritional intake and other relevant data on mother and children are being collected during enrolment, twice during pregnancy, postpartum monthly till 6 months, and every third month thereafter till 24 months.

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Discussion: This c-RCT explores the effectiveness of bundles of *preventive* nutrition intervention approaches addressing the critical window of opportunity to mitigate childhood stunting. The results will provide robust evidence as to which bundle(s) can have significant effect on linear growth of children. Our study also will have policy-level implications for prioritising intervention(s) tackling stunting.

Trial registration: The study was retrospectively registered on May 2, 2016 and is available online at ClinicalTrials.gov (ID: NCT02768181).

Keywords: Randomised controlled trial, Bundling, Nutrition interventions, Stunting, Length-for-age, First 1000 days of life

Background

Globally in 2013, 161 million children under the age of five years (U-5 children) had a height-for-age Z score more than 2 standard deviations (SD) below the median of WHO Multicentre Growth Reference Study (MGRS) Child Growth Standard (termed 'stunting'), and half of these children resided in Asia [1]. Although the stunting prevalence is decreasing worldwide, reductions in South Asia have been slower (36% since 1990) compared to 57% reduction in Europe and more than 70% in East Asia and the Pacific [2]. Stunted children have higher mortality [3], lower academic attainments [4], short stature as adults [5], reduced economic productivity [6], reduced cognition [7] and have a higher risk of cardio-metabolic diseases in adulthood [8], all contributing to the 'stunting syndrome' [9], and the trans-generational cycle of undernutrition and poverty [10]. Thus, stunting is a major public health problem in South Asia. In Bangladesh, the latest Demographic and Health Survey (2014) [11] reports that stunting prevalence has decreased to 36.1%. Despite a reduction in the past decade [12], national stunting prevalence remains high [13], with higher levels in rural areas (37.9%) and among the poorest populations (50.2%). Trends also show widespread geographic disparity - stunting has declined by about 2–3 percentage point per year in most regions except no change in *Sylhet* division, the north-eastern region [11].

Global goals related to stunting

Although unaddressed by the Millennium Development Goals, reduction of stunting prevalence became the focus of several high-profile nutrition initiatives such as Scaling Up Nutrition (SUN, 2010) [14], World Health Assembly 2012 [15] and Nutrition for Growth 2013 [16]. The World Health Assembly 2012 has a target of 40% reduction of U-5 stunting by 2025. Hence, the recent Sustainable Development Goals (SDGs) adopted by the UN in 2015 included stunting reduction as one of their goals (SDG 2.2) [17].

The critical window of opportunity

Childhood stunting is considered to have in utero origins [18]. The first 1000 days of life (conception to postpartum two years) is regarded as a critical 'window of opportunity' for growth and development [19]. The long-term interactions of both proximal (i.e. biological and environmental) and distal (i.e. socioeconomic) factors play significant roles during this period in influencing the linear growth of children [20]. The proximal factors of childhood stunting in South Asia include undernourished mothers, limited dietary diversity during pregnancy, poor infant and young child feeding practices (IYCF) including suboptimal breastfeeding and/or complementary feeding, and inappropriate sanitation and hygiene [21]. However, even short-term improvements in nutritional status (in utero and postnatal) can result in substantial mean height gain of the child even within a single generation [22].

Potential interventions to tackle stunting

In the Lancet Maternal and Child Nutrition Series 2013, Bhutta et al. (2013) statistically modelled the effect of 10 nutrition-specific interventions on lives saved and economic costs in 34 countries containing the majority of the children with stunted growth [23]. They suggested that at an estimated additional cost of $9.6 billion per annum for 90% coverage of these interventions, one-fifth of stunting among the U-5 children can be averted. However, there is a need for primary research to test and clarify the combined impact of nutrition-specific interventions as packages. They agreed about this gap and that further trials are needed.

Relevance of the present study

We have adapted five *preventive* interventions to create our own interventions bundles, based on Bhutta et al.'s list considering feasibility of scale-up in low resource settings and targeting the first 1000 days of life (from conception to two years of age). Our interventions include, a) Behaviour change communication (BCC) on nutrition and health-related practices during pregnancy; b) BCC on exclusive breastfeeding (EBF) for postnatal first 6 months; c) BCC on age-specific complementary feeding (CF) with continued breastfeeding thereafter till 23 completed months; d) Nutritional supplementation during pregnancy (PNS) with preventive doses of micronutrients, and partial provision of protein and lipids; e)

Nutritional supplementation for children (CFS) during 6 to 23 completed months of age, with preventive doses of micronutrients, and partial provision of protein and lipids. In essence, this randomized controlled trial provides a crucible to see how different nutritional interventions interact when delivered in bundled packages in community settings to affect linear growth of the child from conception to two years of age compared to the comparison arm where routines practices will run unhindered.

Study aim and hypothesis

This study aims to test the effectiveness of the intervention bundle(s) on improving length-for-age Z score (LAZ) of children at two years of age. We hypothesised that our intervention bundle(s) would cause a change of at least 0.4 in mean LAZ of children, translating to at least 30% reduction in stunting in that arm(s), compared to that in the comparison arm.

Methods

Study design

This cRCT evaluates the effectiveness of 4 different combinations of the selected pre- and post-natal nutrition-specific interventions for improving children's linear growth, compared to the comparison arm with usual practices. The three types of BCC are combined into one 'BCC' intervention and delivered universally in all four intervention arms. Profile of the four intervention arms are – intervention arm 1: BCC with PNS and CFS; intervention arm 2: BCC with PNS; intervention arm 3: BCC with CFS; intervention arm 4: BCC alone. (Fig. 1). The cohort of the mother-child dyads will be followed-up over the intervention period of ~36 months starting from recruitment to 24 months of child's age.

Study setting

The study is being conducted in the *Habiganj* district of *Sylhet* division in Bangladesh where stunting prevalence has remained stagnant over a decade [11]. Further, the prevalence of household food insecurity was highest (77%) and the prevalence of household food deficit was second highest (33%) in Sylhet [24].

Cluster randomization and intervention allocation

We purposively selected two adjacent sub-districts (*Bahubal* and *Nabiganj*) of *Habiganj* district. These two sub-districts have a total of 20 unions (lowest administrative unit). We excluded 8 unions, 3 being in hard-to-reach areas (seasonal flooding and poor road transport system) and 5 having intensive nutrition intervention projects implemented by other non-government organisations (NGOs). The remaining 12 unions had enough population to cover the desired sample size. Each union was then divided into clusters, each cluster comprising of ~450 households or ~2000 population (average 2–3 villages). We selected five clusters or multiples of 5 clusters from each union, 125 clusters in total following the cluster exclusion criteria detailed in Table 1. We then applied block randomisation by generating random sequence of 1–5 (each number representing a specific study arm) of 25 blocks with the analytical software Stata SE 14.2. Clusters were then allocated to arms, five at a time, based on the random sequence (Fig. 2). Taking equal numbers of clusters per arm from each union will ensure neutralizing the effect of variations, if any, of background characteristics between the unions. Allocation concealment was impractical due to community-based study design and nature of BCC intervention. However, care is taken to keep the outcome assessors blinded to the interventions allocated to specific clusters. The intervention and the evaluation teams have minimal contact to minimise information bias.

Sample size

Each study cluster comprised of an average population of 2000 and necessary adjustments were considered for cluster randomization. Crude birth rate (CBR) in rural Bangladesh in 2011 was 23 live births per 1000 population [25]. Therefore, taking six months of recruitment window for pregnant women, each cluster would have yielded ~23 new pregnancies on average.

Several assumptions were considered for the sample size calculation [26]. The first assumption was that mean LAZ (our primary outcome variable) for 18–23 months old children in the comparison arm will be −2.0, and standard deviation of mean LAZ in both intervention and comparison arms will be 1, based on the mean HAZ reported in this age group in the BDHS 2011. These BDHS 2011 [25] parameters were the latest available during this protocol development. The estimates were still valid in 2015 since the latest BDHS (2014) showed similar stunting rates in *Sylhet* division [11]. Second, a 0.4 difference in mean LAZ score was expected in intervention arms compared to comparison. As the third assumption, we considered an 80% power and 5% alpha; the inter-cluster correlation coefficient of 0.06, derived from the design effect for HAZ in BDHS 2011, was used for adjustment of clustering effects. Fourth, the ratio between 4 intervention and 1 comparison arms was set at 1:1:1:1:1. Taking all the above assumptions into account, the Stata SE 13 software calculated the sample size to be 175 children per arm, which can be yielded from 25 clusters. However, to examine the secondary outcome variables between the comparison arm and individual intervention arm with a higher statistical power, the sample size in the comparison arm was doubled,

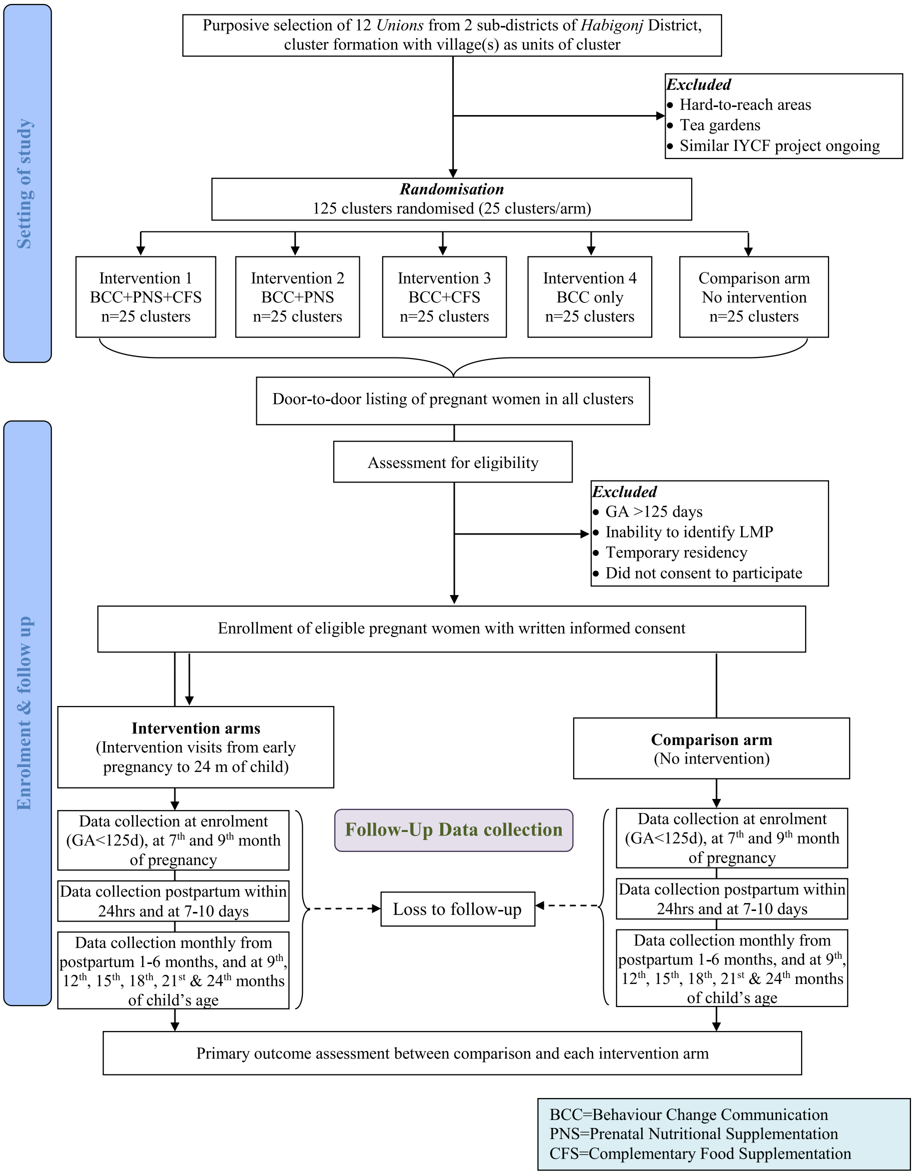

Fig. 1 CONSORT flow diagram of the study

thus the ratio between participant numbers in each intervention arm and comparison arm was raised to 1:2, respectively. The final allocation ratio of study participants was thus 1:1:1:1:2 for intervention arm 1: intervention arm 2: intervention arm 3: intervention arm 4: comparison arm 5. Thus, the final sample size was 175 children in each intervention arm and 350 children in the comparison arm. Considering the characteristics of the intervention, however, enrolment was during pregnancy. We therefore considered the following losses- 11% pregnancy loss due to abortion and still births (personal communication from Health and Demographic Surveillance System run by icddr,b at Mirzapur, Tangail), a 4% mortality in the first two years of life [25], 15% losses due to non-consent to participate by eligible women and loss-to-follow up. Loss-to-follow up includes refusal and migration out of study area. Thus, final sample size considering participant recruitment during pregnancy was 250 pregnant women in each intervention arm and 500 pregnant women in the comparison arm which is expected to yield the required number of children at 24 months from the enrolled cohort.

Participant recruitment

We enrolled 10 pregnant women in each intervention cluster and 20 in each comparison cluster, following the inclusion and exclusion criteria for participant eligibility (Table 1). Data collectors systematically

Table 1 Inclusion and exclusion criteria

Exclusion criteria for clusters

- Similar nutrition interventions currently being implemented by either government or non-government agencies in the selected cluster
- The cluster is too hard to reach
- The cluster includes tea gardens. Communities in tea gardens comprise of unique ethnicity, culture and lifestyle for which our intervention is not customized.

Inclusion criteria for participants

- All newly identified pregnant women aged 15 to 49 years
- Gestational age ≤ 125 days
- Permanent residents of the study area.

Exclusion criteria for participants

- Woman could not recall last menstrual period (LMP).
- Woman not a permanent resident of the study area

conducted door-to-door surveys of all households in the study area to identify newly pregnant women, which were repeated in subsequent monthly cycles. The woman's pregnancy status was assessed by enquiring about the first date of her last menstrual period (LMP), and possible pregnancy was confirmed with a sensitive pregnancy urine test kit (Excel®). Women tested positive were invited to voluntarily participate in the study with appropriate informed written consent. Recruitment of eligible pregnant women started in November 2015 and was completed in May 2016. Follow up of the cohort is ongoing.

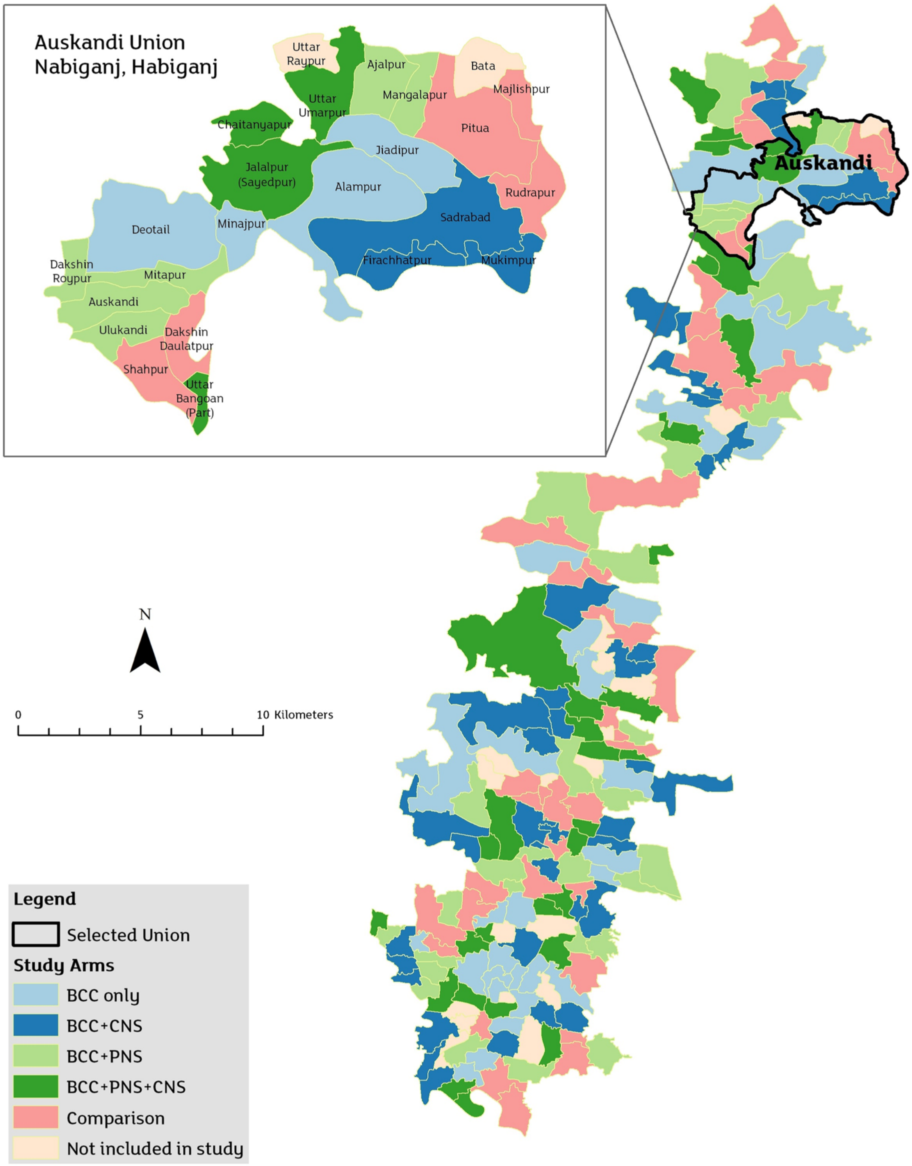

Fig. 2 Study clusters in five arms with close-up view of one union for illustration

Intervention plan

Intervention packages - behaviour change communication (BCC) through home-based counselling

The nutrition-specific BCC modules are adapted from the WHO-UNICEF published 'Key messages booklet on the community infant and young child feeding counselling package' [27] with linguistic help from the nationally adapted and validated BCC modules [28, 29]. The modules combine the three BCC types: i) Maternal nutrition during pregnancy; ii) Infant nutrition through exclusive breastfeeding; iii) Child nutrition through age-appropriate complementary feeding during 6–23 completed months. During pregnancy, counselling sessions include BCC on nutrition during pregnancy; and sensitization for WHO-recommended optimal breastfeeding practices. Starting immediately after birth of offspring to postnatal 5th month, intensive counselling and hands-on demonstrations are conducted every month of optimal breastfeeding practices (including positioning and attachment, expression and storage of breast milk), and nutrition of lactating mothers. From 6th month, counselling and hands-on demonstration sessions are conducted every three months and include preparation and feeding of optimal, age-appropriate and nutritious complementary food made from local ingredients, responsive feeding, continued breastfeeding, and nutrition of lactating mothers. Additional counselling visits are made if requested by respondents or if CHW deems the respondent is resistant to change their current practices. As integral parts of nutrition, counselling on good hygiene and care-seeking practices for both mother and child are also delivered in each session.

Intervention packages - nutritional supplementation

The prenatal and complementary food supplements being provided were previously tested in a supplement trial in Bangladesh [30], and are provided in selected clusters randomised to the three arms to receive either one or both supplements (Fig. 1).

Nutritional supplements for pregnant women

A lipid-based nutritional supplement (LNS) developed by Nutriset™, packed in ~20 g sachets, is provided to pregnant women. The formulation contains vegetable fat (soy), skimmed milk powder, peanuts, vitamin and mineral complex, sugar, stabilizer: fully hydrogenated vegetable fat, and antioxidant: tocopherols. An additional file details the components (see Additional file 1). Each sachet contains 70–75% of the recommended dietary allowance (RDA) for most of the micronutrients, and partial provision of protein and lipids, including essential fatty acids. The dose is one sachet per pregnant woman per day throughout pregnancy.

Complementary food supplements for children

Another LNS formulation developed by Nutriset™, packed in each ~10 g sachets, is provided to be fed to children from 6 to 23 completed months of age. The formulation contains vegetable fat, skimmed milk powder, peanuts, sugar, vitamin and mineral complex, maltodextrin, and emulsifier: lecithin. An additional file details the components (see Additional file 2). Each 20 g of LNS contains 70–75% of RDA for most of the micronutrients, and partial provision of protein and lipids, including essential fatty acids. The dose is two sachets per child per day, starting from 6 completed months of age (180 days) continued till 23 completed months.

Comparison arm (natural practice)

In the comparison arm, study participants are receiving usual nutrition interventions available from routine health services only. Pregnant women are eligible to receive nutrition counselling on maternal and child nutrition during antenatal check-up (ANC) visits and caregivers of children under two years of age receives IYCF counselling during postnatal care visits within 42 days and sick child management visits at health facilities and by NGO workers (if available) [31]. However, contact coverage and content quality of these platforms and interventions is very low and does not reach those who do not seek the services. Antenatal iron-folic acid supplements are available during ANC contacts at public health facilities. Children aged 6–59 months receive vitamin A supplements during biannual national vitamin A campaigns, although coverage is unsatisfactory [11].

Field implementation of interventions

Counselling and supplement sachets are delivered through our specially trained Community Health Workers (CHWs). Their tasks are supervised and monitored by two layers of field supervisors – a team of Field Supervisors (FSs), and a Field Research Assistant (FRA). Minimum educational qualification of the CHWs is Higher Secondary School Certificate (HSC) completed, while the FSs and the FRA have completed their Bachelor's degree. The intervention team was given intense counselling training in three phases, and monthly meetings are held for field-related troubleshooting and as refresher courses. Supervisors provide daily feedback to associated CHWs during on-site counselling supervision.

At least 4 antenatal counselling sessions are delivered during pregnancy. Following live birth notification, 8 counselling sessions are delivered within 48 h and 7–14 days of birth, and at completion of every month till 6 months. Thereafter, counselling is delivered every third month till postnatal 23 completed months (Table 1). The CHWs also distribute supplement sachets every month, and provide counselling on the importance and instructions on supplement taking and storage.

Evaluation plan

A range of quantitative data collection methods, including structured questionnaire and anthropometric measurements, have been adopted for assessments of primary and secondary outcomes. A timeline depicts the schedule of data collection in Table 2.

Trial outcomes and measurements

Primary outcomes

The primary outcome measure will be the LAZ of children at 24 months of age based on WHO MGRS 2006 child growth reference. This will be calculated from the child's age in months and length on associated ages. Length is measured at age 7–10 days, then monthly from 1 to 6 months, and at 9th, 12th, 15th, 18th, 21st and 24th months of age, with locally manufactured collapsible length boards (precision 1 mm).

Secondary outcomes

Gestational weight gain of mothers

Body weight of mothers is measured during enrolment and on the 6th and 9th month of gestation. Gain in weight will be compared among homogenous gestational ages and initial nutritional status of mothers. Weight is measured with a Tanita™ weighing scale (precision 100 g).

Weight of children

Body weight of children is measured at birth, on 7–10 days, then monthly from 1 to 6 months, and every third month thereafter till 24 month, using Salter scales (precision 10 g).

Nutritional intake of mothers Detailed ingredients of the pregnant mothers' dietary intake on the previous 24-h are collected, through an interviewer-administered open 24-h dietary recall form adapted from the FAO dietary diversity guidelines [32], during enrolment and on the 6th and 9th month of gestation. Further, maternal food intake is collected every third month after birth till 24 months. Ingredients will be collated into food groups to calculate dietary diversity score.

Infant and Young Child Feeding (IYCF) practices

Data on IYCF practices (breastfeeding and complementary feeding) are collected through a structured IYCF questionnaire, employing 24-h [11] and 7 day recall methods. WHO-recommended core indicators of optimal breastfeeding include early initiation of breastfeeding (within 1 h of birth), EBF till 6 months after birth and continued breastfeeding till at least 2 years post-birth [33]. Information on all these indicators and associated information are collected. Data on early initiation of breastfeeding and pre-lacteal use is collected within 24-h of birth and on the 7th day. EBF information is collected periodically on the 7th day of birth, and then monthly postpartum from 1 to 6 months. Continued breastfeeding information is collected every three months thereafter till 24 months.

WHO-recommended complementary feeding practices include introduction of solid, semi-solid or soft foods; minimum dietary diversity, meal frequency and acceptable diet; and consumption of iron-rich or iron-fortified foods from postnatal 6 completed months [33]. This information is collected every third month from postnatal 6 to 24 months. Comparison of continued breastfeeding and complementary feeding practices will be made between intervention arms and the comparison arm at these time points.

Other measurements

Background characteristics of study participants: Information on demographic and socio-economic status (SES), family members, reproductive and morbidity history of pregnant women were collected using a structured questionnaire [25]. Household food security (HFS) information was collected through a questionnaire adapted from food security and nutrition surveillance tool [34]. These were recorded once during recruitment of the pregnant women after consent has been taken, to compare background characteristics between the arms.

Water sanitation and hygiene (WASH) and Knowledge attitude and practice (KAP): A questionnaire on the core indicators on water, sanitation and hygiene (WASH) was developed based on a standard manual for WASH [35]. Woman's knowledge, attitude and practices (KAP) regarding maternal and child nutrition was developed based on WHO-recommended IYCF indicators and KAP manual [36]. WASH and KAP are collected during pregnancy and postpartum follow up visits.

Childhood morbidity: Morbidity, especially diarrhoea, directly impedes growth, while better hygiene practices lower infectious disease burden [37]. Therefore, children's morbidity data is collected every month from postnatal 1 to 6 months and every three months thereafter till 24 months, using a 2-week recall questionnaire [11]. Vaccination data would be collected at 12 and 15 months based on EPI schedule.

Additional anthropometric measurements: Mother's height is measured during recruitment for body mass index (BMI) calculation during early pregnancy. Mother's mid-upper arm circumference (MUAC) (precision 1 mm), infant's head circumference (during 1–6 moths age) and infant's MUAC (during 7–24 months) are collected during follow-up visits, for associated z-score calculations.

Table 2 Schedule of enrolment, interventions, and assessments of the study

TIMEPOINT	***GA (month)***				***Live birth***		***Child's age***												
	3-4	*5-6*	*7*	*8-9*	*48hr*	*7-14 days*	*1*	*2*	*3*	*4*	*5*	*6*	*7-9*	*10-12*	*13-15*	*16-18*	*19-21*	*23*	*24*
ENROLMENT:																			
Eligibility screen	X																		
Informed consent	X																		
INTERVENTIONS:																			
Arm 1 (BCC+PNS+CFS)																			
BCC	←	─	─	─	─	─	─	─	─	─	─	─	─	─	─	─	─	→	
PNS	←	─	─	→															
CFS													←	─	─	─	─	→	
Arm 2 (BCC+PNS)																			
BCC	←	─	─	─	─	─	─	─	─	─	─	─	─	─	─	─	─	→	
PNS	←	─	─	─	→														
CFS																			
***Arm 3* (BCC+CFS)**																			
BCC	←	─	─	─	─	─	─	─	─	─	─	─	─	─	─	─	─	→	
PNS																			
CFS													←	─	─	─	─	→	
***Arm 4* (BCC alone)**																			
BCC	←	─	─	─	─	─	─	─	─	─	─	─	─	─	─	─	─	→	
PNS																			
CFS																			
***Arm 5* (Comparison)**																			
ASSESSMENTS:																			
QUESTIONNAIRE:																			
SES	X																		
HFS, DD, KAP, WASH	X	X		X			X			X		X	X	X	X	X	X		X
IYCF practices					X	X	X	X	X	X	X	X	X	X	X	X	X		X
Child's morbidity							X	X	X	X	X	X	X	X	X	X	X		X
Child's vaccination														X	X				
Mother's depression									X				X						
ANTHROPOMETRY:																			
Mother's height	X																		
Mother's weight	X	X		X			X			X		X	X	X	X	X	X		
Mother's MUAC	X	X		X			X			X		X	X	X	X	X	X		
Child's birthweight					X														
Child's length						X	X	X	X	X	X	X	X	X	X	X	X	X	X
Child's weight					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Child's HC							X	X	X	X	X	X							
Child's MUAC													X	X	X	X	X	X	X

GA Gestational age, *BCC* Behaviour Change Communication on Nutrition and health, *PNS* Prenatal Nutritional Supplementation, *CFS* Complementary Food Supplementation, *SES* Socio-economic status, *HFS* Household food security, *DD* Dietary diversity, *KAP* Knowledge, attitude and practice on nutrition, *WASH* Water, sanitation and hygiene, *IYCF* Infant and young child feeding, *MUAC* Mid upper arm circumference, *HC* Head circumference

Data collection

All questionnaire-based data and anthropometric measurements are collected by trained data collectors. Anthropometric measurements are taken following measurement-specific standard operating procedure [38]. Measuring tools are calibrated regularly. All data collectors are female and locally recruited. Before initiation of participant recruitment, the data collection team was intensely trained by the central team on all aspects of data collection, including consent taking, different data collection methods, anthropometric measurements, question throwing techniques, use of the tablet and cultural aspects to consider during data collection. Monthly meetings are held for troubleshooting and refresher trainings are conducted as needed. Following the initial training, all data collectors were standardised for anthropometric measurements against two gold standard trainers from icddr,b. Subsequently, refreshers trainings are conducted every two months to retain measurement standards. The data collectors are directly supervised by two FRAs who monitor data collection quality and provide on-site feedback as needed. One field manager is responsible for overall field coordination.

Project management system for implementation and monitoring

A bespoke automated Project Management Information System (MIS) has been developed linking data collection and intervention delivery through android-based tablet (handheld)-PC with a central database where progress can be monitored by the field supervisors and central staff. On pregnancy enrolment through the tab, an android platform-based application automatically generates subsequent prenatal visit plans and tools at pre-specified schedules and tasks of CHWs and data collectors (intervention modules for CHWs and questionnaire for data collectors). Similarly, birth is registered in the tab immediately upon notification. To ensure post-partum data collection within 24 h of delivery, a mobile phone-based birth-notification system has been established. Enrolled pregnant women and their family members are continuously encouraged to notify birth by text message or voice calls as early as possible, preferably within six hours of birth. Registration of live births then generates appropriate plans and tools for postpartum visits by CHWs and data collectors. The web-linked desktop dashboard system is used to monitor activities/performance of CHWs and data collectors in real time by field supervisors and the central team.

Process evaluation

Adherence to supplements for both mothers and children

Empty supplement sachets are collected and supplement tracking is carried out in each visit by the CHWs. Besides, we are assessing supplement compliance using a structured questionnaire with some open questions with queries on respondents' attitude and practice towards the antenatal and complementary food supplements provided to them. We would collect similar data for checking compliance of complementary supplements to children aged 6 months to 24 months (in associated arms).

BCC monitoring

The BCC modules set in the tablets are customised for each CHW. Date and time of each visit is automatically recorded as the CHW proceeds with the module. The module for each visit has several sub-topics linked to associated details, and timing of these sub-topics is also automatically recorded. These measures ensure an automated machine-based monitoring system from which BCC delivery coverage can easily be tracked and calculated.

Statistical analysis plan

Data analysis to detect change of the primary outcome (mean LAZ) will be conducted with length measured at 1, 3, 6, 9, 12, 15, 18, 21 and 24 months of age using t-tests assuming LAZ will satisfy the normality assumption. Longitudinal assessment of significance using lag time of stunting (mean length > −2SD below median of WHO reference population) will be done by the log rank test, followed by fitting a Cox proportional hazards model for each intervention arm to determine the change in risk of stunting compared to the comparison arm. Multiple linear regression will be employed to quantify the effect of intervention in each intervention arm compared to the comparison arm in terms of mean LAZ change and some secondary continuous outcome measures including changes in mother's weight, birth weight, diarrhoea morbidity. Logistic regression will be used on binary outcome variables which comprise most of our secondary outcomes measures (e.g. – EBF and breastfeeding initiation within 1 h of birth). All these models will be controlled for possible confounders (household food security, educational background and SES) if randomisation of the clusters does not control for differences in these factors at baseline. For regression models, we shall consider random effects of clustering. All analysis will be intention-to-treat. Quantitative data analysis will be done using Stata SE 14.2 (StataCorp LP, College Station, Texas, USA).

Discussion

Our primary study aims to investigate the effects of 5 nutrition-specific *preventive* interventions, adapted from the Lancet's modelled intervention list (Bhutta et al.

[2013]), delivered in different bundles to improve the LAZ score from conception to two years of age in a food-insecure area of rural Bangladesh.

One of the major strength of this study is its depth (multiple community-friendly evidence-based intervention packages) and breadth (first 1000 days with interventions directed at both mother and child). The results will attempt to clarify the effects of counselling combined with prenatal nutritional and/or complementary food supplementation on linear growth of the child. In addition, our study will also explore the interventions impact on nutritional intake during pregnancy, gestational weight gain, birth weight and IYCF practices. The cluster RCT design in a community setting will offer robust evidence on the effectiveness of the bundles compared to the comparison arm where routine practices will run unabated. The relatively homogenous study population in a food-insecure area would further strengthen our inferences, as we would expect minimal inter-cluster differences that would otherwise potentially confound associations.

We are also one of the few studies in Bangladesh using a bespoke digital platform for intervention delivery and monitoring of coverage. Android-based handheld devices are being used by CHW to automate planning of visit schedules as well as aid counselling sessions by providing the appropriate BCC content based on the gestational age and subsequently, age of the child. Visual aids and video demonstrations of good practices included in the electronic counselling modules are expected to result in improved interaction and retention of key messages by the participants. Field level android-based devices are web-linked to a central server to leverage the opportunity for real time monitoring of community health workers performance and coverage of intervention delivery. Thus, this study will contribute to the growing body of implementation research on benefits and challenges of integrating electronic platforms in delivering counselling and supplemental interventions in a community setting.

Recently, the government of Bangladesh undertook significant efforts to digitize service delivery in all spheres of health systems including frontline and community level health care providers who are responsible for delivering nutrition interventions [39]. This trial will provide a timely and pertinent contribution to the knowledge base of use of electronic platforms in not only recording and reporting of service utilization but also aiding the community workers in nutrition service delivery at scale.

A limitation of our study includes not being able collect biological samples from study participants due to funding constraints; this would have allowed us to investigate potential biological mediators of the effect of nutrients as well as exploring inherited differences in metabolism predisposing to the risk of stunting. Our study also does not look at knock-on effects beyond 2 years of age.

We anticipate that the results from this cRCT will have policy-level implications in prioritizing a set of interventions when addressing stunting - whether it is behaviour change communication only or combined with prenatal and/or post-natal nutritional supplementation.

Trial status

Recruitment has been completed. Intervention and data collection is ongoing.

Additional files

Additional file 1: Composition of LNS for pregnant women. (DOCX 16 kb)

Additional file 2: Composition of LNS for children. (DOCX 17 kb)

Abbreviations

ANC: Antenatal check-up; BCC: Behaviour change communication; BDHS: Bangladesh Demographic and Health Survey; BMI: Body mass index; CF: Complementary feeding; CFS: Complementary food supplementation; CHW: Community health workers; cRCT: Community-based cluster randomised controlled trial; EBF: Exclusive breastfeeding; FRA: Field research assistant; FW: Field supervisors; HFS: Household food security; IYCF: Infant and young child feeding practices; KAP: Knowledge attitude and practice; LAZ: Length-for-age Z score; LMP: Last menstrual period; LNS: lipid-based nutritional supplement; MIS: Management Information System; MUAC: Mid-upper arm circumference; NGO: Non-government organisations; PNS: Prenatal nutritional supplementation; RDA: Recommended dietary allowance; SD: Standard deviation; SDG: Sustainable development goals; SES: Socio-economic status; WASH: Water, sanitation and hygiene; WHO MGRS Child Growth Reference: WHO Multicentre Growth Reference Study Child Growth Reference

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Availability of data and materials

Not applicable.

Authors' contributions
SEA, SMB and DMEH conceptualised the study. SMB, SEA, MJD, PM, TA and MAK contributed in selection of the interventions and initial study design. TF, NC, MM, and SR contributed during the finalisation of the study design. SMB led writing of the study protocol with significant inputs from all co-authors. TF, SMB, NC and SR developed the intervention and assessment tools. All authors contributed to the development, review and finalisation of the study protocol manuscript.

Competing interests
The authors declare that they do not have any competing interest. Nutriset, the manufacturer of prenatal and complementary feeding supplements used in the study, has no involvement in the study conception, design, implementation, collection and interpretation of data and presentation of study findings.

Consent for publication
Not applicable.

Ethics approval and consent to participate
Ethics approval for this study was granted by the Ethical Review Committee (ERC) of the icddr,b (PR # 14124). We obtained written informed consent, which provided full disclosure regarding the study, from pregnant women during enrolment into the study. After delivery of live births, we obtained written informed consent from mothers for enrolment and follow-up of the children. Privacy, anonymity and confidentiality of the information provided by respondents are strictly maintained during all phases of the trial. All information are stored in encrypted database with participant's study ID instead of personal identifiers, and none but the associated investigators and data management team will have access to collected data. Findings will be published in peer-reviewed journals towards the end of the study. The trial is registered in the ClinicalTrials.gov (NCT02768181).

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References
1. Levels and Trends in Child Malnutrition: UNICEF/WHO/The World Bank joint child malnutrition estimates [Internet]. UNICEF, WHO and The World Bank. 2014. http://www.who.int/nutgrowthdb/summary_jme_2013.pdf. Accessed 6 Sept 2016.
2. UNICEF. Improving child nutrition: The achievable imperative for global progress. 2013. Report No.: Contract No.
3. Ozaltin E, Hill K, Subramanian SV. Association of maternal stature with offspring mortality, underweight, and stunting in low- to middle-income countries. JAMA. 2010;303(15):1507–16.
4. Martorell R, Horta BL, Adair LS, Stein AD, Richter L, Fall CH, Bhargava SK, Biswas SK, Perez L, Barros FC, et al. Weight gain in the first two years of life is an important predictor of schooling outcomes in pooled analyses from five birth cohorts from low- and middle-income countries. J Nutr. 2010; 140(2):348–54.
5. Martorell R, Khan LK, Schroeder DG. Reversibility of stunting: epidemiological findings in children from developing countries. Eur J Clin Nutr. 1994;48(Suppl 1):S45–57.
6. Thomas D, Strauss J. Health and wages: evidence on men and women in urban Brazil. J Econom. 1997;77:159–85.
7. Kar BR, Rao SL, Chandramouli BA. Cognitive development in children with chronic protein energy malnutrition. Behav Brain Funct. 2008;4:31.
8. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, Sachdev HS. Maternal, child undernutrition study G. Maternal and child undernutrition: consequences for adult health and human capital. Lancet. 2008;371(9609): 340–57.
9. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries. Paediatr Int Child Health. 2014;34(4):250–65.
10. Martorell R, Zongrone A. Intergenerational influences on child growth and undernutrition. Paediatr Perinat Epidemiol. 2012;26(Suppl 1):302–14.
11. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International. Bangladesh Demographic and Health Survey. Dhaka, Bangladesh, and Rockville; 2016. Report No.: Contract No; 2014.
12. Headey D, Hoddinott J, Park S. Drivers of nutritional change in four South Asian countries: a dynamic observational analysis. Matern Child Nutr. 2016;12(Suppl 1):210–8.
13. Global Database on Child Growth and Malnutrition. http://www.who.int/nutgrowthdb/about/introduction/en/index5.html.
14. Scaling up Nutrition. A Framework for Action. Food Nutr Bull. 2010;31(1): 178–86.
15. McGuire S. World Health Organization. Comprehensive Implementation Plan on Maternal, Infant, and Young Child Nutrition. Geneva, Switzerland, 2014. Adv Nutr Intl Rev J. 2015;6(1):134–5.
16. Nutrition for Growth Commitments: Executive Summary. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/207271/nutrition-for-growth-commitments.pdf.
17. Murray CJL. Shifting to Sustainable development goals — implications for Global Health. N Engl J Med. 2015;373(15):1390–3.
18. Christian P, Lee SE, Donahue Angel M, Adair LS, Arifeen SE, Ashorn P, Barros FC, Fall CH, Fawzi WW, Hao W, et al. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. Int J Epidemiol. 2013;42(5):1340–55.
19. Victora CG, de Onis M, Hallal PC, Blossner M, Shrimpton R. Worldwide timing of growth faltering: revisiting implications for interventions. Pediatrics. 2010;125(3):e473–80.
20. Stewart CP, Iannotti L, Dewey KG, Michaelsen KF, Onyango AW. Contextualising complementary feeding in a broader framework for stunting prevention. Matern Child Nutr. 2013;9(Suppl 2):27–45.
21. Dewey KG, Mayers DR. Early child growth: how do nutrition and infection interact? Matern Child Nutr. 2011;7(Suppl 3):129–42.
22. Garza C, Borghi E, Onyango AW, de Onis M, Group WHOMGRS. Parental height and child growth from birth to 2 years in the WHO Multicentre growth reference study. Matern Child Nutr. 2013;9(Suppl 2):58–68.
23. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, Webb P, Lartey A, Black RE. Lancet nutrition interventions review G et al. evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet. 2013;382(9890):452–77.
24. Helen Keller International, James P Grant School of Public Health. State of food security and nutrition in Bangladesh, 2010. 2011. http://dspace.bracu.ac.bd/xmlui/handle/10361/1585. Accessed 6 Sept 2016.
25. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International. Bangladesh Demographic and Health Survey. Dhaka, Bangladesh and Calverton: NIPORT, Mitra and Associates, and ICF international; 2013. Report No.: Contract No; 2011.
26. Carine A. Bellera BJF, James A. Hanley Calculating sample size in anthropometry. In: Preedy VR editor. Handbook of Anthropometry: Physical Measures of Human Form in Health and Diseases. Volume 1–6. 2012. p. 3–27.
27. UNICEF. The Community Infant and Young Child Feeding Counseling Package: Key Messages Booklet. 2012. https://www.unicef.org/nutrition/files/Key_Message_Booklet_2012_small.pdf. Accessed 6 Sept 2016.
28. Ministry of Health GoB. Infant and Young Child Feeding Training Manual (Sub-district and Union level); 2013.
29. Government of Bangladesh. Maternal and Neonatal Care Counselling Module for Community Health Workers training module; 2011.
30. Mridha MK, Matias SL, Chaparro CM, Paul RR, Hussain S, Vosti SA, Harding KL, Cummins JR, Day LT, Saha SL, et al. Lipid-based nutrient supplements for pregnant women reduce newborn stunting in a cluster-randomized controlled effectiveness trial in Bangladesh. Am J Clin Nutr. 2016;103(1):236–49.
31. Saha KK, Billah M, Menon P, El Arifeen S, Mbuya NV. Bangladesh National Nutrition Services: assessment of implementation status: World Bank publications; 2015.
32. Kennedy G, Ballard T, Dop M. Guidelines for measuring household and individual dietary diversity 2010. http://www.fao.org/3/a-i1983e.pdf. Accessed 6 Sept 2016.

33. World Health Organization. Indicators for assessing infant and young child feeding practices, part 2: measurement. 2010. http://apps.who.int/iris/bitstream/10665/44306/1/9789241599290_eng.pdf?ua=1. Accessed 6 Sept 2016.
34. Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v. 3). 2007. https://www.fantaproject.org/sites/default/files/resources/HFIAS_ENG_v3_Aug07.pdf. Accessed 6 Sept 2016.
35. Hernandez O, Tobias S. Access and behavioral outcome indicators for water, sanitation, and hygiene. 2010. http://pdf.usaid.gov/pdf_docs/Pnadw489.pdf. Accessed 6 Sept 2016.
36. Marías Y, Glasauer P. Guidelines for assessing nutrition-related knowledge, attitudes and practices. 2014.
37. Fewtrell L, Kaufmann RB, Kay D, Enanoria W, Haller L, Colford JM Jr. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. Lancet Infect Dis. 2005;5(1):42–52.
38. de Onis M, Onyango AW, Van den Broeck J, Chumlea WC, Martorell R. Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. Food Nutr Bull. 2004;25(1 Suppl):S27–36.
39. Health Bulletin 2016 [Internet]. 2016. http://www.dghs.gov.bd/images/docs/Publicaations/HB%202016%20_2nd_edition_13_01_17.pdf. Accessed 23 Mar 2017.

Appendix C: Response to reviewers’ comments on papers in result chapters

Paper 1 (Chapter 3): Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh

Response to reviewers' comments

Reviewer 1:

1. The study has addressed an important public health issue for Bangladesh, and other LMICs. However, one thing should be noted, the four factors which were finally revealed as independent determinants (logistical readiness of the facilities, HCP's knowledge on maternal nutrition, better HCP-client communication, and use visual aids or ANC card) are essential pre-requisite for delivering quality nutrition service. If the pre-requisites are not fulfilled, it is not possible to deliver quality service. So, in discussion and conclusion sections of the papers should focused on the other factor (service provider: Doctors/paramedics/CHCP) as it is not a prerequisite like other four factors. Considering these issues, the authors should revised the term 'Determinants' used in the Title and introduction section.
   Response: Our study hypothesizes that facility readiness, health care providers, the process of care, and client characteristics all contribute to the provision of high-quality nutrition services at antenatal care contact. We examined a variety of variables in each category (including provider types) and identified which of those variables are associated with (or may influence) high-quality service. We have revised our title and introduction, replacing the term "Determinants" by "Factors influencing". In the discussion, we have included practice variations among different types of providers and essential programmatic inputs to mitigate the practice gap and now have included them in the conclusion.

Reviewer 2:

1. ANC is the classic best entry point for counselling expecting mothers on proper nutrition, danger signs of pregnancy and monitor the health of the mother and the foetus. The authors looked at a critical health system fitness to provide quality nutrition services for pregnant women. The research questions are relevant and the methodology is sound. The results are clearly described and the implications well discussed.
   Response: Thank you for your comments on our manuscript.

   Just one curious question. What did the authors think was the reason for the finding that the quality of nutrition services given during the 2nd and 3rd trimester was better than the one during the 1st trimester? I know that some misperception or misunderstanding from the provider side was mentioned. A bit more explanation would be great, if possible.
   Response: We have discussed some possible explanations in the discussion. The difference in the quality of nutrition service across different trimesters of pregnancy is mainly due to the providers' perception gap and self-prioritisation of some services over others. For instance, among the four service components included in the quality of nutrition service during ANC, weight measurement and provision of IFA supplements were poorer in the 1st trimester compared to women in the 2nd

and 3rd trimesters. Sometimes health care providers choose not to offer IFA in early pregnancy fearing iron's adverse effect on foetal development. Similarly, sometimes they disregard physical measurement and weight assessment during early pregnancy. It is unlikely that the client's demand or choice for service played a big role in this case, as clients often lack knowledge/perception of good quality care and what to anticipate from service providers when seeking health care in low and middle-income settings.

Reviewer 3:

This manuscript will be a useful addition to our knowledge of nutrition services provided during pregnancy, especially for ANC in Low and Low Middle Income Countries.
Response: Thank you for your encouraging comments on our manuscript.

1. I have a few clarification/suggestions that should be addressed; Lines# 23 to 25. Definition is not clear. What is being counted? Will weight measurements done twice and anaemia measurements done two times in one woman across pregnancy be counted as equivalent to weight measurement done once and anaemia measure done three times in another women?

   Response: We counted the number of the selected four services provided at each ANC consultation as the 'quality nutrition service' indicator from observation of the ANC consultations. It was a cross-sectional study, and we observed ANC service consultation for a woman only once. To avoid confusion, we have revised the text as:

   "*We considered four essential nutrition services at each ANC contact including maternal weight measurement, anaemia assessment, nutrition counselling and iron-folic acid (IFA) supplement provision. We defined a composite 'quality nutrition service' outcome by counting the number of services (out of four) provided at each ANC from observation data*".

2. Lines# 64 and 65. Some information is missing. Rephrase the statement for clarity.

   Response: We have rephrased the sentence to improve clarity.

   "*Another challenge is ensuring the quality of nutrition interventions provided at ANC contacts, without which programmes will not fully harness the benefits of these interventions on maternal and child nutrition outcomes. Moreover, a recent study reported incomplete readiness of healthcare facilities to provide nutrition interventions during ANC (51%).*"

3. Line#175. typo.

   Response: We have corrected the typo.

4. Table 1: Haemoglobin testing tool. Was it expected that sub-districts and community clinics will be better than district hospitals? Are they special programs/interventions that are being run by the health authority in Bangladesh that focus on resourcing rural and sub-district hospitals as compared to district hospitals? In most LMICS we see that district level hospitals are better equipped that rural clinics.

   Response: In general, districts and sub-district level facilities have better readiness than union-level health facilities and community clinics. However, the availability of logistics and tests to provide ANC service is expected to be similar across all tiers of facilities. One explanation of poorer on-site readiness of haemoglobin testing at the district and sub-district hospital is out of the Tallquist strips due to high client load and availability of other advanced diagnostic facilities at district and sub-district levels. Health care providers sometimes refer the clients to these diagnostic labs for haemoglobin testing rather than doing the rapid test onsite. We did not consider the availability of advanced diagnostics tests for anaemia outside of ANC consultation as HCPs can recommend the test but do not take a decision if the test is done afterward. However, we have included the following text in the limitation.

"Fourth, we assessed only the on-site availability of rapid haemoglobin testing kits at the ANC room which might under-estimate the haemoglobin testing capacities at district and sub-district hospitals as some of them may have advanced diagnostic tests for anaemia."

5. Table 1: What does "ANC utilization per day" mean?
   Response: ANC utilization per day means the average number of ANC services provided on a day at the facility. We have now clarified this in Table 1.

6. What was the effect of clients (pregnant women) educational status on the outcome variables?
   Response: We did not find any association between the client's educational status and the quality of nutrition service provided at ANC. We have reported this in table 3. Education was not associated with any of the four selected nutrition services in the bivariate analyses and we did not include it in the multiple regression model presented in Table 4.

7. Figure 2 B: should the items add up to 100%? Currently it adds up 99%.
   Response: We have corrected the rounding error in Figure 2B.

Reviewer 4:

1. Methods
   Upon what basis districts were selected?
   Response: We have expanded the text on district selection as follows:
   "We selected the districts based on comparability of population density, literacy rate, housing characteristics, people in the lowest wealth quintile, access to a safe drinking water source, electricity connection, improved sanitation, coverage of childhood immunization, ANC, skilled birth attendance, postnatal care and modern methods of family planning, under-five mortality rate and childhood stunting prevalence. We created a score for each district by principal component analysis of these variables. Then, we applied nearest neighbour matching of district's PCA score to match two intervention districts with one non-intervention district. Finally, we selected seven matched groups of districts (each having two AINNS intervention districts and one non-intervention), which had the minimum difference in the PCA score."

2. Line 109: Better to mention Upa Zilla as sub district is non existent
   Response: We have added upazila health complexes and mentioned sub-district hospitals in parenthesis. However, we have used sub-district hospital throughout the paper for the ease of understanding of the global audience.

3. Please mention how anaemia was defined
   Response: We have defined anaemia screening as:
   "Screening for anaemia included assessing blood haemoglobin level either using Tallquist paper onsite, by previous laboratory investigation or examining eye or palm (clinical assessment)".

4. Conclusion:
   Need to make brief depending upon objective
   Response: We have revised the conclusion and made it relevant only to the study objectives and findings.

Reviewer 5:

General comments

1. This manuscript is very interesting having very important findings, but the paper required same professional proofreading to edit the entire paper for language, grammatical, spelling, and punctuations to improve the paper for publication. Once the authors are able to address the concerns appropriately, the manuscript can be published.
   Response: We have proof-read the manuscript and corrected typos and grammatical errors.

2. The four main target variables (maternal weight measurement, anaemia assessment, nutrition counselling and iron-folic acid (IFA) supplementation) for this study was not properly addressed and exhausted, need to elaborate more.
   Response: We have elaborated the definitions of four target variables for quality of nutrition service:
   "We considered weight assessment performed if the HCPs took the weight of pregnant women using either a digital or analogue weighing scale". "Screening for anaemia included assessing blood haemoglobin level either using Tallquist paper onsite, by previous laboratory investigation or examining eye or palm (clinical assessment). Provision of nutrition counselling included HCPs providing messages on dietary diversity, quantity and types of nutritious food. We defined IFA provision as HCPs distributing IFA supplements during the ANC consultation; however, we did not include HCPs prescribing IFA to be bought from outside pharmacies".

3. Methods
   Page 7, line 133 – 137 the paragraph "We conducted the assessment in 231 facilities, and in 184 facilities, we observed ANC services provided on the assessment days. We interviewed 217 health care providers who offered ANC services at the facilities on the day of the visit, and we observed 1296 ANC consultations. We excluded 54 observations due to missing information about the health care providers, the client's characteristics, or the exit interview" is not clear, need to be reconsidered or rephrased.
   Response: We have rephrased the text as:
   "We assessed the readiness to provide ANC services in 231 facilities (Fig 1). ANC services were not sought in 47 out of the 231 facilities on the assessment days; thus, we observed 1295 ANC service consultations at 184 facilities. We had complete background information from 201 HCPs who offered ANC services on the day of the visit. We excluded 53 observations from the analysis due to missing

information on HCPs or the client characteristics. Finally, we included 1,242 observations of ANC service consultation provided by 201 service providers at 179 facilities in the analysis for this paper".

4. Result

   Page 10 line 213 & 2014 the sentence "On average, clients who received ANC from the facilities were 23 years old and had eight years of schooling" is not clear, need more explanation?.

   Response: We have rephrased the text as:

   "*Clients who received ANC from the facilities had a mean age of 23 years (SD±4.3 years) and had a mean eight years (SD±2.9 years) of schooling***".**

5. Page 14, table 4 are highly congested and it crosses one page requires rearrangement or division into two table or more.

   Response: We have divided Table 4 into two tables.

6. Discussion

   Grammatical, spelling, and punctuations improvement is required in this section

   Response: We have corrected grammatical, spelling and punctuation errors.
7. **Overall comment**

   There are some areas need corrections; such as rephrasing, grammatical, spelling, and language. Kindly review issues raised and if possible get a trained English proof reader to edit the entire manuscript.

   Response: We have revised accordingly.

Response to reviewers' comments (additional)

Reviewer 1:

An interesting and important modifiable and independent service related factor revealed in your results is the TYPE OF PROVIDER. In your abstract, you have mentioned it nicely as- Although nurses provided services of similar quality to the physicians, paramedics were 23% (aIRR: 1.23, 95% CI: 1.06-1.42) and community health care providers were 32% (aIRR: 1.32, 95% CI: 1.12-1.57) more likely to provide quality nutrition services. However, this factor has not been addressed at all in the discussion. As I have mentioned earlier (In the first review, this is the only important influencing factor/determinants and this need to be highlighted/explained in the DISCUSSION.

Response: We agree with the reviewer that the type of HCPs is an important factor influencing the quality of nutrition service. We have now highlighted this in the discussion and proposed some possible explanations in the following additional text:

"Lower-level providers who mainly offer services at lower-tier facilities provided a better quality of nutrition service than physicians and nurses at higher-tier facilities. Previous studies from LMICs including Bangladesh have also reported that lower-level providers had similar or better compliance with standard maternal and child out-patient care than higher-level providers [1, 2]. Several HCP's attitudes and contextual factors may have resulted in the lower performance in nutrition services by doctors and nurses at higher-

level facilities. All of the physicians and nurses in our study provided services at district and subdistrict hospitals where HCP shortage against the sectioned post is a big health systems challenge [3]. These physicians and nurses often provide service under high workload pressure, are responsible for multiple tasks and manage patients with complications [4, 5]. In such situations, they often prioritise curative health services over preventive nutrition services such as counselling and weight assessments for weight gain monitoring [5]. We also found that provision of nutrition counselling was lower at facilities where a higher number of ANC services were provided, and this occurred mostly at district and subdistrict hospitals. The role of the higher-level providers should be clarified based on WHO and national recommendations for nutrition services during pregnancy. Further in-depth qualitative assessment is necessary to better understand provider attitudes and motivation factors influencing their provision of nutrition services."

Reviewer 2:

The study is useful. The findings are relevant. I re-confirm my opinion that the manuscript is clearly written, the methodology is sound and results are well discussed.
Response: We appreciate the positive comment from the reviewer.

Reviewer 3:

Go over the manuscript carefully to correct any grammatical issues and enhance ease of reading. For instance, you can summarize the conclusion to less than half the current length.
Response: We have checked the manuscript thoroughly and corrected grammatical errors and language. We have summarized the conclusion.

Reviewer 4:
manuscript titled Factors influencing quality nutrition service provision at antenatal care contacts: findings from a public health facility-based observational study in 21 districts of Bangladesh. I had reviewed first and made few comments. All comments were addressed properly. It is satisfactory.
Response: We thank the reviewer for the encouraging comment.

Paper 2 (Chapter 4): Iron and Folic Acid Supplementation in Pregnancy: Findings from the Baseline Assessment of a Maternal Nutrition Service Programme in Bangladesh

Response to reviewers' comments

Reviewer 1:

Point 1: The present study applied the data of the baseline situation assessment for the National Nutrition Service's maternal nutrition demonstration programme in Bangladesh to analyze the number of IFA tablets received and consumed during pregnancy and examined the factors influencing IFA consumption and user adherece-adjusted effective coverage of IFA. The subject is not very new, but in my opinion, the analysis perspective and the introduce of effective coverage in this study is advisable. The findings would be positive for the action to improving maternal and infant health. My detailed comments are as following.
Response 1: We appreciate the positive comment from the reviewer. We have responded to the detailed comments below.

Point 2: In the first paragraph of *Introduction,* the reference of 'The national estimate of pregnancy anaemia in Bangladesh suggests that nearly half of women were anaemic' is based on *Bangladesh Demographic and Health Survey 2011.* Could you please give an updated one for example the Survey in 2020?
Response 2: We could not find any published national estimates of anemia in pregnancy after the 2011 Bangladesh Demographic and Health Survey (BDHS). The latest BDHS 2017-18 did not report the prevalence of anemia in pregnancy. The second National Micronutrient Survey conducted in 2019-2020, did not include pregnant women, although the report has not been published (personal communication). A recent study of ours (2020) in Tangail, a rural district of Bangladesh, identified a 48% prevalence of anaemia in pregnant women [6]. We have included this estimate.

Point 3: Is there any difference in the prevalence of anaemia between rural and urban area in Bangladesh? If yes, I suggested describe the difference in the first paragraph.
Response 3: Thank you. Yes, the prevalence of anaemia was higher in rural areas in 2011 BDHS. We have added the following text in the Introduction, "According to the national estimate, the prevalence of anaemia in women was higher in rural areas (45%) than in urban areas (36%)". Please note that the 2011 BDHS did not report anaemia prevalence among pregnant women by area of residence.

Point 4: For *Sampling,* a multistage cluster sampling were applied. Did you had a andomized selection during sampling and in which stage?
Response 4: As described in sampling methods, we selected the seven village clusters from each of the 40 unions by probability proportional to size sampling. Then we listed all existing women who had a pregnancy outcome in the last six months in each cluster and approached them for the interview. We have revised the text to clarify this "Finally, we identified and interviewed all (approximately ten on average) women who had a pregnancy outcome within six months in each selected cluster."

Point 5: For *participants*, were all of the women recruited and interviewed included in finally analysis? Could you please add a flowchart of the participants in finally analysis?

Response 5: We identified 2910 pregnant women who had a pregnancy outcome in the last six months; of those women, 2849 completed the interview, and 2572 had a live birth and were included in the analysis. As suggested by the reviewer, we have added a participant flow diagram (Figure 1), and the following text "Women who had a live birth outcome were included in the final analysis for this paper (Figure 1)."

Point 6: For *statistical analysis*, the data is hierarchical according to sampling of this study? I think use the multi-level model will be more suitable. Did you try?

Response 6: We adjusted all analyses for the survey design, multi-stage cluster sampling, by svyset command in Stata. This approach is a standard methodology for analysing survey data with multi-stage sampling [7]. We have clarified this: "We used Stata (14, StataCorp LLC, College Station, TX) for the analyses and adjusted the multi-stage cluster sampling survey design using the 'svyset' command in all analyses [7]". Nonetheless, as advised by the reviewer, we have analysed the data using a multi-level mixed model and found similar estimates of the association between consuming IFA and the explanatory factors (Table A).

Table A: Factor associated with the number of IFA consumed, comparison of estimates between the model with 'svy' command and mixed model

Variables	**Number of IFA consumed Adjusted Mean Difference (95% CI)**	
	'svy' command model	Multi-level mixed model
Region/area		
North (kurigram)	Ref	Ref
South (Bhola)	2.2(-3.2, 7.6)	3.1(-3.2, 9.3)
Mother's age		
<20	Ref	Ref
20-29	6.0(-0.0, 12.1)	5.2(0.8, 9.6)
30 or more	3.4(-4.04, 11.9)	3.3(-4.04, 10.7)
Mother's education		
Up to primary	Ref	Ref
Secondary	6.0(1.2, 10.8)	5.9(1.2, 10.7)
Higher secondary and above	23.6(15.8, 31.5)	24.2(14.1, 34.3)
Religion		
Muslim	Ref	Ref
Other	9.2(-1.8, 20.1)	9.1(-1.5, 19.6)
Work involvement		
Not employed	Ref	Ref
Employed	6.5(-8.3, 21.3)	6.8(-6.1, 19.7)
Household Wealth (tertile)		
Poor	Ref	Ref
Middle	1.5(-4.2, 7.2)	1.0(-3.9, 5.9)
Rich	3.0(-3.4, 9.4)	2.6(-2.2, 7.3)

Variables	**Number of IFA consumed Adjusted Mean Difference (95% CI)**	
	'svy' command model	Multi-level mixed model
Mother's exposure to print or electronic media (at least once a week)		
No	Ref	Ref
Yes	4.2(-1.5, 9.9)	3.6(-1.6, 8.8)
Birth Order of the last child		
1	Ref	Ref
2	-4.5(-10.0, 1.1)	-3.9(-9.5, 1.7)
3+	-5.2(-12.7, 2.3)	-4.9(-11.1, 1.3)
Women who had pregnancy complications		
No	Ref	Ref
Yes	-7.8(-13.0, -2.0)	-6.0(-10.1, -1.9)
Number of ANC and timing of first ANC		
Number of ANC visits among mothers who received none or started late (≥5 months GA) $^{\alpha}$	9.8(7.8, 11.8)	10.1(7.9, 12.4)
Number of ANC visits among mothers who started early (≤4 months GA)$^{\alpha}$	14.1(11.5, 16.6)	14.0(12.1, 15.8)
Received advice on IFA		
No	Ref	Ref
Yes	30.9(24.2, 37.5)	29.8(20.8, 38.8)
Received IFA free		
No	Ref	Ref
Yes	14.1(9.3, 18.8)	14.5(8.7, 20.3)
Received IFA only from ANC contacts		
No	Ref	Ref
Yes	-39.2(-45.0, -33.2)	-38.9(-48.0, -29.8)

Point 7: For *results*, the description in text is not consistent with the table, for example, in page 7 line 238 and line 234. In Table 3, did you miss the adjusted Mean Difference for '*Any history of abortion/stillbirth before this pregnancy*'? Please check the text and table in *Results*.
Response 7: We apologise for the typographic and rounding inconsistencies. We have checked the results and tables and corrected the typos in the text. We did not include *Any history of abortion/stillbirth before this pregnancy* in the adjusted model as this indicator was not associated with the outcome in the univariate linear regression model, p-value > 0.2, the cut-off specified in the statistical analysis. To avoid confusion, we have included dash (-) in relevant rows in Table 3 and specified "- variable not included in the adjusted model" in the footnote.

Point 8: For *limitation*, this study recruited and interviewed women with live birth in the preceding six months. I think the ideal participants are all pregnant women in the preceding six months. Could you please explain why you did not recruited pregnant women without live birth and clarify the limitation?
Response 8: Previous studies on mother's recall-based surveys reported IFA coverage only among live births. The number of IFA tablets consumed (one tablet is recommended daily) depends on the length of pregnancy. By definition miscarriage/abortion is the termination of pregnancy before 7 completed

months (28 weeks) of gestation. Women would not get enough time in pregnancy to consume recommended 180 or more tablets if they had an abortion/miscarriage. They are theoretically ineligible to be included in the analysis of effective coverage and would bias the mean number of tablets consumed downwards. Similarly, we excluded stillbirth as we did not have information on antepartum and intrapartum stillbirth and length of pregnancy in weeks.

Point 9: For *limitation* The number of IFA tablets received or consumed during pregnancy is self-reported by women. Is there any bias for self-reporting data? Did you consider to conduct any mini prospective cohort to check the potential bias?

Response 9: We have already acknowledged the limitation of using self-reported data on the number of IFA tablets received and consumed, and the potential for response bias. Women may forget the exact number of IFA tablets consumed and may either over-report or under-report the number. To minimise this bias, we restricted our participant selection window to six months post-partum. We did not conduct any prospective cohort follow-up to check the potential bias and specified this in the limitation as a consideration for future study.

Reviewer 2:

Point 1: I suggest that the title of the article be changed because "What influences coverage of Iron and Folic Acid supplementation in pregnancy: Findings from the baseline assessment of a maternal nutrition service program in Bangladesh" does not answer the question posed in the conclusion.
The correct title should be "Iron and folic acid supplementation in pregnancy: findings from the baseline assessment of a maternal nutrition service program in Bangladesh."
Response 1: We thank the reviewer. We have revised the title to "Iron and folic acid supplementation in pregnancy: findings from a baseline assessment of a maternal nutrition service program in Bangladesh".

Paper 3 (Chapter 5): The effect of m-health aided one-to-one counselling to support exclusive breastfeeding among 0–5-month-old infants in rural Bangladesh

Response to reviewers' comments

Reviewer 1:

Major Comments:

1. The authors mentioned that they combined all four intervention arms into a single intervention arm and compared this intervention arm with the comparison arm. This should be explicitly mentioned in the limitation as the authors violated original randomization and cannot measure the individual effect of each intervention.

Response: We did adhere to the original randomisation design in the implementation of the trial, where we had five arms. But for this analysis of nutrition counselling on exclusive breastfeeding (secondary outcome of the trial), we combined all four intervention arms because they had the same nutrition counselling in combination with or without prenatal and/or complementary lipid-based nutrient supplements (LNS). We have done an intention-to-treat analysis according to the original randomisation design (revised Appendix Table S4) and found similar effects across the intervention arms. Nonetheless, we have added the following text in the limitations: "*We combined all four intervention arms into a single intervention arm which had the intervention of interest of this analysis, i.e. nutrition counselling using an electronic job aid. Combining the intervention arms is unlikely to have introduced any bias as neither the LNS provided during 0-5 months of children's age nor prenatal LNS would impact breastfeeding of the infants. Further, we have done an intention to treat analysis according to the original randomisation and found the intervention effect consistent across all intervention arms.*"

2. This needs to be clarified whether the authors consider the current form of study as a randomized controlled trial. If they do, they need to perform intention to treat analysis.

Response: We consider the current study a cluster randomised trial as all intervention participants from the four intervention arms received nutrition counselling (with or without nutrient supplement) according to the original randomisation. We have also conducted an intention-to-treat analysis based on the originally randomised groups, and the results showed a consistent intervention effect on the breastfeeding outcome (revised Appendix Table S4). We, therefore, have not changed our approach of combining the intervention groups. We have clarified this in the statistical analysis section: "*We analysed the outcomes at the individual level using intention-to-treat according to the original study arms. We also analysed by aggregating participants into one arm receiving the nutrition counselling intervention versus a natural practice comparison arm.*" and in the results section: "A *sensitivity analysis of the intervention effect according to the original randomisation demonstrated a similar effect on EBF across all intervention arms individually and in the four intervention arms combined (Appendix Table S4).*"

3. Table 1: mention the unit of age.

Response: We have now specified age (in years) in table 1 and Table 3

4. Table 1: how BMI was categorized. Please mention in the methods section with reference. Which BMI cut-off was used?

Response: We appreciate the reviewer's comment. We have now specified BMI categorisation in the methods section: "*We calculated maternal baseline body mass index (BMI) by dividing the mother's weight in kilogram (kg) with height in meter squared (m^2) and created three categories- too thin (BMI <18.50 kg/m^2), normal (BMI 18.50 – 24.99 kg/m^2) and overweight/obese (BMI ≥ 25 kg/m^2)* [8]."

Reviewer 2:

1. The present study is based on secondary analysis from an impressive, well-conducted, cluster-randomised controlled trial.

   The primary objective of the trial was not to assess the effectiveness of the electronic job-aid assisted one-to-one counselling on exclusive breastfeeding. As mentioned at the end of the discussion (under limitations), to do so the trial should have had an additional arm with CHWs providing counselling and demonstrations in a conventional way without the electronic job aid.

   Response: We thank the reviewer for the encouraging comment. It appears that our statement of aim was not clear enough. In this paper, we considered that 'electronic job aid supported one-to-one counselling and practical demonstration' as a combined intervention package, and analysed the effectiveness on improving exclusive breastfeeding. We have modified our statement of aim specifying "*.....electronic job aid supported nutrition counselling and practical demonstration intervention package...*" to make it clearer. As we had already mentioned this as a limitation, we are not exploring the added benefit of using an electronic job aid compared to traditional counselling.

2. Table 2 shows that the percentage of mothers reporting that they had received any advices on IYCF was much higher in the intervention than in the comparison arm. Also, most of the mothers in the intervention group received counselling from trained CHW, whereas most mothers in the comparison arm received counselling from relatives. Thus, the effect of the intervention was probably due to a combination of more frequent and better qualified counselling and the use of the electronic job aid-assisted device. With the present design it is not possible to disentangle the effect of the electronic job-aid device. This is mentioned at the end of the discussion, but as it is a main point, it should be dealt with earlier in the discussion.

   Response: We agree with your useful comment, and we have added the following text earlier in the discussion: "*However, we cannot disentangle the effect of the electronic job aid alone on improved EBF as we did not have an arm with counselling provided by CHWs without the electronic job aid. Nevertheless, the consistent, structured counselling visits multiple times by trained CHWs using the electronic job aid may have improved EBF among intervention children compared with the comparison group receiving infrequent infant feeding advice mostly from relatives and neighbours.*"

3. However, it is an important finding that the intervention combining scheduled visits of trained CHW using an electronic job-aid device succeeded in increasing the duration of EBF. It would be useful to have some information about feasibility of the electronic job-aid, and also whether it would be economically and otherwise possible to offer such breastfeeding counselling to the other parts of the country.

   Response: We do not have feasibility assessment or an economic evaluation of the feasibility of adopting the electronic job aid. We have added the following text on the possibility of adopting the electronic job aid in routine health service contacts to other parts of the country: "*Nonetheless, the Government of Bangladesh has taken initiatives to digitalise health service delivery and recordkeeping by primary healthcare providers and frontline health workers [9]. The digital job aid tool can be adopted in the existing digital health service initiative to support the healthcare providers offering breastfeeding counselling in prenatal and postpartum health service contacts.*"

4. Comments to the" introduction":
   P. 3, l. 8-9: It is not clear what is meant by the ending of the first sentence: "… nearly all under-five children with inadequate growth reside with widespread inequalities…"
   Response: We have revised the first sentence of the introduction as:
   "*Childhood undernutrition with high geographic disparities and socio-economic inequalities remains a major challenge in low and middle-income countries (LMICs), where nearly all under-five children with inadequate growth reside.*"

5. P. 3, l. 17-51: Several health effects are mentioned in the introduction without any grading according to the level of evidence, e.g. better bonding and metabolic syndrome in the child, and post partum weight retention and lower risk of metabolic diseases in the mother. For the readers of MCN it may not be necessary to specify the health effects.
   Response: We mentioned the positive health effects of breastfeeding based on evidence to justify selecting breastfeeding promotion as an intervention in our study. Greater details on the level of evidence would be out of the scope of this manuscript. As the reviewer advised, we have now reduced the text on the short and long-term benefits of breastfeeding: "*Breastmilk provides the best combination of nutrients, immunologic components, and hormones for newborns and infants. It helps in developing children's gut microbiota, reduces the risk of infections, and contributes to proper physical and cognitive growth through multiple interconnected pathways [10, 11]. These are linked to long-term positive health effects, including reduced risk of obesity, metabolic syndrome, diabetes, and certain cancers [10].*"

6. P. 4, l. 44: This sentence «The difference between outcomes of breastfeeding from research….». Would it be better to relate the gap to the difference between the WHO recommendations and present breastfeeding rates?
   Response: We have deleted the sentence "*The difference between positive outcomes of breastfeeding interventions from research and sub-optimal prevalence of breastfeeding indicators demonstrate that gaps exist*" as we had already mentioned the breastfeeding coverage gap against the desired target in the earlier paragraph.

7. P. 4, l. 19-20: «Successful breastfeeding depends on ensuring proper breastfeeding techniques»… I suggest adding that these factors are at the individual level, as there are many factors at other levels that also affect breastfeeding.
   Response: As advised by the reviewer, we have revised the sentence as: "*Other studies found that successful breastfeeding depends on multiple socio-cultural factors including individual-level factors such as ensuring proper breastfeeding techniques, mothers' confidence, and support from their peers that overcome challenges mentioned above, creating an enabling environment for EBF [12].*"

8. What is meant by "hands-on" demonstration of exclusive breastfeeding? The term "hands-on" can be understood as the counsellor, grasping the mothers breast (without asking for her permission). Hands-off counselling is generally recommended in lactation counselling. Could another term be used, e.g. practical demonstration?

   Response: We appreciate the reviewer's suggestion. We have used the term "practical" instead of "hands-on" throughout the manuscript.

9. METHODOLOGICAL ASPECTS AND ETHICAL ISSUES The manuscript includes a good description of the methodology. The comparison arm with «usual care» should, if possible, be described in more detail under «methods». No ethical issues.

   Response: We have revised and expanded the description of the comparison arm as: *"Participants in the 'usual practice' comparison arm did not receive nutrition counselling visits by study CHWs. In all intervention and comparison arms, mothers could receive nutrition services during antenatal care visits and advice on child feeding practices at postnatal care and out-patient sick child management services, delivered at public, private and non-government health care services. Nonetheless, previous studies reported a low reach of these services during the antenatal and postpartum care continuum and sub-optimal nutrition-specific services at these contacts* [13, 14]*."*

Reviewer 3:

Title

1. Consider rewriting title to make it simpler/apparent which of the aspects of electronic job, aid-assisted and one to one is being compared in as far as its impact/benefit to as the main outcome of improved nutrition from exclusive breast feeding (EBF)…maybe something like "The effect of m-health 1:1 aided counselling to support EBF among 0–5-month-old infants in rural Bangladesh".

   Response: We have revised the title as "*The effect of m-health aided one-to-one counselling to support exclusive breastfeeding among 0–5-month-old infants in rural Bangladesh.*"

Abstract

2. Line 17: If this was a secondary study/analysis from a previously completed RCT I don't understand how you again "randomized pregnant women to one of five study arms and followed mother-child dyads until two years of age"…please clarify what you mean by this…you took the arm as was and combined the other four arms?

   Response: In the current paper, we report secondary outcome (EBF) of a five-arm randomised controlled trial that we recently conducted in Bangladesh. We aimed to measure the effectiveness of electronic job aid supported one-to-one counselling on improving EBF practice in children 0-5 months old. In a protocol paper, we previously described the study in detail. For the current analysis, we took the arms as was, combined all four intervention arms, and compared exclusive breastfeeding practice as our outcome of interest with the natural practice comparison arm. Perhaps the final paragraph of the introduction was too long and included some repetitions of methods. We have simplified the text and made the aims clearer to avoid confusion: "*In the present article, we analysed and presented a secondary outcome of the trial: effectiveness of the electronic job aid-supported nutrition counselling and practical demonstration intervention package on improving EBF practices in the first six months of the infant's life.*"

3. Did you use the data as was or you followed the participants previously recruited in previous RCT as described for the objectives of this study?

   Response: We used the data as was. We did not follow up with participants from a previous RCT. We analysed the secondary outcome of the cluster RCT. We have also clarified this in the revised aim statement. Please see the response to comment 2 also.

4. Line 26: Consider mentioning what the usual practice is and if the combined control arm was monitored with similar timings/intensity if the abstract word count allows.

   Response: We have included the description of usual practice "*The comparison arm continued with the usual practice where mothers could receive nutrition counselling at routine antenatal and postnatal care and during care-seeking for childhood illnesses*." We have revised the description of the monitoring process to make it clear that it was of similar intensity across the arms: "*We assessed breastfeeding indicators at birth and monthly until the child was six months old in both intervention and comparison arms.*"

Key messages

5. Suggestion: I think messages 3 and 4 follow on from 1 and 2 and should be written/combined such that they are consequences of the latter.

   Response: We have combined the messages 1-3 together and presented as follows: *"Using an electronic job aid, repeated, one-to-one counselling and practical demonstration to mothers by locally recruited CHWs reduced prelacteal feeding and improved EBF practice by delaying the early introduction of complementary food."* We have revised message 4 as: "*The positive effect of counselling on EBF remains similar with or without nutrient supplementation.*"

Introduction

6. Authors have done very well to give various literature that give this work context and further explain the importance and benefit(s) of adequate breast feeding. However, in addition to the highlighted first 100days time frame it would be good if the authors also gave important development time frames and linear order of occurrence (i.e., how, and why each milestone is important or interlinked to another subsequent milestone) for the crucial mentioned development milestones of physical and cognitive growth, development of gut microbiota that crucial for metabolism, long term positive effects including bonding towards reducing risks of various mentioned comorbidities.

   Response: Thank you. The 'first 1000 days of a child's life' was mentioned to specify that breastfeeding promotion by nutrition counselling in the first six months is a priority nutrition intervention during this period. As advised by the reviewer in comment 7, we have now reorganised and reduced the text on short and long-term benefits of breastfeeding: "*Breastmilk provides the best combination of nutrients, immunologic components, and hormones for newborns and infants. It helps in developing children's gut microbiota, reduces the risk of infections and contributes to proper physical and cognitive growth through multiple interconnected pathways* [10, 11]. *These are linked to long-term positive health effects including reduced risk of obesity, metabolic syndrome, diabetes, and certain cancers* [10]."

7. Line40: Despite the known benefits, breastfeeding practices are sub-optimal globally…could a sentence be added for why? To link to the reason for attempts such as this work proposes as

highlighted in lines 5 to 14 in page 4 to improve breastfeeding practices in whichever shape or form.

Suggestion: Lines 17 on page 4 onwards seem to have the most relevant or core literature related to the objectives of this study…to see if improved breast feeding using 1:1 m-health methods/tools will lead to better outcomes…so assuming the target audience already appreciate the benefits of breastfeeding there is no use to repeat this…just start with why breastfeeding practices are sub-optimal globally? Then give suggestions to curb this and that sets the stage for this work.

Response: As advised, we have reduced the text on the benefit of breastfeeding (please see the response to comment 6). We have moved the text on hurdles against optimal breastfeeding/reasons for suboptimal breastfeeding earlier.

8. Is there a reference or a reliability/validation for the android-based application used to guide the CHWs to provide one-to-one counselling and hands-on demonstration…how did it guide the process specifically?

   Response: To our knowledge, there is no reliability/validity testing of android based applications used by CHWs. We have focused on exploring if the job aid changes the skills and practice of CWHs. As we did not have an arm without the job aid, we could not assess the job aid's effect on CHW's skills and practices, and we had clarified this issue as a limitation. We feel that we adequately described the job aid and how it guided the CHWs in delivering the counselling in the intervention description section.

Methods

Study settings

9. Line 57: What are unions…presumably an administrative region…consider giving the area of the union to those unfamiliar with the term…is it like a village, country, borough?

   Response: We have clarified the unions as "…the smallest administrative unit consisting of approximately thirty thousand people…"

Trial Design

10. Figure 1 notes that some participants migrated…does this mean they left their locations (relocated) so could not be followed up or moved to a different treatment arm. If the latter, how was it decided which other arm they should move to and eventually was the analysis done on per protocol or intension to treat basis?

    Response: The migrated participants left their household, and relocated outside the study area and could not be followed up. If a participant moved to a different study cluster, we continued to follow them up and considered them part of the arm to which they were originally randomised. As indicated by the reviewer in comment 23, we had specified in the statistical analysis section that we used an intention-to-treat analysis.

11. Suggestion: could the initial BCC, PNS, CFS be also put in the trial design prose so that it is easy to relate what the treatment was for each arm

    Response: We have specified the initial BCC, PNS and CFS allocation in the trial design: "*One arm had both pregnant mother's and children's LNS (arm1: nutrition-specific behaviour change communication counselling (BCC)+ lipid-based prenatal nutrient supplement (PNS)+ lipid-based complementary nutrient supplement (CFS)), and two arms had either mother's LNS or children's LNS (arm 2: BCC+PNS and arm3: BCC+CNS) and arm4 had BCC only.*"

12. Were there instances of multiple births, if so, how were these dealt with or rather were multiple births from one pregnancy all included

    Response: We had 21 multiple live births out of 1355 total live births. We included all multiple births in the analysis.

13. Was there any unique characteristics for the cases that withdrew? Were there instances of adverse (sever) outcomes reported?

    Response: We found no differences in the background characteristics of the thirty women who withdrew with those who stayed in the study. We also note that the number of withdrawals was low (~2.2% of the total) and unlikely to bias the overall study results. No severe adverse outcomes were reported.

14. Please explain the motivation for combining the 4 intervention arms and even if not reported was a sensitivity analysis done if each arm was compared alone to the comparison group while adjusting for multiple comparisons?

    Response: This paper examines the effect of nutrition counselling on exclusive breastfeeding. To answer this research question, a secondary outcome of the RCT, we pooled the four intervention arms of the RCT into one intervention arm to compare it with the natural practice comparison arm. This comparison is valid for the outcome of interest of this paper for the following reasons:

    - We provided the same nutrition counselling on exclusive breastfeeding (BCC) during the first six months of the child's life in all four intervention arms.
    - In addition to nutrition counselling, three of the four intervention arms received either or both prenatal and complementary nutrient supplements (PNS and CFS) in sachets. The small quantity prenatal nutrition supplement (PNS) cannot contribute to breastfeeding, which is our outcome of interest in this paper. In two arms, a complementary feeding supplement (CFS) was provided to children from six months to 24 months of age, which occurred after the period of exclusive breastfeeding (up to six months of age).

    Besides comparing the pooled intervention arm vs the comparison arm, we have done a sensitivity analysis to estimate the effect of each intervention arm versus the comparison arm. We found a similar intervention effect on exclusive breastfeeding across each of the intervention arms and the combined intervention arm compared with the comparison arm (revised Appendix Table S4). We have clarified in the result: "*A sensitivity analysis of intervention effect according to the original randomisation demonstrated a similar effect on EBF across all intervention arms individually and in the four intervention arms combined (Appendix Table S4).*"

Randomisation and participant enrolment

15. Authors have done well to provide Table 1 and 2 summarise the quality of the randomisation in the pooled intervention groups and comparison groups.

    Response: Thank you.

16. It seems there is a somewhat distribution of characteristics I dint see any * on any of the rows, but as implied before was this checked without the intervention groups being pooled? Notice that

Table3 has a significant difference in the mode of birth and borderline significance with maternal education. Suggestion: Check a cross tab of maternal education, mode of birth and social economic status just to see if the randomisation balance was maintained.

Response: The reviewer mentioned in comment 23 that the statistical analysis section clarified their query on analysis type and adjustment for background characteristics.

We have compared the distribution of background characteristics between the intervention (pooled) and comparison groups using crosstab to check the balance between intervention and compassion arms. We have now further clarified, "*Participants' background characteristics were similar between the combined intervention arm and the comparison arms at baseline.*"

We have not compared the background characteristics of each of the intervention arms with the comparison arm separately as we have considered the pooled intervention arm as one single intervention arm for this secondary outcome (explained in response to comment 14). Nonetheless, we have conducted a sensitivity analysis of counselling intervention's effect on exclusive breastfeeding after adjusting for background characteristics and found a similar intervention effect in the adjusted analysis. We clarified this in statistical analysis and the results section. Please see comment 23.

Sample Size

17. I am struggling to understand why for this study the sample size was determined by doubling the original study since this study is designed as a C-RCT? What was the gain in power by doubling the sample size?

    Response: The sample size was calculated for the study's primary outcome, i.e. children's length-for-age z score (LAZ) at 24 months of age. For secondary outcomes, we did not calculate the sample size separately. Increasing the sample size in the comparison arm did not add much cost to the study other than the data collection costs. Therefore, we decided to take the 1:2 ratio of intervention and comparison sample size, which increased the power of the study for a fixed intervention effect. For the trial's primary outcome, doubling the sample size in the comparison arm increased power to 91%.

18. Line 23: "…estimating the intervention effect on secondary outcomes…" at what level? Was the original study also a C-RCT? Put another way what was the smallest unit of measurement for the original study and what is the smallest unit of measurement for this study? Presumably it's the individual participant assessed given that the results tabulated are reporting at individual level and not aggregate cluster level counts, percentages, and RRs.

    Response: The randomisation of intervention was at cluster level; however, we measured all outcomes at the individual level (i.e. child). In the statistical analysis section, we have clarified this as "*We analysed the outcome at the individual level using intention-to-treat…….*"

Ethics approval and participant consent

19. Authors have done well to elaborate on the ethics application and committee. Its commendable that the trial was registered to give this work more credibility.

    Response: We appreciate the positive comment from the reviewer.

Intervention description: exclusive breastfeeding counselling using an electronic job aid

20. Just a general question: With time given the difference in intensity of counselling and hands-on demonstration of exclusive breastfeeding provided by CHWs…was there any risk of participants or

blinded trial team knowing the group allocations…which would impact the outcome reporting? Following on from the above, given the cluster design described mitigate this contamination risk in any way?

Response: Considering the nature of the interventions, i.e. counselling and LNS, it was not always possible to keep the trial teams blinded to which participant was receiving which intervention. There was no blinding of participants. Contamination of the intervention was less likely as the CHWs conducted one-to-one counselling to intervention participants. We kept the outcome assessment team separate from the CHW team to reduce bias in outcome assessment. Also, the data collectors were not aware of the outcome indicator definitions. We have explained this in the 'Randomisation and participant enrolment' section and now clarified further in the limitation: "*Data collectors were independent of the CHWs, unaware of outcome indicator definitions, and the same data collectors interviewed participants in both intervention and comparison arms.*"

Outcome measures

21. I see that a cluster effect was included in the statistical analysis to investigate group differences…was breastfeeding behaviours or practice uniform within clusters…put another way could the strength of the association of outcomes be quantified and reported to justify the design as opposed to a traditional RCT.

    Response: As the study design was a cluster-randomised trial, we adjusted for clustering. We assumed that participants living in the same cluster would have similarities in breastfeeding and other health behaviour. The main reason for conducting a cluster RCT instead of a traditional individually randomised trial was to avoid contamination of the intervention. Further, it would not be appropriate to implement the study in a cohesive rural community in a developing country setting and give the study interventions to one woman and leave another woman from the same neighbourhood to continue without the intervention in the comparison arm.

Data collection

22. Line 21: It is noted in case a mother was absent then up to two repeat attempts were made within the month…I realise this is pragmatic decision to overcome this challenge and fully agree with it given trial data collection realities and resources available…therefore could a sentence giving reassurance that the slight change in data collection time alignment will have no impact on analyses and conclusions and possibly such instances were isolated if that was the case.

    Response: Thank you for the suggestion. We have added the text "*The minor change in data collection time alignment is not likely to impact analyses and conclusions as the child remained in the same month of age.*"

Statistical analyses

23. Authors have done well to explain how maternal baseline characteristics were summarised, answer my previous query on whether per protocol or INT was used for analysis, explain factors used for adjustments and what sensitivity analysis were done.

    Response: Thank you for the positive feedback.

24. Line 13: Please elaborate why the standard errors derived from Poisson models were empirically adjusted. Am not clear on how the hierarchy of the clustering effects were dealt with… there are the clusters because of the design, and then there is a repeat of outcome measures…this needs to be explained very clearly.

Response: We used the Poisson model to estimate the measure of effect, the relative risk. We empirically adjusted the standard error by using a Poisson distribution to model the outcome instead of a binomial distribution. If we did not apply empirical adjustment, the standard errors would be inflated. The Poisson regression approach to estimate relative risk as the measure of effect is recommended for prospective studies with binary outcomes [15]. We have revised the text to improve the clarity of the methods used to adjust for clustering: "*We applied separate Poisson models to estimate the effect on EIBF, colostrum feeding, prelacteal feeding and EBF. All models included study arm and randomisation blocks as fixed effects and a random effect for the study clusters for C-RCT design. For EBF, we report the relative risk by month (1 to 5) after birth, estimated by adding month as a categorical fixed effect and an interaction effect with the study arm. We also included an additional random effect for the child nested within the random effect for study clusters in the model to take into account the repeated measurements of EBF.*"

25. Given that outcomes were binary…please elaborate the specific indicators of breastfeeding practices among children aged 0-5 months e.g., each mother responded to whether she practised EBF, practised predominant breastfeeding, was or was not breastfeeding and giving other milk, practised early introduction to complementary food? Then presumably all those responding to the affirmative to the EBF indicators were counted and hence the Poisson model was fitted. Kindly consider explicitly itemising the statistical models fitted…showing the outcome and the independent variables for each model…This comes out in the results and appendices…but just to make it easier to follow for the reader would be helpful.

    Response: We defined outcome indicator in the outcome measure section. We have further clarified the binary outcome variables "*Each outcome indicator was coded 1,0 where 1 denoting the practice was done.*"

    Breastfeeding indicators such as EBF, predominant breastfeeding, breastfeeding with other non-milk liquids, breastfeeding with formula feeding /non-human milk are mutually exclusive. A child can have one type of breastfeeding at a time. We have not created a count variable of breastfeeding indicators and fitted Poisson models for the binary EBF indicator (1=yes, 0=No). We have clarified the reasons for fitting the Poisson model in response to comment 24.

    We do not see the need to provide the detailed mathematical equation of separate models fitted for EIBF, colostrum feeding, prelacteal feeding, and EBF outcomes in an article in a journal focused on maternal and child nutrition. Therefore, we have described how we built the models but have not presented the itemised equations.

26. What assumptions on the cluster effect arising from the design and or repeated measures was assumed and why?

    Response: We assumed the random effects for clusters and children are normally distributed with a mean of zero as the assumption of normality is the default distribution for random effects used in multi-level models.

27. Table 3 shows the important factors driving and or influencing which outcome? I presume the main outcome of EBF practice…were the significant factors the same for all other outcomes…notice that depending on outcome as demonstrated in Table S1, the forest plot in Figure S2 and Figure 3 there is a time effect…so are some factors only relevant for certain times during the 0 to 5 months, are there some that act all the time etc.

Response: In Table 3, we have compared the counselling intervention's effect on EBF at five months of age across the subgroups of background characteristics of the study participants. The table reports the interaction p-values from tests if the participants' background characteristics modified the effect of nutrition counselling intervention on exclusive breastfeeding at five completed months of children's age. We assessed the effect modification for EBF at five months only as the counselling intervention aimed to sustain EBF up to six months (180 days) according to WHO recommendation. We did not conduct sub-group analysis for EIBF, colostrum feeding and prelacteal feeding outcomes as they were not the main outcomes of interest of this paper.

28. Overall, an interesting piece of research. Some re-writing of the statistical analysis is required to map the design choices made to give a clear understanding of the study's findings. Even if I have dwelt of the unclear aspects of this work, I do feel that this research really comes from a good place. Good luck.
    Response: Thank you. We have made relevant edits to the manuscript as advised by the reviewer.

Response to reviewers' comments (additional)

1. Is the term mhealth understood by most readers? Maybe, mobile application or electronic job aid is understood better?
   Response: We agree with the reviewer and have used "electronic job aid" instead of m-health.

2. Is "practical counselling" a better term than "practical demonstration"?
   Response: We have used the term "practical demonstration" to refer to the demonstrations of breastfeeding techniques provided by the CHWs in addition to verbal counselling. We believe the term "practical demonstration" is more appropriate here.

3. In the introduction reduction of the risk of metabolic syndrom is mentioned as one of the effects of breastfeeding with reference to Victora et al .(2016), but I cannot find this stated in that paper.
   Response: Thank you. We have included a reference on the protective effect of breastfeeding on metabolic syndrome [16].

4. Page 3-4: There is some repetitions in the paragraph on hurdles to breastfeeding
   Response: We have deleted repetitions in the paragraph on hurdles to breastfeeding.

5. Page 4, line 23: replace devoloped countries with high-income countries
   Response: We have replaced developed countries with high-income countries.

6. Page 12, line 18: replace natural practice with usual practice?
   Response: We have replaced natural practice with usual practice.

7. Page 45, line 12: Replace "evidence of an electronic job aid in BF councelling" with " evidence of an intervention using/including an electronic job aid in BF counselling"?
   Response: As advised by the reviewer, we have revised the text as "evidence of an intervention using an electronic job aid in breastfeeding counselling".

Paper 4 (Chapter 6): Effect of nutrition counselling with a digital job aid on child dietary diversity: Analysis of secondary outcomes from a cluster randomised controlled trial in rural Bangladesh

Response to reviewers' comments

Reviewer 1:

1. Excellent paper based on a valuable and well designed study. The abstract is a little misleading as the reader might interpret the intervention as the job aid, which is not correct; it was nutrition counselling. As the authors point out in the discussion, the study did not enable independent evaluation of the impact of the job aid. This should be mentioned in the abstract.
   Response: Thank you very much for the encouraging comment. We defined the intervention as 'nutrition counselling using a digital job aid'. We have revised the last sentence of the abstract as "*Although the study did not evaluate the impact of digital job aid alone, the findings indicate to the utility of nutrition counselling by CHWs using a digital job aid to improve child feeding practices in broader programmes*".

2. On page 17, line 48 there is a statement that the intervention increased mean dietary diversity score by 18% but not statistically significant at p=.07. Is this for the entire study population -- all ages and levels of food insecurity? I did not see reference to this figure in the Results section.
   Response: The reviewer is correct that the 18% difference is for the entire study population. We have revised the sentence as "*The minimum dietary diversity was 18% higher in the intervention arm irrespective of the child's age and household food insecurity, although the finding was not statistically significant (p=0.07)*". We have included this overall difference in table 2 and clarified in the footnote.

Reviewer 2:

1. This is a clearly written, well analyzed study reporting the association between a BCC strategy for IYCF used in a five-arm cluster-randomized trial to examine a secondar outcome of dietary diversity among children 6-23 mo of age in Bangladesh.
   Response: Thank you

2. The introduction could update the Black, Fanzo, Bhutta, Heady references now with the new Lancet papers. Nutrition specific intervention such as the SQ-LNS has led to reductions in stunting, wasting and anemia – this needs to be mentioned, especially since the trial may has tested this.
   Response: We have updated relevant references as suggested.

3. Methods:
   I could not find any description of what was done in the control group. I looked up the reported trials method paper and found that what is called the "Control" group in this paper is called a comparison group, and that BCC in that group was not done by the study team, rather it represents a "no-intervention" comparison group (with limited BCC described as "natural practice" delivered by the existing systems). It would be very useful to understand what was done in the comparison group in terms of intervention on IYCF and what was the level of exposure to BCC. It would also be appropriate to use the "Comparison" group terminology perhaps to be consistent with the methods paper.

Response: We agree with the reviewer that our "control group" represents a "comparison group with natural practice". We have changed the term "control" to "comparison" throughout the revised manuscript to make it consistent with the methods paper. We have described in the revised manuscript: "*Participants in the natural practice comparison arm received no intervention from the study but had access to routine care and nutrition counselling for children from routine paediatric outpatient health service contacts. However, previous literature reported that current curative service platforms have very low coverage and quality in providing preventive nutrition service like nutrition counselling* [5]". As per data from our study, exposure to nutrition-related BCC from existing government and NGO health service providers was low. We have added following text in the results "*exposure to nutrition counselling from existing government and NGO health service providers was low, 11% and 13% in intervention and comparison arms at 12 months of child's age, respectively.*"

4. What was not clear in the description of the m-health application to BCC was if its use could be specially evaluated. It doesn't seem so. Thus, the title also may need to be reworked, as it implies that the mhealth job aid was evaluated.

   Response: We used 'nutrition counselling with a digital job-aid' as the intervention in this study. We did not have a separate arm with nutrition counselling without the digital job-aid to explore the effect of digital job-aid explicitly. We described this in the limitations.

5. Results

   Is this predominantly a rural or urban context? Can you add that variable, if available, to Table 1 to provide context? The rate of C-section is high. Given that about 40% delivered in a facility, it appears almost half of these were C-section births. How does this compare to the general population? Do you know if these were indicated or elective?

   Response: All our study clusters were from rural area. We have now specified this in the methods as "*We conducted the study in two rural subdistricts, Bahubal and Nabiganj of Habiganj district*". C-section rate among our study population is consistent with the rate in general population [17]. We do not have the data on indicated vs elective C-section from this study. In national data, 19% of the all C-sections occurred before the onset of labour pain [17].

6. Table 2. Specify in the title what the ORs represent, i.e. the odds of having reported consuming a food group in the past 24 hours. Remove the category called "animal source protein". It seems an attempt to combine eggs and flesh foods (but not dairy!) to report a significant ORs. Or else combine all three animal source categories shown in the table.

   Response: We have clarified the ORs as "*OR represents the ratio of odds of having reported consuming a food group in past 24 hours*" in the footnote of table 2. We have removed "animal-sourced protein" from Table 2.

7. Include DDS and MAD in this table as these are the overall main outcome indicators, otherwise the overall differences are relegated to the forest plots, which are looking at effect modification.

   Response: We have included the dietary diversity score (DDS) and minimum dietary diversity (MDD) in Table 2.

8. It is hard to know what to make of the age interaction, given its not consistent between DDS and MAD except for age 9. The lack of a difference for later ages as explained is reasonable, but given the numerous comparisons, it could also be noise as the pattern is not so clear.
   Response: The direction of association is similar for DDS and MDD at different ages. Difference in statistical significance could be due to the difference in type and measure of variables (DDS is continuous vs MDD is categorical by a cut-off of 4+ food groups).

9. Recommend excluding Figures 4 as it does not show significant interactions and I am also worried about multiple comparison and testing here, which is not adjusted for in the analysis. And it is also a selective presentation of the significant food groups rather than an a priori analysis to examine interactions for each food group.
   Response: We have dropped Figure 4 as suggested and included the findings in the Appendix Table S3 and S4. We had analysed and reported interactions for each of the food groups in Appendix Table S3 and S4.

10. Discussion and Overall: I find the overall difference between DDS and MAD less than impressive after 7 contacts of intensive BCC with mhealth aids. The 0.09 shift in DDS is underwhelming even if significant. The difference appears to have occurred earlier on as indicated in the secondary age stratified analysis but still these results call for a re-examination of BCC for improving IYCF and the need for de-intensifying contacts.
    Response: We agree that the average difference in dietary diversity score (DDS) and minimum dietary diversity (MDD) over 6-23 months is small. However, we do see a significant and meaningful difference up to 12 months of children's age. We revised key message as "*Nutrition counselling can result in early introduction of multiple food groups but may have less effect at older ages*." Please see response to the comment 12 for further clarification on the effect modification of age and how our results compare to previous studies.

11. In relation to the age factor, what do you think is going on with dairy as it would seem like the best animal source for the younger age group. What flesh foods were commonly given to the 6-9 month olds? Was it largely fish? This could have be discussed.
    Response: Feeding children with dairy food is low in general in Bangladesh. We have added this in the discussion: "*Consumption of dairy food was low among both intervention and comparison children, consistent with general child feeding practices in Bangladesh*". Community Health Workers from our study promoted early introduction of animal proteins like egg, meat fish and dairy in regular diet, which resulted in overall higher consumption of animal-sourced food among the intervention children from a younger age. Previous studies also reported that prioritising messages on animal-sourced protein resulted in an improved consumption of these food groups. We had clarified this in discussion section. Yes, fish was the most common flesh food for children aged 6-9 months. We have added in the discussion section: "*Higher consumption of flesh food among the intervention children between 6 to 15 months of age was mainly from increased consumption of fish (data not presented)*."

12. It would be helpful to know what differences have been found previously with IYCF BCC without use of the mhealth component to speak to what this component may have added, especially since

the study design is unable to tease apart BCC with and without the use of the mhealth aids. Page 15, lines 6-12 should be revised, as the study does not provide any evidence of the specific benefit of the job aid (at the very end in the limitations this is acknowledged).

Response: Comparisons with previous literature without digital job aid are unlikely to provide a clear indication of the benefits of adding this technology to IYCF counselling interventions. Earlier literature assessing nutrition counselling and its effects on dietary diversity is of limited relevance to our findings as most of those studies do not describe how the effects changed with age nor by the level of household food security. The best comparison with our trial is a recent study from urban Bangladesh which reported a 1.95-fold increase in minimum dietary diversity among 7-12 months old children whose mothers received peer counselling, consistent with the intervention effect observed at 9 months of children's age in our study [18]. A meta-analysis of three studies that involved nutrition counselling, including one from rural Bangladesh, showed a 1.64-fold increase (95% CI: 0.92, 2.03) in minimum dietary diversity among 6-23 months old children [19]. However, it is difficult to directly compare the findings from these studies with our study findings as none of these studies reported the effect by age-groups, and if there was any effect modification by age. We have added the following to discussion to illustrate the limitations of comparing our trial with earlier literature: "*The findings on overall effect of nutrition counselling on dietary diversity should be interpreted with caution as the substantial effect modification by age and limited effect beyond 12 months have resulted in an overall low effect size on dietary diversity. A recent study from urban Bangladesh reported 1.95-fold increase in minimum dietary diversity among 7-12 months old children whose mothers received peer counselling, consistent with the intervention effect observed at 9 months of children's age in our study [18]. A meta-analysis of three studies that involved nutrition counselling, including one from rural Bangladesh, showed 1.64-fold increase (95% CI: 0.92, 2.03) in minimum dietary diversity among 6-23 months old children [19]. However, it is difficult to directly compare the findings from these studies with our findings as none of these studies reported the effect by age groups, and if there was any effect modification by age. These earlier studies did not use digital job aid and are too diverse to easily compare with our trial to elucidate any added impact from the use of digital technology.*"

We agree with the reviewer and have deleted the following text: "*add to the evidence of the impact of the application of a digital job aid in counselling to improve IYCF practice*" from the first paragraph of the discussion.

13. I have never seen any costing of such IYCF interventions, including in the A&T programs, which is critical to do to assess whether such intensive interventions (with limited evidence of any impact on stunting) are cost-effective, especially in contexts such as Bangladesh, where resource allocation needs to be done with care and prioritization is important. Rather than say more research is needed, I recommend addressing the minimal differences achieved despite the intensive efforts and include cost information if collected ($/child for the 0.09 DDS shift). Also, how could targeting be done given the findings of the stratified analysis?

    Response: We are unable to conduct a cost-effectiveness analysis of the study intervention as costing information was not collected. Regarding targeting based on findings from stratified analysis, we had mentioned in the discussion that "*adding nutrition-sensitive interventions like cash transfers with nutrition counselling might have a better outcome for all food groups and minimum dietary diversity in food insecure settings, as was found in a social safety net study in Bangladesh*".

Reviewer 3:

1. According to the manuscript, the objective was to assess the impact of nutrition counselling using a digital job aid on dietary diversity of children aged 6-23 months. Authors conclude that nutrition counselling of mothers by community health workers using a digital job aid improved dietary diversity and consumption of animal sourced protein among 6-23 old children. This conclusion was based on analysis by amalgamating 4 intervention arms as the intervention in contrast to the control arm which says 'natural' intervention. Since 3 out of 4 intervention arms had food supplementations too, the above conclusion is not valid. The control group had neither BCC nor supplementation. Therefore, it is difficult to come to a definitive conclusion that effect was due to supplements or BCC with digital aim from this design.

   Response: We understand the reviewer's concern. However, we believe that the conclusion on the effect of nutrition counselling using a digital job on children's dietary diversity by combining all four intervention arms as one intervention arm in contrast to the natural practice comparison arm is valid due to the following reasons:

   - The small quantity lipid-based prenatal nutrient supplements and small quantity lipid-based complementary nutrient supplements cannot directly contribute to dietary diversity among children aged 6-23 months which is our outcome of interest. Prenatal nutrient supplements were taken during pregnancy (arm 1 and arm 2), and complementary nutrient supplements (in arm 1 and arm 3) consisted of selected micronutrients in peanut-oil paste provided in sachets, none of which contribute to child's dietary diversity. We have clarified on lipid-based nutrient supplement in the methods section.
   - Same counselling on appropriate IYCF practices was provided in all intervention arms by the same staff. In relevant intervention arms, supplements were provided in the same contact sessions as nutrition counselling, with no additional contacts made.
   - Evidence from previous RCTs comparing provision of small quantity lipid-based nutrient supplement versus no supplement concluded that there was no difference in children's dietary diversity between the intervened and comparison groups [20].
   - We have also analysed the effect of counselling with or without supplements (please see Appendix Table S2). We found that dietary diversity score was statistically significantly higher in the 'counselling only' arm compared to the comparison arm, and that effects were similar across the four intervention arms separately and in all intervention arms combined. From these results, we can conclude that supplementation did not change the effect of nutrient counselling.
   - We are unable to assess the effect of nutrient supplement alone on children's dietary diversity, as we did not have a nutrient supplement only arm. But this was not among the aims of our study and supplement alone in absence of IYCF counselling would not be an ethical intervention.

   We have clarified this in discussion as "*Combining these arms to explore nutrition counselling's impact on dietary diversity among children 6-23 months is valid. Counselling on appropriate IYCF practices was same in all intervention arms by the same staff. Furthermore, we saw that the effects were similar across the four intervention arms including the arm with nutrition counselling alone (Appendix Table S2). Previous studies reported that provision of LNS had no impact on an children's dietary diversity [20]. Consistent with these findings, we did not see any difference in dietary diversity across the intervention arms with or without LNS*".

2. Authors have stated that the process was monitored through a web-based MIS. It would be good to give a brief account on utilization pattern of mobile application by the community health workers for BCC (though details are described elsewhere).

   Response: CHWs conducted all counselling visits using the android application. We have now clarified this in the methods: "*The application recorded the completion status in different colour codes of all visits made by CHWs to provide nutrition counselling. Visit status and relevant information from the application were synced with the central server everyday*". In the results section we mentioned: *"The study implementation monitoring reports suggested >90% completion of scheduled counselling visits by CHWs between 6-23 months of children's age"*.

Statistical review: Comments to the Author

3. I'm confused about whether this is the principle results of this trial. If it is then it should focus on the planned primary outcome which was LAZ, to be analysed and reported as in the protocol. If the principle results are published elsewhere then that needs to be made clear in the title e.g. '.... analysis of secondary outcomes from a cluster RCT in rural Bangladesh'. It would be misleading to present these results as though they are the main findings of the trial due to the risk of bias from selective outcome reporting (see https://www.bmj.com/content/342/bmj.c7153)

   Response: We appreciate the suggestion from the reviewer. We have revised the title as "*Effect of nutrition counselling with a digital job aid on child dietary diversity: analysis of secondary outcomes from a cluster RCT in rural Bangladesh*"

4. I think the statement 'Allocation concealment was not possible due to the type of interventions, i.e., counselling and LNS' has confused the term allocation concealment with blinding. Allocation concealment is about minimising selection bias, there is allocation concealment in a trial when participants are unaware of the intervention allocation at the point of recruitment/consent. Please see item 9 of the CONSORT extension for cluster trials https://www.bmj.com/content/345/bmj.e5661 and add description of whether or not their was any allocation concealment at the cluster or participant level. Please also include a statement on blinding/masking.

   Response: We have revised the text on allocation concealment as "*We had allocation concealment at the cluster level. A statistician assigned deidentified clusters into study arms before starting enrolment of participants. A field manager unmasked cluster identity and disclosed to the CHWs about the interventions to be provided to participants in each cluster according to the assigned study arm*". We have added a statement on blinding: "*Blinding of CHWs and the participants was not possible due to the type of interventions, i.e., counselling and LNS*".

5. Overall the counselling using a digital job aid increased dietary diversity score by 0.09 points(95% CI 0.02 to 0.16) and the odds of receiving at least 4 food groups by 18% (95 % CI -1% to +40%). I would recommend that these are the headlines in the abstract rather than selectively reporting the 'statistically significant results'. Please also discuss the magnitude of these differences and whether they are large enough to be meaningful.

   Response: As recommended by the reviewer, we have added the overall effect estimates in the abstract and have added some text into the discussion on the magnitude of the difference in relation to other study findings. Please also see the response to comment 12 of reviewer 2.

6. I think the statistical analyses are appropriate and I like the use of the forest plots to illustrate the interactions. I think it needs to be clearer that these analyses are secondary exploratory analyses designed post-hoc rather than main trial results, and therefore conclusions should be cautious and hypothesis generating.

   Response: We have clarified that dietary diversity is a secondary outcome of the trial throughout the paper- title, introduction and method.

Response to reviewers' comments (additional)

1. Most of my queries and suggestions have been adequately addressed. Two major limitations of the study need acknowledgement. One is that no data on the cost of the BCC intervention or the job aid were collected and described. This is a limitation and should be fully acknowledged.

   Response: We thank the reviewer. We have acknowledged the lack of cost data for the BCC intervention and the job aid for an economic evaluation in the limitations. We have added the following text: "*We did not collect data on the cost of the nutrition counselling with digital job aid intervention and therefore did not conduct an economic analysis in the study.*"

2. Second, because the four groups that received BCC also received a LNS, this may have resulted in influencing the home-based complementary food intake of children. For e.g. micronutrients in the LNS could increase physical activity, appetite etc. influencing food intake. In regard to this, acknowledge this limitation in the discussion and cite the manuscript by Campbell et al; AJCN 2016, which in fact showed that complementary food supplementation may enhance dietary diversity.

   Response: We have added the following text in the limitations: "*we did not assess if providing small-quantity lipid-based complementary nutrient supplements in two intervention arms influenced the child's dietary diversity. A previous study reported an equal or greater MDD in complementary food supplemented arms compared with a child feeding counselling only arm [21]. The authors speculated that food supplements might have improved appetite among children and influenced mothers' active and responsive child feeding behaviours. Nonetheless, we found a similar effect size for each of the intervention arms with or without complementary nutrient supplement compared with the comparison arm.*"

3. Finally, given that this was a pragmatic study with a "natural comparison group", the use of the word "Effect" denoting causality is incorrect. At best this could be called an effectiveness study. I recommend changing the title and the use of the word "effect" throughout the manuscript.

   Response: We respectfully disagree with this comment from the reviewer. The question on causality is more relevant to the appropriateness of randomization rather than the nature of control (no intervention vs natural practice comparison). The natural practice comparison will underestimate the intervention effect if many participants in the comparison arm have exposure to similar interventions. In the results section, we have already mentioned that exposure to nutrition counselling from existing service providers was low and similar in both intervention and comparison arms (11% and 13%, respectively). Nonetheless, several studies have reported the "effect" of a study intervention compared to a natural/existing practice comparison arm [22, 23]. We, therefore, have made no change to the manuscript in response to this comment.

References

1. Amoakoh-Coleman M, Agyepong IA, Zuithoff NP, Kayode GA, Grobbee DE, Klipstein-Grobusch K, et al. Client factors affect provider adherence to clinical guidelines during first antenatal care. PLoS One. 2016;11(6):e0157542.
2. Hoque DE, Arifeen SE, Rahman M, Chowdhury EK, Haque TM, Begum K, et al. Improving and sustaining quality of child health care through IMCI training and supervision: experience from rural Bangladesh. Health policy and planning. 2014;29(6):753-62.
3. World Health Organization. Bangladesh health system review: WHO Regional Office for the Western Pacific; 2015.
4. Joarder T, Tune SNBK, Nuruzzaman M, Alam S, de Oliveira Cruz V, Zapata T. Assessment of staffing needs for physicians and nurses at Upazila health complexes in Bangladesh using WHO workload indicators of staffing need (WISN) method. BMJ Open. 2020;10(2):e035183.
5. Saha KK, Billah M, Menon P, El Arifeen S, Mbuya NV. Bangladesh National Nutrition Services: assessment of implementation status: The World Bank; 2015.
6. Carpenter RM, Billah SM, Lyons GR, Siraj MS, Rahman QS, Thorsten V, et al. U-Shaped Association between Maternal Hemoglobin and Low Birth Weight in Rural Bangladesh. The American Journal of Tropical Medicine Hygiene. 2022;106(2):424.
7. StataCorp. Stata Survey Data Reference Manual Release 14. College Station, TX: StataCorp LP; 2015.
8. World Health Organization. Obesity: preventing and managing the global epidemic. Geneva: World Health Organization; 2000. Report No.: 9241208945.
9. MEASURE Evaluation. Implementation of the Electronic Management Information System in Bangladesh: Experience and Lessons Learned. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina.; 2019.
10. Victora CG, Bahl R, Barros AJ, França GV, Horton S, Krasevec J, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. The Lancet. 2016;387(10017):475-90.
11. Ho NT, Li F, Lee-Sarwar KA, Tun HM, Brown BP, Pannaraj PS, et al. Meta-analysis of effects of exclusive breastfeeding on infant gut microbiota across populations. Nature communications. 2018;9(1):1-13.
12. Brockway M, Benzies K, Hayden KA. Interventions to improve breastfeeding self-efficacy and resultant breastfeeding rates: a systematic review and meta-analysis. Journal of Human Lactation. 2017;33(3):486-99.
13. Saha KK, Billah M, Menon P, El Arifeen S, Mbuya NV. Bangladesh National Nutrition Services: assessment of implementation status. Washington DC: World Bank Publications; 2015. Report No.: 1464806411.
14. Billah SM, Ali NB, Khan ANS, Raynes-Greenow C, Kelly PJ, Siraj MS, et al. Factors influencing quality nutrition service provision at antenatal care contacts: Findings from a public health facility-based observational study in 21 districts of Bangladesh. PloS one. 2022;17(1):e0262867.
15. Zou G. A modified poisson regression approach to prospective studies with binary data. American journal of epidemiology. 2004;159(7):702-6.
16. Wisnieski L, Kerver J, Holzman C, Todem D, Margerison-Zilko C. Breastfeeding and risk of metabolic syndrome in children and adolescents: a systematic review. Journal of Human Lactation. 2018;34(3):515-25.
17. NIPORT, Associates Ma, ICF. Bangladesh Demographic and Health Survey 2017-18. Dhaka, Bangladesh, and Rockville, Maryland, USA: National Institute of Population Research and Training (NIPORT) and ICF; 2020.
18. Ara G, Khanam M, Papri N, Nahar B, Kabir I, Sanin KI, et al. Peer Counseling Promotes Appropriate Infant Feeding Practices and Improves Infant Growth and Development in an Urban Slum in Bangladesh: A Community-Based Cluster Randomized Controlled Trial. Current developments in nutrition. 2019;3(7):nzz072.

19. Janmohamed A, Sohani N, Lassi ZS, Bhutta ZA. The Effects of Community Home Visit and Peer Group Nutrition Intervention Delivery Platforms on Nutrition Outcomes in Low and Middle-Income Countries: A Systematic Review and Meta-Analysis. Nutrients. 2020;12(2):440.
20. Arimond M, Abbeddou S, Kumwenda C, Okronipa H, Hemsworth J, Jimenez EY, et al. Impact of small quantity lipid-based nutrient supplements on infant and young child feeding practices at 18 months of age: Results from four randomized controlled trials in Africa. Maternal & Child Nutrition. 2017;13(3):e12377.
21. Campbell RK, Hurley KM, Shamim AA, Shaikh S, Chowdhury ZT, Mehra S, et al. Effect of complementary food supplementation on breastfeeding and home diet in rural Bangladeshi children. The American journal of clinical nutrition. 2016;104(5):1450-8.
22. Arifeen SE, Hoque DE, Akter T, Rahman M, Hoque ME, Begum K, et al. Effect of the Integrated Management of Childhood Illness strategy on childhood mortality and nutrition in a rural area in Bangladesh: a cluster randomised trial. The Lancet. 2009;374(9687):393-403.
23. Galasso E, Weber AM, Stewart CP, Ratsifandrihamanana L, Fernald LC. Effects of nutritional supplementation and home visiting on growth and development in young children in Madagascar: a cluster-randomised controlled trial. The Lancet Global Health. 2019;7(9):e1257-e68.

Appendix D: Data collection instruments and questionnaires

Questionnaires for Paper 1 in Chapter 3

1. Health facility assessment module
2. Antenatal care observation module
3. Healthcare provider interview module
4. Client exit interview module

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Evaluation of accelerating implementation of National Nutrition Services

Health Facility Assessment Checklist

A. Information about observation

Observer's Name and ID: ____________________	☐☐	Date: / / dd mm yy

Starting time of observation	: hh : mm	**Ending time** of observation	: hh : mm

B. Information about facility identification

Name and code of facility: ____________________	
Address of the facility:	District: ____________________
Upazila: ____________________	Union: ____________________
Village: ____________________	Ward No: Ka/ Kha/ Ga/ Gha

Type of the facility:	District hospital/ Medical College and hospital........	1
	Upazila Health Complex...	2
	Union Health and Family Welfare Centre	3
	Community Clinic...	4
	Others(specify):	7
If the facility provides in-patient care mention the number of beds that facility have	No. of beds ....__________ Does not have in-patient care........................999	

C. Information about the respondent

Civil surgeon/Superintendent.............................	11	FWV	16
UHFPO	12	SACMO..	17
UFPO	13	CHCP	18
Medical officer...	14	Statistician	19
Nurse	15	Others..	98

No.	Name of the respondent	Designation	Phone no
1		☐☐	
2		☐☐	
3		☐☐	
4		☐☐	
5		☐☐	

D. General information on service availability:

Does this facility offer any of the following client services (either at the facility or as outreach)? In other words, is there any location in this facility where clients can receive any of the following services:

#	Name of service	Yes	No
S01	IMCI services for children under age 5	1	2
S02	Child vaccination services	1	2
S03	Growth monitoring services	1	2
S04	Antenatal care (ANC) services	1	2
S05	Normal delivery	1	2
S06a	Functional SAM center	1	2
S06b	If YES, mention the date of establishment of SAM center |___|___|- |___|___|-|___|___|		
S06	Management of Severe Acute Malnutrition (SAM)	1	2
S07	Management of Moderate Acute Malnutrition (MAM)	1	2
S08	Laboratory diagnostic services, including any rapid diagnostic testing	1	2

#	Service delivery	Response	Code	Skip
S09	How many days per week is the facility open?	Days/week	☐☐	
S10	How many days per week are child health services provided?	Days/week	☐☐	
S11	How many days per week are vaccination services available?	Days/week	☐☐	
	Check S04: If **1** is **NOT circled Skip S12-S16**			
S12	How many days per week are antenatal care services available?	Days/week	☐☐	
S13	Is IFA supplement provided to pregnant woman during ANC?	Yes........................1 No.........................2		→ **S15**
S14	How many IFA tablets are given to pregnant women normally in each ANC visit?	Number	☐☐	
S15	Is ANC report submitted in each month?	Yes........................1 No.........................2		

E. Infrastructure

Sl.	নাম Name of logistics	Functional	Not Functional, Available only	Not Available	মন্তব্য Comment
I01	A waiting room/area	1	2	9	
I02	Sitting arrangement in the waiting room/area	1	2	9	
I03	Examination room/area	1	2	9	
I04	Privacy in the examination room/area	1	2	9	
I05	Examination bed for patient	1	2	9	
I06	Examination chair/tool for patient	1	2	9	
I07	Window for light and ventilation	1	2	9	
I08	Electricity connection	1	2	9	

I09	Generator/solar electricity source for power cuts?	**1**	**2**	**9**	
I10	Toilet for patient's use	**1**	**2**	**9**	
I11	Water supply	**1**	**2**	**9**	
I12	**If FUNCTIONAL water supply**, Circle the Source of water	Piped water .... **1** Tubewell........................ **2** Dug well .... **3** Pond water..................... **4** Other **7**			

F. Supplies and logistics in the ANC room:

Sl.	**নাম Name of logistics**	**Functional**	**Not Functional, Available only**	**Not Available**	**মন্তব্য Comment**
H01	ওজন মোশন (বড়দের) Adult weighing scale	1	2	9	
H02	ওজন মোশন (শিশুদের) Infant weighing scale	1	2	9	
H03	উচ্চতো েোপোর মেল Height scale	1	2	9	
H04	েোপোর শিতো Measuring tape	1	2	9	
H05	থার্ম শেটোর Thermometer	1	2	9	
H06	মেদথোদোপ (বড়দের) Stethoscope (adult)	1	2	9	
H07	মেদথোদোপ (শিটোল) Stethoscope (Fetal)	1	2	9	
H08	রক্তচোপ েোপোর মোশন BP machine	1	2	9	
H09	আদলোর উৎস/ ষ্ট লোইট Light source/ Torch light	1	2	9	
H10	হোতঘশড়/মেয়োল ঘশড় Watch/clock	1	2	9	
H11	ভ্যোজোইনোল মেকুলোে Vaginal Speculum	1	2	9	
H12	শহদোদলোশবন েোপোর টলকুইস বই Tallquist Book for Hb estimation	1	2	9	
H13	*প্রস্রাব পরীক্ষার জন্য কাঠি/ স্ট্রিপ* Strip for testing glucose and albumin in urine	1	2	9	
H14	লযোনদসট Blood lancets	1	2	9	
H15	তু লোর বল Cotton swabs	1	2	9	
H16	স্বোস্থ্যশিক্ষোর জদনয শবযুক্ত উপকরণ (মপোেোর, শিপ চোর্ট, বই) Visual aids for client education (poster, flip-chart,	1	2	9	

Sl.	নাম Name of logistics	Functional	Not Functional, Available only	Not Available	মন্তব্য Comment
	booklets)				
H17	Pictorial cards/Posters with maternal danger signs	1	2	9	
H18	জন্মশবরশতকরণ পদ্ধশত সূেহ Any contraceptive commodities	1	2	9	
H19	[illegible] কোলীন মসবো [illegible] ANC Cards	1	2	9	
H20	জোতীয় ANC গোইডলোইন National ANC guideline	1	2	9	
H21	মরোগী মরশজোর খোতো Client records/ register	1	2	9	
H22	[illegible]কোলীন মসবো মরশজোর খোতে ANC visit record/ register	1	2	9	
H23	মারোরোল মরশজোর খোতো Referral register	1	2	9	
H24	মারোরোল শিপ Referral slip	1	2	9	
H25	[illegible] য বযোবস্থ্াপনের গোইডলোইন Guideline for waste management	1	2	9	
H26	একবোর বযোবহোরদযোগয শডসদপোদজবল শসশরঞ্জ Disposable syringes	1	2	9	
H27	লোভ্স Gloves	1	2	9	
H28	হোত ম োয়োর সোবোন Hand washing soap	1	2	9	
H29	মহাশসল সশলাডন Hand-rub solution/ Hexisol	1	2	9	
H30	োরোদলো শজশনস(সুহ, লযোনদসট, মেড) মিলোর আলো ো ো বোি Sharp disposable box	1	2	9	
H31	সো োরণ [illegible]য মিলোর ঝু শড় Waste bin/ plastic bin	1	2	9	
H32	জীবোনুনো িক সশলউিন (Chlorine, hibitane, alcohol)	1	2	9	

G. Availability of drugs: Does this facility have the following drugs on the day of visit?

Sl.	নাম Name of drugs	Available in Pharmacy or examination room		Available in Store		মন্তব্য Comment
		Yes	No →	Yes	No	
J01	ORS	1	2 →	1	2	
J02	Cotrimoxazole	1	2 →	1	2	
J03	Amoxicillin	1	2 →	1	2	
J04	Nalidixic	1	2 →	1	2	
J05	Chloroquine	1	2 →	1	2	

Sl.	**নাম Name of drugs**	**Available in Pharmacy or examination room**		**Available in Store**		**মন্তব্য Comment**
		Yes	**No →**	**Yes**	**No**	
J06	Fansidar	1	2 →	1	2	
J07	Vitamin A capsule	1	2 →	1	2	
J08	Iron tablet	1	2 →	1	2	
J09	Iron syrup	1	2 →	1	2	
J10	Iron-folate tablet	1	2 →	1	2	
J11	Calcium tablet	1	2 →	1	2	
J12	Paracetamol	1	2 →	1	2	
J13	Diclofenac	1	2 →	1	2	
J14	Misoprostol	1	2 →	1	2	
J15	Mebendazole/ Albendazole	1	2 →	1	2	
J16	Tetracycline	1	2 →	1	2	
J17	Gentian violet	1	2 →	1	2	
J18	Multivitamin minerals	1	2 →	1	2	
J19	Zinc tablet	1	2 →	1	2	
J20	Zinc syrup	1	2 →	1	2	
J21	Injection Ampicillin	1	2 →	1	2	
J22	Injection Quinine	1	2 →	1	2	
J23	Injection Benzylpenicillin	1	2 →	1	2	
J24	Injection Gentamycin	1	2 →	1	2	
J25	Injection. Magnesium Sulphate	1	2 →	1	2	
J26	Sterile water for injection	1	2 →	1	2	
J27	Cholera Saline	1	2 →	1	2	
J28	Ringer's Lactate Solution	1	2 →	1	2	
J29	Tetanus Toxoid (TT) vaccine	1	2 →	1	2	

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Evaluation of accelerating implementation of National Nutrition Services

Antenatal Care Observation Checklist

Client ID: |__|__|__|__|__|__|

A. Information about observatio

Observer's Name and ID: ____________________	☐☐	Date: / / dd mm yy	
Starting time of observation	: hh : mm	**Ending time** of observation	: hh : mm

B. Information about facility identification:

Name and code of facility: ____________________		
Address of the facility: Upazila: ____________	District: ____________ Union: ____________	
Village: ____________	Ward No: Ka/ Kha/ Ga/ Gha	
Type of the facility:	District hospital/ Medical College and hospital........	1
	Upazila Health Complex...	2
	Union Health and Family Welfare Centre	3
	Community Clinic..	4
	Others(specify):	7

C. Information about service provider

Name of the service provider:			☐☐|☐☐
Designation of health service provider	Medical officer		1
	Nurse		2
	FWV		3
	SACMO...		4
	FWA		5
	CHCP..		6
	Others(specify):		7
Sex of the provider Male...........1	EmOC training	Y...... 1	N......2
Female........2	Basic Nutrition Training	Y...... 1	N......2

D. Information about the pregnant woman

Ask the provider the following questions and verify in the ANC register or on woman's ANC card, *Record "98" for Age, Duration of pregnancy, Para, Gravida, LMP or EDD if the response is "Don't know"*	
Name and Reg.no: ____________________	☐☐|☐☐
Age of the woman years	Duration of pregnancy weeks

Is this the patient's 1st, 2nd, 3rd, 4th or more ANC visit for the current pregnancy	1st visit ....1 2nd visit ....2 3rd visit..3 4th or more visit...4 Don't know 8
Para (Total Live birth and Still birth)	LMP / / dd mm yy
Gravida (Total Conception)	EDD / / dd mm yy

E. Observation of ANC session:

Take consent from the provider as well as the pregnant woman. Then closely observe all the activities performed by the providers and fill up the following according to the observation

i. Client history

Record whether the provider asked about (or the client mentioned) any of the following facts		
H01	Women's **AGE**	A
H02	**LAST MENSTRUAL PERIOD** (LMP) of the woman	B
H03	Number of **PRIOR PREGNANCY**(ies)	C
H04	**DURATION** of current pregnancy	D
H05	Any prior **ANTENATAL VISIT/CHECK-UP(s)** during current pregnancy	E
H06	History of **ILLNESS** (allergy, hypertension, diabetes, asthma, heart disease, goitre etc)	F
H07	History of **MEDICINE** use (iron, folic acid, vitamin, calcium, anti-hypertensive etc)	G
H08	None of the above	Y

ii. Physical examination

Record whether the provider performed the following procedures		
E01	**EXPLAINS** the examination to the pregnant woman	A
E02	**WASH HANDS** with soap or use sanitizer prior to examination	B
E03	Measure the **WEIGHT**	C
E04	Measure the **HEIGHT**	D
E05	Examine the **PULSE**	E
E06	Take the **BLOOD PRESSURE**	F
E07	Examine the EYE (conjunctiva) or PALM for **ANEMIA**	G
E08	Examine the EYE (sclera) or tongue for **JAUNDICE**	H
E09	Examine hand or feet or leg for **EDEMA**	I
E10	Examine the abdomen for **FETAL PRESENTATION**	J
E11	Examine the abdomen and measure the **UTERINE HEIGHT**	K
E12	Listen to the abdomen for **FETAL HEART BEAT** with stethoscope	L
E13	Examine the woman's **BREAST**	M
E14	Examine the perineal area or perform a **VAGINAL EXAMINATION**	N
E15	None of the above	Y

iii. Routine test

Record whether the provider A) Asked about B) Performed or C) Referred for the following test		**(A)** **Provider** **ASKED**	**(B)** **Provider** **PERFORMED**	**(C)** **Provider** **REFERRED**	**(D)** **NO action taken**
T01	**PREGNANCY** test	A	B	C	D
T02	Blood test for **HAEMOGLOBIN**	A	B	C	D
T03	Blood **GROUPING AND TYPING**	A	B	C	D
T04	Urine test for **ALBUMIN**	A	B	C	D
T05	Urine test for **GLUCOSE**	A	B	C	D
T06	**ULTRASONOGRAM**	A	B	C	D

iv. Provision of medicine

Record whether the provider gave the woman any of the following medicine		
M01	Provided **IRON-FOLATE TABLET (IFA)**	A
M02	Provided **CALCIUM** tablet	B
M03	Provided **VITAMINS**	C
M04	Provided **MISOPROSTOL**	D

v. General Counselling

Record whether the provider gave the woman any of the following advices or counselling		
C01	Advised to take **REST** for at least 2 hours during daytime	A
C02	Advised to take extra food/**NUTRITIOUS FOOD**	B
C03	Advised to take seasonal/available **FRUITS**	C
C04	Advised to take green/colored **VEGETABLES**	D
C05	Advised to drink **MORE WATER**	E
C06	Advised to take **IODIZED SALT**	F
C07	Advised/Prescribed to take **IFA TABLETS**	G
C08	Explained **HOW TO TAKE IFA** tablets	H
C09	Explained **SIDE EFFECTS of IFA** tablet (stomach ache, diarrhea, constipation etc.)	I
C10	Advised/Prescribed to take **TETANUS TOXOID (TT) VACCINE**	J
C11	Explained the purpose of the **TT vaccine**	K
C12	Advised to maintain **PERSONAL HYGIENE**	L
C13	Advised to avoid **HEAVY WORK**	M
C14	Discuss the risks of **HARMFUL PRACTICES** (drinking alcohol, smoking tobacco)	N
C15	Advised to **AVOID COITUS** in first and last trimester	O
C16	Discussed **FAMILY PLANNING** options for after delivery	P
C17	Discussed the importance of completing **FOUR (4) ANC VISITS**	Q
C18	Advised to seek expert care if any of the **DANGER SIGNS** occurs	R
C19	None of the above	Y

vi. Observation of the provider-patient interaction:

Based on your overall observation of the provider-patient interaction please answer the following			
Q01	Provider **GREETED** the woman with respect as she entered the ANC room	Yes	1
		No.......................................	2
Q02	Informed the patient about the **PROGRESS** of the pregnancy	Yes	1
		No.......................................	2
		Yes	1

Q03	Provider asked If the client had any **QUESTIONS**	No.......................................	2
Q04	Provider used any **VISUAL AIDS** for health education or counselling during the consultation	Yes	1
		No.......................................	2
Q05	Use of a **HEALTH CARD/ ANC CARD** by the provider	Wrote on the previous card......	1
		No ANC card was used...........	2
		Provided a new card................	3
		Don't know	8
Q06	Outcome of the ANC session *(Record the outcome at the time when observation was concluded)*	Goes home	1
		Referred to lab or other provider in same facility	2
		Referred to other facility..........	3

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Evaluation of accelerating implementation of National Nutrition Services

Healthcare provider Interview

A. Information Interveiw

Interviewer's Name and ID: ______________________	☐☐	Date: / / dd mm yy	
Starting time of interview	: hh : mm	**Ending time** of interview	: hh : mm

B. Information about facility identification:

Name and code of facility: ______________________		
Address of the facility:	District: ______________________	☐☐☐
Upazila: ______________________	Union: ______________________	
Village: ______________________	Ward No: Ka/ Kha/ Ga/ Gha	

Type of the facility:	District hospital/ Medical College and hospital........	1
	Upazila Health Complex..	2
	Union Health and Family Welfare Centre	3
	Community Clinic..	4
	Others(specify):	7

C. Information about service provider

Name of the service provider:	______________________	☐☐☐
Designation of health service provider	Medical officer	1
	Nurse	2
	FWV	3
	SACMO..	4
	FWA	5
	CHCP...	6
	Others(specify):______________________	7
Sex of the provider Male............1 Female........2	Age of the provider (in years)	
Maximum availed education	Completed years of schooling if less than SSC.............	1
	SSC..	2
	HSC..	3
	Diploma	4
	Bachelor and/or honors..	5
	Masters or Higher degree..	6
How long have you been working in this facility? *Record in complete year, if less than 1 year record in complete months*	Year .... _____	
	Month .... ____	

D. সেবাদানকারীর ট্রেনিং তথ্য Information about Training of health care providers

Q.	Questions	Responses		Skip
D01	আপনি কি কখনও পুষ্টি বিষয়ক কোন ধরনের ট্রেনিং পেয়েছেন? Did you ever receive any training on nutrition?	Yes...	1	
		No	2	→D08
D02	আপনি পুষ্টি বিষয়ক যে ট্রেনিংগুলো পেয়েছেন তার নাম বলতে পারেন? (প্রোব করতে হলে নির্দিষ্ট ট্রেনিং এর নাম না বলে , ট্রেনিং এর মূলবিষয় গুলো উলে-খ Can you mention the names of the training that you have received?	Basic Nutrition Training.....................................	A	
		IYCF training..	B	
		Training on growth monitoring	C	
		Management of SAM	C	
		Management of MAM	D	
		Others ________________________________	X	

E. স্বাস্থ্যসেবাদানকারীর পুষ্টি বিষয়ক জ্ঞান Knowledge of service provider about nutrition

No.	Question	Response	Code
গর্ভকালীন পুষ্টি বিষয়ক জ্ঞান/ Knowledge about nutrion during pregancy			
E04.	একজন গর্ভবতী মা গর্ভকালীন সময়ে কি কি খাবার বেশী খাওয়া উচিৎ? What are the food needs to be consumed more during pregnancy (multiple choices)	Animal source food (Egg, Milk, Liver).................................A Green leafy vegetable ....B Seasonal Fruits .... C Others ____ X Don't know ....Y	
প্রসব পূর্ববর্তী পুষ্টি সংক্রান্ত কিকি সেবা এ কেন্দ্র থেকে দেয়া উচিত বলে মনে করেন? What nutrition services do you expect to provide at this facility? **Please DO NOT prompt**			
F01.	Iron-folate distribution during pregnancy		A
F02.	Calcium supplementation		B
F03.	Multiple micronutrient supplementation		C
F04.	Diagnosis and mangement of Anemia		D
F05.	Anthropomery/ Measurement of height and weight		E
F06.	Nutritional counselling of pregnant women		F
F07.	Counsel pregnant women for using iodized salt in cooking		G
F08.	Counselling on early initiation of breastfeeding		H
F09.	Counsel to practice exclusive breast-feeding after delivery		I
F10.	Mentioned None		Y

F. তত্ত্বাবধায়ন Supervision

	Question	Response	Skip
H01.	আপনার সরাসরি সুপারভাইজার কে? Who is your DIRECT supervisor?	Civil Surgeon/Superintendent................................11 DDFP..12 UHFPO...13 RMO...14 Medical Officer..15 MO-MCH...16 MO-Clinic..17 HI ....18 AHI ....19 FPI...20 Others ______________________________________97	
H02.	গত ৬ মাসে কেউ কি এসে আপনার কাজের সুপারভিশন করেছিল? In last 6 months did anybody come for supervision of your work in facility?	Yes...1 No...2 Don't Know 8	

icddr,b

Evaluation of accelerating implementation of National Nutrition Services

Exit-interview of Client of Antenatal Care

Client ID: |__|__|__|__|__|__|

A. Information about interview

Interviewer's Name and ID: ______________________________	☐☐	Date: / / dd mm yy

Starting time of interview	: hh : mm	**Ending time** of interview	: hh : mm

B. Information about facility identification:

Name and code of facility: ______________________________	
Address of the facility:	District: ____________________ ☐☐☐
Upazila: ____________________	Union: ____________________
Village: ____________________	Ward No: Ka/ Kha/ Ga/ Gha

Type of the facility:	District hospital/ Medical College and hospital........	1
	Upazila Health Complex...	2
	Union Health and Family Welfare Centre	3
	Community Clinic...	4
	Others(specify):	7

C. Information about pregnant woman:

মহিলার নাম ও রেজি নং Name and registration no.	______________________________	
বয়স Age ________বছর years	গর্ভধারণ কাল Gestational age	___________সপ্তাহ Weeks
শেষ মাসিকের তারিখ Date of last menustral period	/ / দিন (day)/ মাস (month) /বছর (year)	
আপনার এই গর্ভাবস্থায় আজকে নিয়ে মোট কতবার গর্ভকালীন সেবা নিতে এসেছেন? Including today how many times have you received antental care service?	1st Visit ভিজিট..	1
	2nd Visit ভিজিট...	2
	3rd Visit ভিজিট	3
	4th Visit অথবা তার বেশী ভিজিট..........................	4
	Don't know/can't remember জানা/মনে নেই..........	8
আপনার লেখাপড়া সর্বোচ্চ কতদূর? যদি ১ বছরের কম হয় তবে "০০" লিখুন How many years of education do you have? Write 00 if less than 1 year	ক্লাস Class/years	_______
	স্কুল বা মাদ্রাসা এমন কোন প্রাতিষ্ঠানিক শিক্ষা নেই No formal/institutional education	99

Questionnaires for Paper 2 in Chapter 4

1. Pregnancy history module
2. Household characteristics module
3. Respondent’s background module
4. Antenatal care module
5. Iron and Folic Acid (IFA) supplementation during pregnancy module

icddr,b

Demonstration programme to improve maternal nutrition service delivery including multiple micronutrient supplementation (MMS) through public health ANC platforms - A community based cluster randomized control trial

Household Survey

(Baseline)

	নাম Name	কোড Code
জেলা District		☐☐
উপজেলা Sub-district		☐☐
ইউনিয়ন Union		☐☐
ক্লাস্টার নং Cluster number		☐☐☐☐
গ্রামের নাম ও কোড Name of village & code		☐☐☐☐
Index নংও কোড Index # & code		☐☐☐☐
বাড়ির নাম Name of the house		▨
খানা প্রধানের নাম ও খানা নং Name of household head & HH #		☐☐☐☐
সম্প্রতি প্রসবকারীমহিলার নাম, ফোন নাম্বার এবং সিরিয়াল নং Name&contact number and Serial number of RDW		☐☐

সাক্ষাতকার শুরু হবার সময়:
Interview starting time:

|______|______| : |______|______|
ঘন্টা(Hour)মিনিট (Min)

সাক্ষাতকার শেষ করার সময়:
Interview end time:

|______|______| : |______|______|
ঘন্টা (Hour)মিনিট (Min)

<table>
<tr><th colspan="6">Interviewer's visit and status</th></tr>
<tr><td></td><td>Visit 1</td><td>Visit 2</td><td>Visit-3</td><td colspan="2">Final Visit</td></tr>
<tr><td>Date</td><td>__ __/ __ __/ __ __</td><td>__ __/ __ __/ __ __</td><td>__ __/ __ __/ __ __</td><td colspan="2">Date __ __/ __ __/ __ __</td></tr>
<tr><td>Name of Interviewer</td><td></td><td></td><td></td><td>(Interviewer code)</td><td>|_____|_____|_____|</td></tr>
<tr><td>Result code*</td><td>|_____|_____|</td><td>|_____|_____|</td><td>|_____|_____|</td><td>Result code*</td><td>|_____|_____|</td></tr>
<tr><td>Next visit</td><td>Date
Time</td><td>Date
Time</td><td>▨</td><td>Total # of visit</td><td>|_____|</td></tr>
</table>

Result codes: 01. Interview Complete;02. No household member or competent respondent were present at home at time of household visit/ RDW is absent; 03. Interview cancelled/Or partly completed; 04. Refused to give interview; 08. Others

____

<table>
<tr><th>Supervision</th><th>Name</th><th>Code</th><th>Date</th></tr>
<tr><td>Reviewed by FRA</td><td></td><td>|____|____|</td><td>|____|____|-|____|____|-|____|____|</td></tr>
<tr><td>Checked by FRO</td><td></td><td>|____|____|</td><td>|____|____|-|____|____|-|____|____|</td></tr>
</table>

Section A: Pregnancy History

সাক্ষাতকারগ্রহনকারী: ১৫ই মার্চ ২০২০ থেকে ১৫ই সেপ্টেম্বর ২০২০এর মধ্যে গর্ভশেষ হয়েছে এমন মহিলা তার সারা জীবনে যতবার গর্ভবতী হয়েছেন তার সবগুলো সম্পর্কে জিজ্ঞাসা করতে হবে সুতরাং উত্তরাদাতাকে সবগুলো গর্ভ সম্পর্কে ভালো ভাবে বুঝিয়ে তার পর প্রশ্ন জিজ্ঞাসা করুন? আপনি জীবনে যতবার গর্ভবতী হয়েছেন, এবার আমি তার প্রত্যেকটির ব্যাপারে আলোচনা করতে চাই। সেই গর্ভের বা গর্ভাবস্থাগুলো জীবিত শিশু বা মৃতশিশু বা গর্ভ/গর্ভসমূহ মেয়াদের আগে শেষ হয়ে যাওয়া, যাই হোক না কেন সবগুলো সম্পর্কেই আলোচনা করতে চাই। আপনার শেষ গর্ভাবস্থা দিয়েই আলোচনা শুরু করতে চাই। *[যমজ বা একই সাথে হওয়া তার চেয়ে বেশী সংখ্যক সন্তানের ক্ষেত্রে আলাদা লাইন ব্যবহার করুন]* Now I would like to talk to you about all of your pregnancies, whether the child was born alive, born dead or the pregnancy was lost before full-term, which is as a miscarriage or an abortion. (I would like to start with your last pregnancy. Record Twins and Triplets on separate lines.) ***Total number of outcome (live birth, Still Birth, miscarriage and Abortion.) আপনার জীবনের মোট গর্ভফলাফল (জীবিত জন্ম, মৃত জন্ম, গর্ভপাত এবং গর্ভনষ্ট) \|___\|___

আপনার সর্বশেষ/পূর্ববর্তী গর্ভাবস্থার কথা চিন্তা করুন	এই গর্ভে কয়টি বাচ্চা ছিল? এক বা একাধিক (যেমন: যমজ)? **Single/multiple Pregnancy**	কোন বছরের কোন মাসের কত তারিখে এই গর্ভাবস্থা শেষ হয়েছিল? **Date of pregnancy Outcome**	এই গর্ভাবস্থার ফলাফল কি ছিল? জীবিত শিশু নাকি মৃতশিশু নাকি মেয়াদের আগে (২৮ সপ্তাহ) নষ্ট হওয়া গর্ভ যেমন: গর্ভনষ্ট বা গর্ভপাত? **Status of pregnancy Outcome**	জন্মের পর বাচ্চাটি কি কেঁদেছিল বা নড়াচড়া করেছিল বা শ্বাসপ্রশ্বাস নিয়েছিল? **Cry/move/breathe after birth**	বাচ্চাটির কি নাম দেয়া হয়েছিল ? *[যদি নাম না থাকে তবে XX লিখুন]* **Name of the child**	(নাম) কি মেয়ে না ছেলে? **Sex**	(নাম) কি এখনও জীবিত? **Status of the child (alive or dead)**	যদি জীবিত হয়: সর্বশেষ বা গত জন্মদিনে (নাম) এর বয়স কত ছিল? *[পূর্ণ বছরের হিসাবে বয়স লিখুন। 1 বছরের কম হলে 00 লিখূন।]*	যদি মৃত হয়: মৃত্যুর সময় তার বয়স কত ছিল? *[দুই মাস (60 দিন) এর কম হলে দিনে, পাঁচ বছরের কম হলে মাসে, পাঁচ বছরের বেশী হলে বছরে লিখুন]*	এই গর্ভ এবং এর আগের গর্ভের মাঝখানে অন্য কোনো গর্ভ শেষ হয়েছিল কি? মৃত জন্ম. মেয়াদের আগে নষ্ট বা বাচ্চা জন্মের পর মারা গিয়ে থাকলেও তাকে অন্তর্ভুক্ত করুন।
A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11
01	একক Single.........1 একাধিক Multiple 2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to next row) ↵	হ্যাঁ Yes ....1 না No ....2 (go to next row) ↵	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A10) ↵	বয়স AGE |___|___| (go to next row)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___|	হ্যাঁ..............1 জন্ম যোগ করুন ↵ না...............2 পরবর্তী বাচ্চায় যান ↵
02	একক Single.........1 একাধিক Multiple 2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to next row) ↵	হ্যাঁ Yes ....1 না No ....2 (go to next row) ↵	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A10) ↵	বয়স AGE |___|___| (go to next row)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___|	হ্যাঁ..............1 জন্ম যোগ করুন ↵ না...............2 পরবর্তী বাচ্চায় যান ↵
03	একক Single.........1 একাধিক Multiple 2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to next row) ↵	হ্যাঁ Yes ....1 না No ....2 (go to next row) ↵	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A10) ↵	বয়স AGE |___|___| (go to next row)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___|	হ্যাঁ..............1 জন্ম যোগ করুন ↵ না...............2 পরবর্তী বাচ্চায় যান ↵
04	একক Single.........1 একাধিক Multiple 2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to next row) ↵	হ্যাঁ Yes ....1 না No ....2 (go to next row) ↵	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A10) ↵	বয়স AGE |___|___| (go to next row)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___|	হ্যাঁ..............1 জন্ম যোগ করুন ↵ না...............2 পরবর্তী বাচ্চায় যান ↵

আপনার সর্বশেষ/পূর্ববর্তী গর্ভাবস্থার কথা চিন্তা করুন	এই গর্ভে কয়টি বাচ্চা ছিল? এক বা একাধিক (যেমনঃ যমজ)? **Single/multiple Pregnancy**	কোন বছরের কোন মাসের কত তারিখে এই গর্ভাবস্থা শেষ হয়েছিল? **Date of pregnancy Outcome**	এই গর্ভাবস্থার ফলাফল কি ছিল? জীবিত শিশু নাকি মৃতশিশু নাকি মেয়াদের আগে (২৮ সপ্তাহ) নষ্ট হওয়া গর্ভ যেমনঃ গর্ভনষ্ট বা গর্ভপাত? **Status of pregnancy Outcome**	জন্মের পর বাচ্চাটি কি কেঁদেছিল বা নড়াচড়া করেছিল বা শ্বাসপ্রশ্বাস নিয়েছিল? **Cry/move/breathe after birth**	বাচ্চাটির কি নাম দেয়া হয়েছিল ? *[যদি নাম না থাকে তবে **XX** লিখুন]* **Name of the child**	(নাম) কি মেয়ে না ছেলে? **Sex**	(নাম) কি এখনও জীবিত? **Status of the child (alive or dead)**	যদি জীবিত হয়ঃ সর্বশেষ বা গত জন্মদিনে (নাম) এর বয়স কত ছিল? *[পূর্ণ বছরের হিসাবে বয়স লিখুন। **1** বছরের কম হলে **00** লিখুন।]*	যদি মৃত হয়ঃ মৃত্যুর সময় তার বয়স কত ছিল? *[দুই মাস (**60** দিন) এর কম হলে দিনে, পাঁচ বছরের কম হলে মাসে, পাঁচ বছরের বেশী হলে বছরে লিখুন]*	এই গর্ভ এবং এর আগের গর্ভের মাঝখানে অন্য কোনো গর্ভ শেষ হয়েছিল কি? মৃত জন্ম. মেয়াদের আগে নষ্ট বা বাচ্চা জন্মের পর মারা গিয়ে থাকলেও তাকে অন্তর্ভুক্ত করুন।
A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11
05	একক Single.........1 একাধিক Multiple2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to next row)	হ্যাঁ Yes ....1 না No ....2 (go to next row)	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A10)	বয়স AGE |___|___| (go to next row)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___|	হ্যাঁ..............1 জন্ম যোগ করুন না...............2 পরবর্তী বাচ্চায় যান
06	একক Single.........1 একাধিক Multiple2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to next row)	হ্যাঁ Yes ....1 না No ....2 (go to next row)	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A10)	বয়স AGE |___|___| (go to next row)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___|	হ্যাঁ..............1 জন্ম যোগ করুন না...............2 পরবর্তী বাচ্চায় যান
07	একক Single.........1 একাধিক Multiple2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to next row)	হ্যাঁ Yes ....1 না No ....2 (go to next row)	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A10)	বয়স AGE |___|___| (go to next row)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___|	হ্যাঁ..............1 জন্ম যোগ করুন না...............2 পরবর্তী বাচ্চায় যান
08	একক Single.........1 একাধিক Multiple2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to next row)	হ্যাঁ Yes ....1 না No ....2 (go to next row)	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A10)	বয়স AGE |___|___| (go to next row)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___|	হ্যাঁ..............1 জন্ম যোগ করুন না...............2 পরবর্তী বাচ্চায় যান
09	একক Single.........1 একাধিক Multiple2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to next row)	হ্যাঁ Yes ....1 না No ....2 (go to next row)	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A10)	বয়স AGE |___|___| (go to next row)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___|	হ্যাঁ..............1 জন্ম যোগ করুন না...............2 পরবর্তী বাচ্চায় যান
10	একক Single.........1 একাধিক Multiple2 জানি না DK............9	Day..............|___|___| Month.........|___|___| Year|___|___|___|___|	জীবিত জন্ম Live birth...........1 (go to A06) মৃত জন্ম. Still Birth......... 2 মেয়াদের আগে নষ্ট Abortion . 3 (go to A12)	হ্যাঁ Yes ....1 না No ....2 (go to A12)	নাম Name	ছেলে Boy...... 1 মেয়ে Girl 2	হ্যাঁ Yes ....1 না No ....2 (go to A12)	বয়স AGE |___|___| (যদি আর কোন গর্ভের ইতিহাস না থাকে তবে SKIP to A12)	দিন Days.......1 |___|___| মাস Months...2 |___|___| বছর Years.....3 |___|___| (যদি আর কোন গর্ভের ইতিহাস না থাকে তবে skip to A12	হ্যাঁ..............1 জন্ম যোগ করুন না...............2 যদি আর কোন গর্ভের ইতিহাস না থাকে তবে skip to A12

Section B: Household Characteristics

SI	QUESTIONS & FILTERS	CODING CATEGORIES	SKIP
B. খানার বৈশিষ্ট্য **Household characteristics** **এই সেকশনে উত্তরদাতা এবং একই খানার অন্যান্য সদস্যদের কিছু তথ্য সম্বন্ধে আলোচনা করা হয়েছে** **This section contains some information of the respondent and other members of the same household**			
B01	আপনার খানায় সাধারণত কতজন লোক বাস করে? অর্থাৎ আপনাদের খানার মোট সদস্য সংখ্যা কতজন? How many members usually live in your household? Please give the number of household member	**খানার মোট সদস্য সংখ্যা..** Total number of household members	
B02	আপনাদের খানায় কয়টি শোবার রুম আছে? How many rooms are there in your house for household members to sleep in?	শোবার কক্ষের সংখ্যা Rooms.....................|_____|_____|	
B03	[পর্যবেক্ষণ করুন] বসত ঘরের ছাদের প্রধান নির্মাণ সামগ্রী? [Observe] Which principle material is the roof of the largest structure of the household made of?	স্বাভাবিক ছাদ Natural roofing ছাদ নেই No roof ....11 খড়/ছন/তাল পাতা Thatch/palm leaf ....12 ঘাসেরআস্তরণ Grass ceiling......................................13 কাঁচা ছাদ Rudimentary roof পাটি PALM/BAMBOO..................................... 21 বাঁশ Bamboo ....22 কাঠের তক্তা Wood planks ....23 কার্ডবোর্ড Cardboard ....24 পরিপূর্ন ছাদ Finished Roofing টিন Tin ....31 কাঠ Wood..32 সিরামিক টাইলস্ Ceramic Tiles ....33 সিমেন্ট Cement ....34 টালি Roofing Shingles...35 অন্যান্য Other ....98 নির্দিষ্ট করুন(Specify)	
B04	[পর্যবেক্ষণ করুন] বসত ঘরের দেয়ালের প্রধান নির্মাণ-সামগ্রী [Observe] Which principle material is the wall of the largest structure of the household made of?	স্বাভাবিক দেয়াল Natural Walls দেয়াল নাই No wall...11 পাটকাঠি/তাল গাছ/গাছের গুড়ি Cane/ Palm/Trunks..........................12 মাটি Dirt .... 13 প্রাথমিক পর্যায়ের দেয়াল Rudimentary Walls মাটি সহ বাঁশ Bamboo with mud .... 22 মাটিসহ পাথর Stone with mud .... 23 প্লাইউড Plywood .... 24 কার্ডবোর্ড Cardboard ....25 পরিপূর্ণ দেয়াল Finished Walls টিন Tin .... 31 সিমেন্ট Cement .... 32 চুনা পাথর/সিমেন্ট Stone with Lime/Cement.................................... 33 ইট Bricks.. 34 কাঠের তক্তা Wood Planks/Shingles................................... 35 অন্যান্য Other.. 98 নির্দিষ্ট করুন(Specify)	

SI	QUESTIONS & FILTERS	CODING CATEGORIES	SKIP
B05	[পর্যবেক্ষণ করুন] বসত ঘরের মেঝের প্রধান নিমাণ-সামগ্রী [Observe] Which principle material is the floor of the largest room made of?	স্বাভাবিক মেঝে Natural Floor মাটি/বালু Mud/Sand ... 11 প্রাথমিক পর্যায়ের মেঝে Rudimentary Floor কাঠের তক্তা Wood Planks ... 21 তাল গাছ/বাঁশ Palm/Bamboo ... 22 পরিপূর্ণ মেঝে Finished Floor নকশা কাটা কাঠের পাটাতন/পলিশকৃত কাঠ Parquet or Polished Wood ... 31 সিরামিক টাইলস্/মোজাইক Ceramic Tiles ... 32 সিমেন্ট Cement ... 33 অন্যান্য Other ... 98 নির্দিষ্ট করুন (Specify)	
B06	আপনার খানার সদস্যদের খাবার পানির প্রধান উৎস কি? What is the main source of drinking water for members of your household?	পাইপের পানি Piped water ঘরের মধ্যে পাইপের পানি Piped into dwelling... 11 বাড়ির চত্বরে/আঙ্গিনায় পাইপ Piped to yard/plot... 12 সরকারি (পাবলিক) ট্যাপ/স্থায়ী পাইপ Public Tap/standpipe... 13 টিউবওয়েল (নলকূপ)Tube well or borehole... 14 কূপ/ইদারা Dug well সংরক্ষিত কূপ/ইদারা Protected well ... 31 অসংরক্ষিত কূপ/ইদারা Unprotected well ... 32 ঝরণার পানি Water from spring সংরক্ষিত ঝরণার পানি Protected spring ... 41 অসংরক্ষিত ঝরণার পানি Unprotected spring... 42 সংগৃহিত বৃষ্টির পানি Rainwater... 43 ভূ-পৃষ্ঠের পানি (নদী, খাল, পুকুর লেক ইত্যাদি) Surface water (river/dam/Lake/pond/stream/ canal/ ... 44 বোতলের পানি Bottled water... 45 অন্যান্য Other ... 98 নির্দিষ্ট করুন (Specify)	
B07	আপনার খানার সদস্যরা সাধারণত কোন ধরনের পায়খানা ব্যবহার করে? What kind of toilet facility does your household member's usually use?	ফ্ল্যাশ ল্যাট্রিন Flush or pour flush toilet ফ্ল্যাশ করে পাইপের মাধ্যমে অপসারণ Flush to piped sewer system... 11 ফ্ল্যাশ করে ট্যাংকে ধারণ Flush to septic tank... 12 ফ্ল্যাশ করে গর্তে ধারণ Flush to pit latrine... 13 ফ্ল্যাশ করে অন্য কোথাও অপসারণ Flush to somewhere else ... 14 ফ্ল্যাশ করে কোথায় অপসারিত হয় তা জানিনা Flush, don't know where ... 15 পিট ল্যাট্রিন Pit latrine বায়ু চলাচলের ব্যবস্থাসহ উন্নতমানের পিট ল্যাট্রিন Ventilated improved pit latrine... 21 পিট ল্যাট্রিন (স্লাব সহ) Pit latrine with slab ... 22 পিট ল্যাট্রিন (স্লাব বিহীন)/ খোলা গর্ত Pit latrine without slab/open pit... 23 বাকেট ল্যাট্রিন Bucket toilet... 24 খোলা /স্লাব ল্যাট্রিন Hanging toilet/hanging latrine... 25 ল্যাট্রিন নাই/ঝোপ-ঝাড়/মাঠ No facility/bush/field... 26	

SI	QUESTIONS & FILTERS	CODING CATEGORIES	SKIP
		অন্যান্য Other .... 98 নির্দিষ্ট করুন (Specify)	
B10	আপনার খানায় রান্নার জন্য প্রধানতঃ কোন ধরনের জ্বালানি ব্যবহার করা হয়? What type of fuel do you mainly use in your household for cooking?	বিদ্যুৎ Electricity .... 01 তরল গ্যাস Liquid gas (LPG).................................. 02 প্রাকৃতিক গ্যাস Natural gas....................................... 03 বায়োগ্যাস Bio gas.. 04 কেরোসিন Kerosene.. 05 কয়লা/লিগনাইট Coal/ Lignite.................................. 06 চারকৌল Charcoal... 07 কাঠ /বাঁশ Wood/Bamboo....................................... 08 ভুষি/তুষ/ঘাস Roughage/ Husk/ Grass...................... 09 ফসলের অবশিষ্টাংশ (খড়/কুটা/পাতা) (Crops remnants (Straw/ leaves).......................... 10 গোবর Cow dung……………….………….......... 11 খানায় কোন রান্না হয় না No food cooked in the household……………..………….............. 12 অন্যান্য Other…………………………………………...98 নির্দিষ্ট করুন (Specify)	
B11	আপনার খানার রান্না কি সাধারণতঃ আপনারা যে ঘরে বসবাস করেন সেই ঘরে করা হয় নাকি থাকার ঘর থেকে আলাদা ঘরে, নাকি বাহিরে কোথাও করা হয়? Is the cooking usually done in the house, in a separate building, or outdoors?	যে ঘরে বাসকরেন/ঘুমান living /sleeping room........ 01 সম্পূর্ণ পৃথকবিল্ডিং/ ঘরে Separate building/room..... 02 বাহিরে/ খোলাজায়গায় in an open place.................. 03 অন্যান্য Others(Specify)..................................... 98 (নির্দিষ্ট করুন)	2/03/98 skip to B13
B12	আপনারা রান্নার জন্য কি পৃথক রুম ব্যবহার করেন? Do you use a separate room for cooking?	হ্যাঁ Yes ....1 না No 2	
B13	আপনার খানায় বা খানার কোন সদস্যের নিম্নে বর্ণিত জিনিস গুলো আছে কি? যেমনঃ Does your household have the following materials? বিদ্যুৎ Electricity? রেডিও A radio? টেলিভিশন A television? মোবাইল ফোন A mobile telephone?** টেলিফোন A non-mobile telephone? রেফ্রিজারেটর A refrigerator? আলমারি/ওয়াড্রব An almirah/wardrobe? টেবিল A table? চেয়ার A chair? ইলেকট্রিক পাখা An electric fan? ডিভিডি/ভিসিডি পে-য়ার A DVD/VCD player? পানির পাম্প A water pump? আই পি এস/ জেনারেটর Ips/generator? এয়ার কনডিসনার Air conditioner?	হ্যাঁ না বিদ্যুৎ Electricity .... 1 2 রেডিও Radio.. 1 2 টেলিভিশন Television....................................... 1 2 *মোবাইল ফোন Mobile telephone .... 1 2 টেলিফোন Non-mobile telephone....................... 1 2 রেফ্রিজারেটর Refrigerator.................................. 1 2 আলমারি/ওয়াড্রব Almirah/wardrobe..................... 1 2 টেবিল Table... 1 2 চেয়ার Chair... 1 2 ইলেকট্রিক পাখা Electric fan................................ 1 2 ডিভিডি/ভিসিডি পে-য়ারউঠউ/VCD Player............... 1 2 পানির পাম্প Water pump.................................... 1 2 আই পি এস/ জেনারেটর Ips/generator…………… 1 2 এয়ার কন্ডিশনার Air conditioner…………………. 1 2 কম্পিউটার / ল্যাপটপ Computer/laptop…………. 1 2 ট্রাক্টর/ধানমাড়াইযন্ত্র Tractor/ Paddy thresher …….. 1 2 সৌরবিদ্যুৎ solar light …………………………… 1 2	

SI	QUESTIONS & FILTERS	CODING CATEGORIES	SKIP
	কমপিউটার/ ল্যাপটপ Computer/laptop? ট্রাক্টর/ধানমাড়াইযন্ত্র Tractor/ Paddy thresher? সৌরবিদ্যুৎ Solar light?		
*এ মোবাইল ফোন এর উত্তর ১/ হ্যাঁ হলে B14 – B15 জিগ্যেস করুন, নতুবা B16 এ চলে যান. If the response to mobile phone is yes the ask B14 - B15, otherwise go to B16.			
B14	আপনার খানায় কি ধরনের মোবাইল ফোন আছে? What type of mobile phone do the household possesses?	সাধারণ মোবাইল ফোন Ordinary mobile phone............. 1 স্মার্ট ফোন Smart phone................................. 2 উভয় প্রকার Both.. 3	
B15	এই মোবাইল ফোনটি / ফোনগুলো কার? Whoom does/do the mobile phone/ phones belong to?	আমার নিজের Women herself................................. A আমার স্বামীর Husband.. B আমার মা / শাশুড়ির Mother/Mother in Law..................... C আমার বাবা/ শ্বশুii Father/Father in Law...................... D ছেলে/ মেয়ে জামাইয়ের Son/ Son in law........................ ... E মেয়ে/ ছেলের বউয়ের Daughter/ Daughter in Law................. F অন্যান্য Others.. X	
B16	আপনার খানায় বা খানার কোন সদস্যের নিম্নে বর্ণিত জিনিসগুলো আছে কি? Does your household/ any member in your household own the following things? কার/ ট্রাক/ মোটর বাস? Car / truck/ motorbus? অটোবাইক/টেম্পু/ সিএনজি? Autobike / Tempu/ CNG? রিক্সা? Rickshaw? বাই সাইকেল? Bi-cycle? মোটর সাইকেল/স্কুটার? Motor cycle/ Scooter? ইঞ্জিনচালিত নৌকা/ট্রলার Boat with engine? ইঞ্জিনবিহীন নৌকা/ট্রলার/ Boat without engine?	হ্যাঁ না কার/ ট্রাক/ মোটর বাস Car / truck/ motorbus ....1..........2 অটোবাইক/টেম্পু/সিএনজি Autobike / Tempu/ CNG ....1..........2 রিক্সা/ Rickshaw....................1..........2 বাই সাইকেল/Bi-cycle ....1..........2 মোটর সাইকেল/স্কুটার Motor cycle/ Scooter .... 1..........2 ইঞ্জিনচালিত নৌকা/ট্রলার Boat with engine .... 1..........2 ইঞ্জিনবিহীন নৌকা/ট্রলার/ Boat without engine..... 1..........2	
B17	এই খানায় নির্দিষ্ট কোন গৃহপালিত পশু, যেমন, গরু-মহিষ, ছাগল-ভেড়া, হাঁস-মুরগি ইত্যাদি আছে কি? Does this household own any livestock, herds, other farm animals, or poultry?	হ্যাঁ Yes ....1 না No 2	2→ B19
B18	আপনার খানায় নিচের প্রাণীগুলোর মধ্যে নিজস্ব কতগুলো আছে? যদি না থাকে, লিখুন '00' যদি ৯৫ এর বেশী থাকে তাহলে লিখুন '95' যদি জানা না থাকে, লিখুন '99' ষাঁড় অথবা মহিষ? দুগ্ধবতী গরু? ছাগল অথবা ভেড়া? মুরগী অথবা হাঁস? How many of the following animals does this household own? If none, enter '00' If more than 95, enter '95' If unknown, enter '99'	ষাঁড় অথবা মহিষ? Bulls/Buffalos .... |___|___| দুগ্ধবতী গরু? Milky cows/ Bulls ..... |___|___| ছাগল অথবা ভেড়া? Goats/Sheep .... |___|___| মুরগী অথবা হাঁস? Chickens/Duck...... |___|___|	

SI	QUESTIONS & FILTERS	CODING CATEGORIES	SKIP
	Bulls or Buffalos? Cows? Goats or sheep? Chicken or ducks?		
B19	আপনার খানার বসতভিটা আছে কি? Does your household own any homestead? যদি না' হয় প্রোব করুন: আপনার খানার অন্য কোথাও কোন বসতভিটা আছে কি? If 'no,' probe: Does your household own any homestead in any other places?	হ্যাঁ Yes ....1 না No 2	
B20	আপনাদের কোন জমি আছে কি? (খানার বসতভিটা ছাড়া অন্য কোন জমি)? Does your household own any land (other than the homestead land)?	হ্যাঁ Yes ....1 না No 2	2→ B22
B21	আপনার এই খানায় (বসতভিটা ছাড়া) কি পরিমান জমি আছে? (পরিমাণ)-------------- একক-----------(নির্দিষ্ট করুন) ৯৫ একর বা তার বেশী পরিমাণ হলে ৯৫ রেকর্ড করুন। যদি জমির পরিমাণ সঠিক জানা না থাকে তাহলে ৯৯ লিখুন। How much land does your household own (other than the homestead land)? (Amount)___________________ Unit____________________ (specify) If 95 acres or more record 95 If amount not known exactly then record 99	|___|___| . |___|___| একর শতাংশ Acres Decimals 95 একর বা তার বেশী 95 acres or more record ....95 জানা নেই Do not know......................................99	

Section C: Respondents Background

<table>
<tr><td colspan="4">C. পটভূমি/ কিছু গুরুত্বপূর্ণ তথ্য Background information of mothers
এই সেকশনে উত্তরদাতা মহিলা এবং তার স্বামীর কিছু গুরুত্বপূর্ণ তথ্য উল্লেখ করা হয়েছে। This section contains some background information of the respondent (woman) and her husband. তথ্য সংগ্রহকারি- মহিলাকে বলুন আমি এখন আপনার এবং আপনার স্বামী সম্পর্কে কিছু প্রশ্ন করব।
[For Data Collector- I would like to ask some question about you and your husband]</td></tr>
<tr><td>C01</td><td>আপনার কি জাতীয় পরিচয় পত্র আছে?
Do you have National ID card?</td><td>হ্যাঁ Yes..1
না No ....2</td><td>2→C03</td></tr>
<tr><td>C02</td><td>আমাকে কি আপনার জাতীয় পরিচয় পত্র দেখাবেন?
Can you please show me your National ID card?</td><td>Observed সাক্ষাৎকারগ্রহণকারী কার্ড দেখেছেন..........................1
Not Observed সাক্ষাৎকারগ্রহণকারী কার্ড দেখেননি...................2</td><td></td></tr>
<tr><td>C03</td><td>আপনি কোন সালের কোন মাসে জন্ম গ্রহণ করেছিলেন? [মায়ের সাথে যাচাই করুন এবং রেকর্ড করুন] মাস জানা না থাকলে ৯৯ বৃত্তায়িত করুন In what month and year were you born? [Probe and record]
In case of Months, If do not know, circle 99</td><td>মাস Month.......................................|____|____|
বছর Year...............................|____|____|____|____|
জানা নাই Do not know ....99</td><td></td></tr>
<tr><td>C04</td><td>বর্তমানে আপনার বয়স কত? How old were you at your last birthday?[Compare and Correct 2.01 and/or 2.02 if inconsistent]</td><td>বয়স (পূর্ণ বছরে) Age in completed Years |____|____|</td><td></td></tr>
<tr><td>C05</td><td>আপনি কি বর্তমানে বিবাহিতা, বিচ্ছিন্না, পরিত্যক্তা, তালাকপ্রাপ্তা, বিধবা? Are you now married, separated, deserted, divorced, widowed, or have you never been married?</td><td>বিবাহিতা Currently Married.................................. 1
বিচ্ছিন্না Separated 2
পরিত্যক্তা Deserted 3
তালাকপ্রাপ্তা Divorced 4
বিধবা Widowed... 5</td><td></td></tr>
<tr><td>C06</td><td>আপনি কি কখনো স্কুলে/কলেজে বা মাদ্রাসায় লেখাপড়া করেছেন? Have you ever attended school/madrasha?</td><td>হ্যাঁ Yes... 1
না No...2</td><td>2→ C12</td></tr>
<tr><td>C07</td><td>আপনি সর্বশেষ স্কুল/কলেজে নাকি মাদ্রাসায় লেখাপড়া করেছেন?What type of school have you last attended?</td><td>স্কুল School 1
মাদ্রাসা Madrasha ....2</td><td></td></tr>
<tr><td>C08</td><td>আপনি শিক্ষার সর্বশেষ কোন স্তর পর্যন্ত লেখাপড়া করেছেন, প্রাথমিক বিদ্যালয়, মাধ্যমিক বিদ্যালয়, কলেজ নাকি বিশ্ববিদ্যালয়?What is the highest level of school you attended: primary, secondary, or higher?</td><td>প্রাথমিক Primary.. 1
মাধ্যমিক Secondary 2
উচ্চতর (কলেজ বা বিশ্ববিদ্যালয়) Higher....................3</td><td></td></tr>
<tr><td>C09</td><td>আপনি সর্বোচ্চ কোন শ্রেনী/ ক্লাশ পাশ করেছেন? (১ম শ্রেনীর নিচে হলে ০০ লিখুন)What is the highest class you completed at that level?[If completed less than one year at that level, Record ‘00’]</td><td>শ্রেণী/ ক্লাশ Class |____|____|</td><td></td></tr>
<tr><td>C10</td><td colspan="2">CHECK C08: C08 নং প্রশ্ন যাচাই করুন:
Primary প্রাথমিক ☐ ↓
Secondary or Higher মাধ্যমিক বা তার উপরে ☐ →</td><td>C12</td></tr>
</table>

C11	দয়া করে আমাকে এই বাক্যটি পরে শোনান। উত্তরদাতাকে কার্ডটি পরতে দিন। যদি উত্তরদাতা পুরো বাক্যটি পড়তে না পারে তবে প্রব করুন। উতরদাতাকে বলুন আমাকে বাক্যের কিছু অংশ পড়ে শোনান Ask the respondent to read the sentence with due respect (Give the card to the respondent) Probe if the respondent is unable to read the complete sentence Ask to read at least a part of the sentance	মোটেও পড়তে পারেন না Cann't read at all……………………………1 বাক্যের কিছু অংশ পড়তে পারেন Can read a partially……………………2 বাক্যের পুরো অংশ পড়তে পারেন Can read the whole sentence……………3 উত্তরদাতার কাঙ্খিত ভাষার কোন বাক্য এখানে নেই The sentence is not in the language the respondent know.............................4 অন্ধ/ প্রতিবন্ধী Blind/ Disable……………………………………………5	
C12	আপনার ধর্ম কি? What is your religion?	মুসলিম Muslim……………………………………………1 হিন্দু Hindu ………………………………………………2 খ্রিস্টান Christian…………………………………………3 বৌদ্ধ Buddhist/neo-Buddhist …………………………4 অন্যান্য Other ______________________________ 8	
C13	এখন আমি আপনার কাজ সম্বন্ধে কিছু প্রশ্ন করতে চাই। আপনার নিজের ঘর সংসারের কাজ ছাড়া আপনি অন্যান্য কিছু করেন যেমন-আপনার ছোট কোন ব্যবসা অথবা পারিবারিক ব্যবসা? Now I would like to ask you some questions about your work. Do you do anything (i.e. have a small business, or work on the family farm or in the family business), apart from your household work?	হ্যাঁ Yes ……………………………………………………1 না No ……………………………………………………2	2→C17
C14	আপনি কি সাধারণত সারা বছরই কাজ করেন নাকি বছরের বিশেষ বিশেষ সময় (সীজনাল) কাজ করেন, নাকি মাঝে মধ্যে কাজ করেন?Do you usually work throughout the year, or do you work seasonally or only once in a while?	সারা বছর Throughout the year …………………………1 কোন কোন সময় (সীজনাল) Seasonally/part of the year…2 মাঝে মধ্যে Once in a while………………………………3	
C15	এই কাজের বিনিময়ে আপনি কি নগদ টাকা পান, না জিনিসপত্র পান, না কোন কিছুই পান না?Are you paid in cash or kind for this work, or are you not paid at all?	নগদ অর্থ Cash only ………………………………………1 টাকা ও জিনিসপ্‌ত্র উভয়ই Cash and kind…………………2 জিনিসের বিনিময়ে In kind only …………………………3 কিছুই না Not paid…………………………………………4	
C16	আপনার প্রাথমিক পেশা কি, অর্থাৎ আপনি প্রধানত কি ধরনের কাজ করেন? What is your primary occupation, that is, what kind of work do (did) you mainly do?	দৈহিক কাজ Physical work অদক্ষ কর্মী (যেমন কামলা, মাটি কাটা কৃষিকাজ বা মাছ চাষাবাদের সাথে জড়িত কামলা) Unskilled labourer………………………………………… 1 দক্ষ কর্মী (যেমন কাঠের কাজ, মিস্ত্রি, সিমেন্টের কাজ, রিক্সা চালক, সেলাই) Skilled worker ………………………………………………………… 2 বিনা কায়িক পরিশ্রম Non physical work ব্যবসা Business/trade ……………………………………………… 3 চাকুরীজীবি Service holder…………………………………………… 4 পেশাজীবি (ডাক্তার/ ইঞ্জিনিয়ার/শিক্ষক/উকিলঁ) Professional ………………… 5 কৃষিকাজ, মাছ চাষাবাদ agriculture, farming or fishing …………………… 6 অন্যান্য Other ______________________________............. 8 (নির্দিষ্ট করুন Please specify)	
C11 এ ২/৩/৪ হলে C17 প্রশ্নটি করুন C11 এ ১/৫ হলে C18 প্রশ্ন হতে নিম্নের প্রশ্ন গুলো করুন If response to question C11 is 2/3/4 then ask C17 while if response to C11 is 1/5 then go to question C18 and following			
C17		সপ্তাহে অন্তত একবার At least once a week 1	

	আপনি কত ঘন ঘন খবরের কাগজ বা ম্যাগাজিন (সাময়িকী) পড়েন: সপ্তাহে অন্ততঃ একবার, নাকি সপ্তাহে একবারেরও কম, নাকি একেবারেই পড়েন না? Do you read a newspaper or magazine at least once a week, less than once a week or not at all?	সপ্তাহে একবারেরও কম Less than once a week		2	
		একেবারেই শুনেন না Not at all		3	
C18	আপনি কত ঘন ঘন রেডিও শুনেন (এফ, এম এবং কমিউনিটি রেডিও সহ): সপ্তাহে অন্ততঃ একবার, নাকি সপ্তাহে একবারেরও কম, নাকি একেবারেই শুনেন না? Do you listen to the radio at least once a week, less than once a week or not at all?	সপ্তাহে অন্ততঃ একবার At least once a week সপ্তাহে একবারেরও কম Less than once a week একেবারেই শুনেন না Not at all		1 2 3	
C19	আপনি কত ঘন ঘন টেলিভিশন দেখেন: সপ্তাহে অন্ততঃ একবার, নাকি সপ্তাহে একবারেরও কম, নাকি একেবারেই দেখেন না? Do you watch television at least once a week, less than once a week or not at all?	সপ্তাহে অন্ততঃ একবার At least once a week সপ্তাহে একবারেরও কম Less than once a week একেবারেই দেখেন না Not at all		1 2 3	
C20	আপনি কি কোন সমিতির সদস্য যেমন... উত্তর পরে শোনান এবং রেকর্ড করুন Are you a member of any group, such as.... read out all the options and record asnwers		হ্যাঁ Yes	না No	
		গ্রামীন ব্যাংক Grameen Bank	1	2	
		ব্র্যাক BRAC	1	2	
		বি, আর, ডি, বি B, R, D, B	1	2	
		আশা ASHA	1	2	
		প্রশিকা Proshika	1	2	
		মাদারস ক্লাব Mother’s club	1	2	
		অন্যান্য (ক্ষুদ্র ঋণ কর্মসূচী) Other	1	2	

Section D: Antenatal Care

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES		SKIP
D01	আপনার সর্বশেষ যে গর্ভশেষ হয়েছে সেই গর্ভকালীন সময়ে আপনি কি মেডিকেল চেকআপ/ স্বাস্থ্য পরীক্ষা করিয়েছিলেন? Did you see anyone for antenatal care for the pregnancy outcome that you had in last 1 year	হ্যাঁ Yes	1	
		না No	2	→D12
D02	আপনার এই গর্ভকালীন সময় কতবার মেডিকেল চেকআপ করিয়েছিলেন? How many times you receive ANC during this pregnancy?	বার Number of times ....|______|_____|		

NO.	QUESTIONS AND FILTERS	ANC visit চেকআপ	হ্যাঁ YES	না NO	গর্ভ মাস Gestational age (months)
D03	আপনি যখন এই গর্ভের জন্য মেডিকেল চেকআপ করিয়েছেন, তখন আপনি কত মাসের গর্ভবতী ছিলেন? How many months pregnant were you when you received antenatal care for this pregnancy? Completed weeks সঠিক মাস বলতে না পারলে, গর্ভ মাসের ঘরে **’98’** লিখুন। Enter ’98’ if can’t recall correct months.	ANC-1	1	2	
		ANC-2	1	2	
		ANC-3	1	2	
		ANC-4	1	2	
		ANC-5	1	2	
		ANC-6	1	2	
		ANC-7	1	2	
		ANC-8	1	2	

			ANC PROVIDER							
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
D04	আপনি কাকে দেখিয়েছিলেন? Whom did you see? জিজ্ঞেস করুনঃ আর কেউ? Anyone else? ব্যক্তি সর্ম্পকে নিশ্চিত হোন এবং সঠিক উত্তরের কোড বৃত্তায়িত করুন Probe to identify each type of person and record all mentioned.	পাশ করা ডাক্তার Qualified doctor	11	11	11	11	11	11	11	11
		নার্স/ধাত্রী/প্যারামেডিক Nurse/midwife/ Paramedic	12	12	12	12	12	12	12	12
		পরিবার কল্যাণ পরিদর্শিকা FWV	13	13	13	13	13	13	13	13
		মেডিকেল এসিসটেন্ট/স্যাকমো MA/SACMO	14	14	14	14	14	14	14	14
		সি,এস,বি,এ CSBA	15	15	15	15	15	15	15	15
		সি,এইচ, সি, পি CHCP	16	16	16	16	16	16	16	16
		স্বাস্থ্য সহকারী HA	17	17	17	17	17	17	17	17
		পরিবার কল্যান সহকারী FWA	18	18	18	18	18	18	18	18
		প্রশিক্ষণ প্রাপ্ত টিবিএ (প্রশিক্ষণ প্রাপ্ত ধন্নী, চাউনী, দাই) TTBA	21	21	21	21	21	21	21	21
		প্রশিক্ষণহীন টিবিএ (ধন্নী, চাউনী, দাই) UTBA(Dai/Dhorni/Chauni)	22	22	22	22	22	22	22	22
		সনাতন /পাশ না করা ডাক্তার Unqualified doctor	23	23	23	23	23	23	23	23
		ঔষধ বিক্রেতা Drug seller	24	24	24	24	24	24	24	24
		এনজিও কর্মী NGO worker	25	25	25	25	25	25	25	25
		অন্যান্য(নির্দিষ্ট করুন) Other	98	98	98	98	98	98	98	98

			ANC PLACES							
			1	2	3	4	5	6	7	8
D05	এই গর্ভকালীন সময়ে গর্ভকালীন সেবার জন্য আপনি কোথায়	বাড়িতে Home	11	11	11	11	11	11	11	11
		সরকারী সেক্টর Public sector:								

	গিয়েছিলেন? Where did you receive antenatal care for this pregnancy? এছাড়া অন্য কোথাও? Anywhere else? Probe করে নিশ্চিত হোন কি ধরনের উৎসে গিয়েছিলেন এবং সঠিক কোড লিপিবদ্ধ করুন। Probe to identify each type of source. যদি নিশ্চিত হতে না পারেন যে এটা সরকারি, নাকি প্রাইভেট হাসপাতাল, ক্লিনিক বা স্বাস্থ্যকেন্দ্র তবে স্থানের নাম লিখে রাখুন If unable to determine if public or private sector, write the name of the place: __________ __________ স্থানের নাম (Name of place)	মেডিকেল কলেজ হাসপাতাল Medical College	21	21	21	21	21	21	21	21	
		বিশেষায়িত হাসপাতাল Specialized hospital	22	22	22	22	22	22	22	22	
		জেলা হাসপাতাল District hospital	23	23	23	23	23	23	23	23	
		মাতৃ মঙ্গল কেন্দ্র Maternal & Child Welfare Centre (MCWC)	24	24	24	24	24	24	24	24	
		উপজেলা স্বাস্থ্য কমপ্লেক্স Upazila Health Complex	25	25	25	25	25	25	25	25	
		পরিবার কল্যাণ কেন্দ্র Family Welfare Centre (FWC)	26	26	26	26	26	26	26	26	
		স্যাটেলাইট ক্লিনিক/ইপআই কেন্দ্র Satellite clinic/EPI centre	27	27	27	27	27	27	27	27	
		কমিউনিটি ক্লিনিক Community clinic	28	28	28	28	28	28	28	28	
		এন জি ও সেকটর NGO sector:									
		এন জি ও স্থায়ী ক্লিনিক NGO static clinic	31	31	31	31	31	31	31	31	
		এন জি ও স্যাটেলাইট ক্লিনিক NGO satellite clinic	32	32	32	32	32	32	32	32	
		প্রাইভেট সেকটর Private sector:									
		প্রাইভেট হাসপাতাল / ক্লিনিক Private hospital/Clinic	32	32	32	32	32	32	32	32	
		পাশ করা ডাতারের চেম্বার MBBS doctor (Qualified)	33	33	33	33	33	33	33	33	
		সনাতন/অপ্রশিক্ষিত ডাতারের চেম্বার Traditional doctor	34	34	34	34	34	34	34	34	
		ফার্মেসী/ওষুধের দোকান Pharmacy	35	35	35	35	35	35	35	35	
		প্রাইভেট মেডিকেল কলেজ হাসপাতাল Private Medical College	36	36	36	36	36	36	36	36	
		অন্যান্য(নির্দিষ্ট করুন) Other:	98	98	98	98	98	98	98	98	
D06	এই গর্ভকালীন সময়ে গর্ভকালীন সেবা দেওয়ার সময় কমপক্ষে একবার কি নিম্নে.র বিষয়ের কোনটি দেখা হয়েছিল? (প্রত্যেকটি বিষয় পড়ে শোনান, প্রযোজ্য ক্ষেত্রে নমুনা দেখান) Were any of the following done at least once in of the ANCs? Ask about each item and show sample where applicable	বিষয় Item হাঁ YES না NO ওজন Weight ....1 2 ব্লাড প্রেসার Blood pressure ....1 2 প্রস্রাব পরীক্ষা Urine test ....1 2 রক্ত পরীক্ষা Blood test ....1 2 আলট্রাসনোগ্রাম Ultrasonogram ....1 2 বিপদচিহ্ন সম্পর্কে কাউন্সেল Counselled on danger signs .....1 2 পেটে হাত দিয়ে পরীক্ষা Abdominal examination ....1 2 আয়রন ট্যাবলেট বা সিরাপ Iron tablets or iron syrup ....1 2 ক্যালসিয়াম ট্যাবলেট বা সিরাপ Calcium tablets or syrup ....1 2 রক্তক্ষরণ বন্ধ করার জন্য ২ টি ট্যাবলেট 2 tablets of Misoprostol to prevent bleeding after deliver... 1 2 অন্যান্য (নির্দিষ্ট করুন) Other (specify): 1 2									
D07	আপনি কি আপনার শেষ গর্ভাবস্থায় কোন আল্ট্রাসনোগ্রাম পরীক্ষা করিয়েছিলেন? Did you receive an USG during your last pregnancy?	হ্যাঁ Yes .... 1 না No .... 2 জানিনা/মনে নাই Don't know 9									If 2/9 → D09

D08	যদি সর্বশেষ গর্ভাবস্থায় আল্ট্রাসনোগ্রাম করা হয়ে থাকে তবে জিজ্ঞাসা করুন প্রথমবার করার সময় তার গর্ভের বয়স কত ছিল? If USG is received please ask what was the gestational age when she first received the USG?	গর্ভকাল (সপ্তাহ) Weeks of pregnancy..........|____|____| জানিনা/মনে নাই Don't know 99		
D09	এই গর্ভকালীন সময়ে গর্ভকালীন চেক আপ করার সময় কোন ধরণের উপদেশ দেয়া হয়েছিল কি? Did the provider give any advice or counseling during ANC visit?	হ্যাঁ Yes না No জানিনা/মনে নাই Don't know/Can't remember	1 2 99	If 2/9 → D11
D10	গর্ভকালীন মেডিকেল চেক-আপের জন্য আপনি যাদের দেখিয়েছিলেন, তাদের কাছ থেকে কি কি উপদেশ আপনি পেয়েছিলেন? [মহিলাকে জিজ্ঞেস করুন] আরও কিছু? [মহিলার নিজে থেকে দেয়া সবগুলো উত্তরই বৃত্তায়িত করুন । উত্তরগুলো পড়ে শুনাবেন না। একাধিক উত্তর হতে পারে ।] What sort of advices have you received from these people during your most recent pregnancy? Can you recall what advice the person gave you regarding care during pregnancy? [Do not read the answers, Ask: is there anything else? Record all the un-prompted answers]	দিনে অন্তত ২ ঘন্টা বিশ্রাম নিবেন Advised to take REST for at least 2 hours during daytime	A	
		বাড়তি পুষ্টিকর খাবার খাবেন Advised to take extra food/NUTRITIOUS FOOD	B	
		মৌসুমি ফল খাবেন Advised to take seasonal/available FRUITS	C	
		সবুজ শাক-সবজি খাবেন Advised to take green/colored VEGETABLES	D	
		পর্যাপ্ত পানি খাবেন Advised to drink MORE WATER	E	
		আয়োডিন যুক্ত লবণ খাবেন Advised to take IODIZED SALT	F	
		ধনুষ্টংকার প্রতিরোধে টি,টি ইনজেকশন দিবেন Advised/Prescribed to take TETANUS TOXOID (TT) VACCINE	G	
		টি,টি ইনজেকশন দেওয়ার কারন Explained the purpose of the TT vaccine	H	
		পরিষ্কার পরিচ্ছন্নতা Advised to maintain PERSONAL HYGIENE	I	
		ভারী কাজ না করা Advised to avoid HEAVY WORK	J	
		ধূমপান না করা Discuss the risks of HARMFUL PRACTICES (drinking alcohol, smoking tobacco)	K	
		১ম ও শেষ ৩ মাসে সহবাস না করা Advised to AVOID COITUS in first and last trimester	L	
		পরিবার পরিকল্পনা Discussed FAMILY PLANNING options immediately after delivery (Post Partum)	M	
		4 টা ANC ভিজিট Discussed the importance of completing FOUR (4) ANC VISITS	N	
		প্রসব পরবর্তী উপদেশ Advise on PNC	O	
		কতদিন পরপর চেক-আপ করাবে Advised when to RE-VISIT	P	
		গর্ভকালীন/ প্রসব/বাচ্চার বিপদ চিহ্ন Educate on DANGER SIGNS of pregnancy/child birth/ newborn	Q	
		বিপদ চিহ্ন দেখা দিলে বিশেষজ্ঞ এর কাছে যাওয়া Advised to seek expert care if any of the DANGER SIGNS occurs	R	
		জরুরী অবস্থার জন্য টাকা জমানোর কথা Savings for emergency	S	
		জরুরী অবস্থায় যানবাহনের ব্যবস্থা করা Arrangement of transport for emergency	T	
		জরুরী অবস্থার জন্য রক্তর ব্যাবস্থা করা Arrange blood/ blood donor for emergency	U	
		পশিক্ষণপাপ্ত সেবাদানকারী দিয়ে ডেলিভারী করানো Delivery by Skilled providers	V	
		কোন হাসপাতালে ডেলিভারি হবে তা আগে থেকে ঠিক করে রাখা Decide on palce of delivery / facility delivery	W	
		জানিনা/মনে নাই Don't know/Can't remember	Y	

			Yes	**No**	
D11	নির্দিষ্ট করুন যে আপনাকে কি ধরণের পুষ্টি বিষয়ক উপদেশ দেয়া হয়েছে? প্রতিটি উত্তর পরে শোনান What nutrition advice did you receive? Please specifiy	প্রতি বেলায় কি কি ধরণের খাবার খেতে হবে বলা হয়েছে Advice on diversity of food for pregnant women	1	2	
		প্রতি বারে কি পরিমান খাবার খেতে হবে বলা হয়েছে Advice on quantity of food consumed per meal	1	2	
		প্রতি দিন কয় বার খাবার খেতে হবে বলা হয়েছে Advice on frequency of food intake during pregnancy	1	2	

		গর্ভ কালীন সময়ে ওজন পরিমাপের গুরুত্ব সম্পরকে বলা হয়েছে Advice on weight monitoring	1	2	
D12	এই গর্ভকালীন সময়ে আপনার কোন সমস্যা বা জটিলতা হয়েছিল?During the pregnancy with (NAME), did you develop any problem/complication?	হ্যাঁ Yes		1	
		না No		2	→D17
		জানিনা/মনে নাই Don't know/Can't remember		99	→D17
D13	আপনার কি ধরণের সমস্যা বা জটিলতা হয়েছিল? Please tell me what was that problem or complication? উত্তর পড়ে শোনাবেন না। Do not read out the answers জিজ্ঞেস করুনঃ আরও কিছু? ASK: Anything else? উত্তরের কোড বৃত্তায়িত করুন। Circle code of all the answers	তীব্র মাথা ব্যাথা Severe Headache		A	
		চোখে ঝাপসা দেখা Blurred Vision		B	
		গর্ভের বাচ্চার নড়াচড়া কমে যাওয়া Fetal movement reduced		C	
		গর্ভের বাচ্চার নড়াচড়া বন্ধ হওয়া Fetal movement absent		D	
		মুখমন্ডলে পানি আসা/ফুলে যাওয়া Oedema of the face/swelling		E	
		হাতে পানি আসা/ফুলে যাওয়া Oedema of the hands/swelling		F	
		খিঁচুনী/ফিট Convulsions/fits		G	
		বাচ্চা হওয়ার রাস্তায় অতিরিক্ত রক্তস্রাব Excessive Vaginal Bleeding		H	
		তলপেটে তীব্র ব্যথা Severe abdominal pain		I	
		পায়ে পানি আসা Oedema of the legs		J	
		তীব্র জ্বর Fever		K	
		সময় পূর্ণ হওয়ার আগে পানি ভাঙ্গা Premature rupture of membrane		L	
		অচেতন হওয়া/জ্ঞান হারিয়ে ফেলা Loss of consciousness		M	
		কষ্ট করে শ্বাস নেয়া Difficulty breathing		N	
		প্রচন্ড দুর্বলতা Severe weakness		O	
		অতিরিক্ত বমি Excessive vomiting		P	
		অতিরিক্ত সাদা স্রাব Excessive whitish vaginal discharge		Q	
		অন্যান্য Others (নির্দিষ্ট করুন) ________________________________		X	

Section E: IFA Supplementation during pregnancy

D01 এর উত্তর যদি "No" হয়, তাহলে E01-E07 পর্যন্ত প্রশ্ন জিজ্ঞেস করা বাদ দেবেন এবং E08 থেকে শুরু করবেন। If D01=2, then skip E01-E07 number questions, and start from E08.

SI	QUESTIONS & FILTERS	CODING CATEGORIES		SKIP
E01	আপনার শেষ গর্ভাবস্থায় আপনি কি ANC এর সময় কোন আয়রন ফলিক বড়ি / সিরাপ পেয়েছিলেন? Did you receive IFA tablets/syrups during ANC in your last pregnancy	হ্যাঁ Yes	1	
		না No	2	→E08
		জানিনা/মনে নাই Don’t know/Can’t remember	99	→E08
E02	ANC এর সময় আপনাকে কি কিভাবে আয়রন ফলিক বড়ি / সিরাপ খেতে হবে (দিনে কয়টা খাবে ; কখন খাবে) বলা হয়েছিল কি ? Were you adviced how to take IFA tables during ANC	হ্যাঁ Yes	1	
		না No	2	
E03	ANC এর সময় আপনাকে আয়রন ফলিক বড়ি / সিরাপ খেলে আপনার কি কি সমস্যা হতে পারে তা বলা হয়েছিল কি ? Were you adviced what could be the side effects of IFA during ANC	হ্যাঁ Yes	1	
		না No	2	
E04	ANC এর সময় আপনাকে আয়রন ফলিক বড়ি / সিরাপ খেয়ে সমস্যা হলে কি করতে হবে তা বলা হয়েছিল কি ? Were you adviced what you need to do if the side effects occur?	হ্যাঁ Yes	1	
		না No	2	
E05	প্রতিবার ANC এর সময় আপনি কয়টি করে আয়রন ফলিক বড়ি / সিরাপ পেয়েছিলেন তার সংখ্যা লিখুন আয়রন ফলিক বড়ি / সিরাপ না পেলে ০০ লিখুন ANC না নিলে ৯৮ লিখুন Please specifiy the number of tablets /syrups received in each ANC in your last pregnancy Please record 00 if IFA is not consumed Please record 98 if ANC is not received	ANC1 ☐☐ সংখ্যা ANC2 ☐☐ সংখ্যা ANC3 ☐☐ সংখ্যা ANC4 ☐☐ সংখ্যা ANC5 ☐☐ সংখ্যা ANC6 ☐☐ সংখ্যা ANC7 ☐☐ সংখ্যা ANC 8 ☐☐ সংখ্যা		
E06	আপনার শেষ গর্ভাবস্থায় আপনি ANC এর সময় মোট কতটি কোন আয়রন ফলিক বড়ি / সিরাপ পেয়েছিলেন (E05 নং প্রশ্নের উত্তর যোগ করুন এবং যোগফল লিখুন) Total number of IFA tablets received from ANC in your last pregnancy	☐☐☐ সংখ্যা		
E07	প্রতিবার ANC এর পর কয়টি করে আয়রন ফলিক বড়ি / সিরাপ খেয়েছিলেন তার সংখ্যা লিখুন একে বারে না খেলে ০০ লিখুন ANC না নিলে ৯৮ লিখুন Number of IFA tablets/syrup consumed after each ANC in your last pregnancy Please record 00 if IFA is not consumed	ANC1 ☐☐ সংখ্যা ANC2 ☐☐ সংখ্যা ANC3 ☐☐ সংখ্যা ANC4 ☐☐ সংখ্যা ANC5 ☐☐ সংখ্যা ANC6 ☐☐ সংখ্যা ANC7 ☐☐ সংখ্যা ANC 8 ☐☐ সংখ্যা		

	Please record 98 if ANC is not received			
E08	ANC ছাড়া আপনি আর কোথাও থেকে আয়রন ফলিক বড়ি / সিরাপ পেয়েছিলেন /কিনেছিলেন কি Did you buy/get any IFA tablets other than ANC in your last pregnancy	হ্যাঁ Yes না No জানিনা/মনে নাই Don't know/Can't remember	1 2 99	2/99 skip to E12
E09	ANC ছাড়া আপনি আর কোথাও থেকে মোট কতটি আয়রন ফলিক বড়ি / সিরাপ পেয়েছিলেন /কিনেছিলেন কি Number of IFA tablets/syrup bought /get other than ANC in your last pregnancy	☐☐☐ সংখ্যা		
E10	ANC ছাড়া আপনি আর অন্য কোথা আয়রন ফলিক বড়ি / সিরাপ পেয়েছিলেন /কিনেছিলেন Source of buying /getting IFA tablets other than ANC in your last pregnancy	বাড়িতে Home	A	
		সরকারী সেক্টর: Public sector		
		মেডিকেল কলেজ হাসপাতাল Medical College	B	
		বিশেষায়িত হাসপাতাল Specialized hospital	C	
		জেলা হাসপাতাল District hospital	D	
		মাতৃমঙ্গল কেন্দ্র Maternal & Child Welfare Centre	E	
		উপজেলা স্বাস্থ্য কমপ্লেক্স Upazila Health Complex	F	
		পরিবার কল্যাণ কেন্দ্র Family Welfare Centre (FWC)	G	
		স্যাটেলাইট ক্লিনিক/ইপিআই কেন্দ্র Satellite clinic/EPI centre	H	
		কমিউনিটি ক্লিনিক Community clinic	I	
		এন জি ও সেক্টর: NGO sector		
		এন জি ও স্থায়ী ক্লিনিক NGO static clinic	J	
		এন জি ও স্যাটেলাইট ক্লিনিক NGO satellite clinic	K	
		প্রাইভেট সেক্টর: Private sector		
		প্রাইভেট হাসপাতাল / ক্লিনিক Private hospital/Clinic	L	
		পাশ করা ডাক্তার MBBS doctor (Qualified)	M	
		অপ্রশিক্ষিত ডাক্তার (কোয়াক/ পল্লী চিকিৎসক/ হোমিওপ্যাথ) Quack/ Village doctor /Aiurved /Homeopath	N	
		ফার্মেসী Pharmacy	O	
		প্রাইভেট মেডিকেল কলেজ হাসপাতাল Private Medical College	P	
		অন্যান্য (নির্দিষ্ট করুন) Other:__________________________	Q	
		অন্যান্য Other sources:		
		দোকান Shop	R	
		বন্ধু/আত্মীয় Friends/Relatives	S	
		টিবিএ / দাই TBA	T	
		অন্যান্য (নির্দিষ্ট করুন) Other__________________	X	
E11	আপনার শেষ গর্ভাবস্থায় আপনি মোট কতটি কোন আয়রন ফলিক বড়ি / সিরাপ পেয়েছিলেন তার সংখ্যা লিখুন (E06 + E09) নং প্রশ্নের উত্তর যোগ করুন এবং যোগফল লিখুন) Total number of IFA tablets received /bought in your last pregnancy including all sources	☐☐☐ সংখ্যা		

E12	আপনার শেষ গর্ভাবস্থায় আপনি মোট কতটি কোন আয়রন ফলিক বড়ি / সিরাপ খেয়েছিলেন তার সংখ্যা লিখুন. সর্বমোট যে আয়রন ফলিক বড়ি / সিরাপ আপনি খেয়েছেন তা E11 এর চেয়ে কম অথবা সমান হতে হবে, E11 এর চেয়ে বেশি না। Total number of IFA tablets consumed in your last pregnancy Should be less than or equal to E11		☐☐☐ সংখ্যা	If<180 (000-179) →skip to E14
E13	আপনার শেষ গর্ভাবস্থায় আপনি সর্ব প্রথম গর্ভের কত সপ্তাহ থেকে আয়রন ফলিক বড়ি / সিরাপ খাওয়া শুরু করেছিলেন (পূর্ণ সপ্তাহে লিখুন) In which gestational week of pregnancy you started taking IFA tablets /syrup in your last pregnancy. Please record in completed weeks		☐☐ গর্ভ সপ্তাহ	
E14	আয়রন ফলিক বড়ি <১৮০ ট্যাবলেট এর কম খেলে অথবা কখনো একটিও না খেয়ে থাকলে/ না কিনে থাকলে, ঠিকমত না খাওয়ার কারন জিজ্ঞেশ করুন ? প্রব করুন আর কিছু Reason for not taking IFA tablets Please probe উল্লেখিত সবগুলো উত্তরের কোড বৃত্তায়িত করুন। Circle code of all the answers	পেটের ব্যথা Abdominal pain	A	
		বমি Vomiting	B	
		বমি বমি ভাব Nausea	C	
		কোষ্ঠকাঠিন্য Constipation	D	
		বুক জ্বালাপোড়া Heartburn	E	
		ডায়রিয়া Diarrhoea	F	
		কালো পায়খানা Black stool	G	
		অতিরিক্ত ক্লান্তি Extreme fatigue	H	
		অতি দুর্বলতা/নিস্তেজ ভাব Severe weakness	I	
		বুক ধরফরানি Palpitation	J	
		শ্বাস কষ্ট Shortness of breath	K	
		মাথা ঘোরা/ঝিমঝিম Diziness	L	
		চোখ, মুখ এবং হাতের তালু ফ্যাকাসে হওয়া Pale eyes, face, plam	M	
		স্বামী/সঙ্গী অনুমতি দেয় না Husband/partner will not permit	N	
		ধর্মীয় কারণ Religious reasons	O	
		সমস্যা নেই No problems	P	
		খেতে মনে ছিল না Forgot to take	Q	
		ওষুধ হারিয়ে গেছে Lost	R	
		ওষুধ নষ্ট হয়ে গেছে Damaged	S	
		জানি না Don’t know	T	
		উত্তর দেয়নি No response	U	
		অন্যকোন সমস্যা Other problem	X1	
		অন্যকোন সমস্যা Other problem	X2	

Questionnaires for Paper 3 and 4 in Chapters 5-6

1. Household characteristics module
2. Women’s background module
3. Marriage and birth history module
4. Household food insecurity module
5. Pregnancy outcome/birth module
6. Infant and Young Child Feeding (IYCF) practices module

International Centre for Diarrhoeal Disease Research, Bangladesh [icddr,b]

Bundling of nutrition-specific nutrition interventions
Women’s household and background questionnaire

SECTION A - পরিচিতিমূলক তথ্য (Identification)

	Name (নাম)	Code (কোড)
উপজেলার নাম ও কোড (Upazila name and code)		☐
ইউনিয়নের নাম ও কোড নম্বর (Union name & code)		☐☐
গ্রামের নাম ও কোড নম্বর (Village name & code)		☐☐☐☐
বাড়ীর নাম ও নম্বর (Bari name & number)		☐☐☐
খানা প্রধানের নাম ও খানা নম্বর (HH Head name & HH Number)		☐☐
মায়ের’র নাম (Mother’s Name)		
কমিউনিটি স্বাস্থ্য কর্মীর নাম ও কোড নং (Name of the CHW and Code #)	________________________________	☐☐

SECTION B - খানার বৈশিষ্ট্য (Household characteristics)

এই সেকশনে উত্তরদাতা এবং একই খানার অন্যান্য সদস্যদের কিছু তথ্য সম্বন্ধে আলোচনা করা হয়েছে
This section contains some information of the respondent and other members of the same household

No.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
B01	আপনাদের খানায় কয়টি শোবার রুম আছে? How many rooms are there in your house for household members to sleep in?	শোবার কক্ষের সংখ্যা Rooms.....................|____|____|	
B02	[পর্যবেক্ষণ করুন] বসত ঘরের ছাদের প্রধান নির্মাণ সামগ্রী? *[Observe]* Which material is the roof of the largest structure of the household made of?	স্বাভাবিক ছাদ Natural roofing ছাদ নেই No roof ....11 খড়/ছন/তাল পাতা Thatch/palm leaf..12 কাঁচা ছাদ Rudimentary roof বাঁশ Bamboo ....23 কাঠের তক্তা Wood planks ....24 কার্ডবোর্ড Cardboard ....25 পরিপূর্ন ছাদ Finished Roofing টিন Tin ....31 কাঠ Wood ....32 সিরামিক টাইলস্ Ceramic Tiles..........33 সিমেন্ট Cement..................................34 টালি Roofing Shingles........................35 অন্যান্য Other______________________96 (Specify) নির্দিষ্ট করুন	

B03	[পর্যবেক্ষণ করুন] বসত ঘরের দেয়ালের প্রধান নির্মাণ-সামগ্রী ***[Observe]*** Which material is the wall of the largest structure of the household made of?	স্বাভাবিক দেয়াল Natural Walls দেয়াল নাই No wall ....11 পাটকাঠি/তাল গাছ/গাছের গুড়ি Cane/ Palm/Trunks ....12 মাটি Dirt...13 প্রাথমিক পর্যায়ের দেয়াল Rudimentary Walls মাটি সহ বাঁশ Bamboo with mud........22 মাটিসহ পাথর Stone with mud...........23 প্লাইউড Plywood...............................24 কার্ডবোর্ড Cardboard ....25 পরিপূর্ণ দেয়াল Finished Walls টিন Tin ....31 সিমেন্ট Cement..................................32 চুনা পাথর/সিমেন্ট Stone with Lime/Cement.....................................33 ইট Bricks ....34 কাঠের তক্তা Wood Planks/Shingles ...35 অন্যান্য Other___________________________96 (Specify) নির্দিষ্ট করুন	
3.04	[পর্যবেক্ষণ করুন] বসত ঘরের মেঝের প্রধান নিমাণ-সামগ্রী ***[Observe]*** Which material is the floor of the largest room made of?	স্বাভাবিক মেঝে Natural Floor মাটি/বালু Earth/Sand ....11 প্রাথমিক পর্যায়ের মেঝে Rudimentary Floor কাঠের তক্তা Wood Planks..................21 তাল গাছ/বাঁশ Palm/Bamboo.............22 পরিপূর্ণ মেঝে Finished Floor নকশা কাটা কাঠের পাটাতন/পলিশকৃত কাঠ Parquet or Polished Wood ....31 সিরামিক টাইলস্/মোজাইক Ceramic Tiles ....33 সিমেন্ট Cement..................................34 অন্যান্য Other___________________________96 (Specify) নির্দিষ্ট করুন	
3.05	আপনার খানার সদস্যদের খাবার পানির প্রধান উৎস কি? What is the main source of drinking water for members of your household?	পাইপের পানি Piped water ঘরের মধ্যে পাইপের পানি Piped into dwelling...11 বাড়ির চত্বরে/আঙ্গিনায় পাইপ Piped to yard/plot..12 সরকারি (পাবলিক) ট্যাপ/স্থায়ী পাইপ Public Tap/standpipe..13 টিউবওয়েল (নলকূপ)Tube well or borehole..........21 কূপ/ইদারা Dug well সংরক্ষিত কূপ/ইদারা Protected well.......................31 অসংরক্ষিত কূপ/ইদারা Unprotected well...............32 ঝরণার পানি Water from spring সংরক্ষিত ঝরণার পানি Protected spring.................41 অসংরক্ষিত ঝরণার পানি Unprotected spring.........42 সংগৃহিত বৃষ্টির পানি Rainwater.............................51 ভূ-পৃষ্ঠের পানি (নদী, খাল, পুকুর লেক ইত্যাদি)	

		Surface water (river/dam/Lake/pond/stream/ canal/..81 বোতলের পানি Bottled water.................................91 অন্যান্য Other ___________________________ 96 নির্দিষ্ট করুন (Specify)	
B04	আপনার খানার সদস্যরা সাধারণত কোন ধরনের পায়খানা ব্যবহার করে? What kind of toilet facility does your household have?	ফ্ল্যাশ ল্যাট্রিন Flush or pour flush toilet ফ্ল্যাশ করে পাইপের মাধ্যমে অপসারণ Flush to piped sewer system.................................11 ফ্ল্যাশ করে ট্যাংকে ধারণ Flush to septic tank.....12 ফ্ল্যাশ করে গর্তে ধারণ Flush to pit latrine...........13 ফ্ল্যাশ করে অন্য কোথাও অপসারণ Flush to somewhere else. . ...14 ফ্ল্যাশ করে কোথায় অপসারিত হয় তা জানিনা Flush, don't know where.....................................15 পিট ল্যাট্রিন Pit latrine বায়ু চলাচলের ব্যবস্থাসহ উন্নতমানের পিট ল্যাট্রিন Ventilated improved pit latrine ....21 পিট ল্যাট্রিন (স্-াব সহ) Pit latrine with slab......22 পিট ল্যাট্রিন (স্-াব বিহীন)/ খোলা গর্ত Pit latrine without slab/open pit. ....23 বাকেট ল্যাট্রিন Bucket toilet.................................41 খোলা/স্-াব ল্যাট্রিন Hanging toilet/hanging latrine....................... ....51 ল্যাট্রিন নাই/ঝোপ-ঝাড়/মাঠ No facility/bush/field .... 61 অন্যান্য Other___________________________ 96 উলে-খ করুন (Specify)	
B05	আপনার খানায় বা খানার কোন সদস্যের নিম্নে বর্ণিত জিনিস গুলো আছে কি? যেমনঃ Does your household have the following materials? বিদ্যুৎ Electricity? রেডিও A radio? টেলিভিশন A television? মোবাইল ফোন A mobile telephone? টেলিফোন A non-mobile telephone? রেফ্রিজারেটর A refrigerator? আলমারি/ওয়াড্রব An almirah/wardrobe? টেবিল A table? চেয়ার A chair? ইলেকট্রিক পাখা An electric fan? ডিভিডি/ভিসিডি পে-য়ার A DVD/VCD player? পানির পাম্প A water pump?	হ্যাঁ না বিদ্যুৎ Electricity ....1….......2 রেডিও Radio ....1….......2 টেলিভিশন Television ....1….......2 মোবাইল ফোন Mobile telephone ....1….......2 টেলিফোন Non-mobile telephone ....1….......2 রেফ্রিজারেটর Refrigerator..................1….......2 আলমারি/ওয়াড্রব Almirah/wardrobe....1….......2 টেবিল Table.......................................1….......2 চেয়ার Chair...1….......2 ইলেকট্রিক পাখা Electric fan..............1….......2 ডিভিডি/ভিসিডি পে-য়ার DVD/VCD Player 1….......2 পানির পাম্প Water pump...................1….......2 কিছুই নাই None of the above.............1….......2	
B06	আপনার খানায় বা খানার কোন সদস্যের নিম্নে বর্ণিত জিনিসগুলো আছে কি? Does your household/ any member in your household have the following things? অটোবাইক? Autobike? রিক্সা/ভ্যান? Rickshaw/ Van? বাই সাইকেল? Bi-cycle? মোটর সাইকেল/স্কুটার/টেম্পু/সিএনজি? Motor cycle/ Scooter/ Tempu/ CNG?	হ্যাঁ না অটোবাইক/Autobike…………………… 1…......2 রিক্সা/ভ্যান/Rickshaw/ Van ....1..........2 বাই সাইকেল/Bi-cycle...........................1..........2 মোটর সাইকেল/স্কুটার/টেম্পু/সিএনজি Motor cycle/ Scooter/ Tempu/ CNG ....1..........2	

B07	এই খানায় নির্দিষ্ট কোন গৃহপালিত পশু, যেমন, গরু-মহিষ, ছাগল-ভেড়া, হাঁস-মুরগি ইত্যাদি আছে কি? Does this household own any livestock, herds, other farm animals, or poultry?	হ্যাঁ Yes...1 না No...2	→B09
B08	আপনার খানায় নিচের প্রাণীগুলোর মধ্যে নিজস্ব কতগুলো আছে? যদি না থাকে, লিখুন '00' যদি 95 এর বেশী থাকে তাহলে লিখুন '95' যদি জানা না থাকে, লিখুন '98' ষাঁড় অথবা মহিষ? গরু? ছাগল অথবা ভেড়া? মুরগী অথবা হাঁস? How many of the following animals does this household own? If none, enter '00' If more than 95, enter '95' If unknown, enter '98' Bulls or Buffalos? Cows? Goats or sheep? Chicken or ducks?	ষাঁড় অথবা মহিষ?Bulls/Buffalos.........|___|___| গরু? Cows...|___|___| ছাগল অথবা ভেড়া? Goats/Sheep.......|___|___| মুরগী অথবা হাঁস?Chickens/Duck.......|___|___|	
B09	আপনার খানার বসতভিটা আছে কি? Does your household own any homestead? যদি 'না' হয় প্রোব করুন: আপনার খানার অন্য কোথাও কোন বসতভিটা আছে কি? If *'no,' probe: Does your household own any homestead in any other places?*	হ্যাঁ Yes...1 না No...2	
B10	আপনাদের কোন জমি আছে কি? (খানার বসতভিটা ছাড়া অন্য কোন জমি)? Does your household own any land (other than the homestead land)?	হ্যাঁ Yes...1 না No...2	→END
B11	আপনার এই খানায় (বসতভিটা ছাড়া) কি পরিমান জমি আছে? (পরিমাণ)-------------- একক-----------(নির্দিষ্ট করুন) ৯৫ একর বা তার বেশী পরিমাণ হলে 95 রেকর্ড করুন । যদি জমির পরিমাণ সঠিক জানা না থাকে তাহলে 99 লিখুন। How much land does your household own (other than the homestead land)? (Amount)___________________ Unit_____________________ (specify) If 95 acres or more record 9995 If amount not known exactly then record 99	|___|___| . |___|___| একর শতাংশ Acres Decimals 95 একর বা তার বেশী 95 acres or more record……………………….95 জানা নেই Do not know…………………..…….99	

Section C: মহিলার ইতিহাস (Women’s Background)

This Section contains some background information of the respondent (woman) and her husband
আপনি এবং আপনার স্বামী সম্পর্কে এখন আমি আপনাকে কিছু প্রশ্ন করতে চাই

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
C01	আপনি কোন সালের কোন মাসে জন্ম গ্রহন করেছিলেন? In what month and year were you born?	মাস (Month)..|____|____| জানি না (Don’t know month)..99 সাল (Year)....................................|____|____||____|____|	
C02	বর্তমানে আপনার বয়স কত? (C01 ও C02 মিলিয়ে দেখুন, অসামঞ্জস্য হলে C01 ও C02 সংশোধন করুন)How old were you at your last birthday?	বয়স (পূর্ন বছরে) Age in completed years.....................|____|____|	
C03	আপনার যখন বিয়ে হয়েছিল, তখন আপনার বয়স কত ছিল? How old were you when you got married?	বয়স (পূর্ন বছরে) Age in completed years.....................|____|____|	
C04	আপনি কি কখনও স্কুলে, মাদ্রাসায় বা উপানুষ্ঠানিক শিক্ষা স্কুলে (বয়স্ক শিক্ষা কেন্দ্র বা অন্যকোথাও) লেখাপড়া করেছেন? Did you ever study in school, madrasa or non formal school?	হ্যাঁ (Yes)..1 না (No)..2	 →C09
C05	আপনি সর্বোচ্চ কোন ক্লাস/শ্রেণী পর্যন্ত লেখাপড়া করেছেন? (কোন ক্লাস/শ্রেণী সম্পুর্ন করে না থাকলে ”00” লিখুন) What is the highest grade/class or number of years of studies you have completed at that schooling?*[Write ‘00’ if no class completed]*	সর্বোচ্চ কোন ক্লাস/শ্রেণী Highest Class/Grade...........................|____|____|	
C06	আপনি কোথায় কোথায় লেখাপড়া করেছেন? What type of institution/s have you attended?	স্কুল School/College/University ....A বোর্ড” মাদ্রাসা “Board” madrasah..B কওমী মাদ্রাসা “Qowmi” madrasah ....C উপানুষ্ঠানিক শিক্ষা স্কুল Non Formal Education Program......................D অন্যান্য Others ______________________________________.X (নির্দিষ্ট করুন Please specify)	
C07	আপনি কি দৈনিক খবরের কাগজ বা অন্যান্য পত্রিকা/ম্যাগাজিন পড়েন? Do you read a newspaper or magazine?	হ্যাঁ Yes..1 না No..2	 →C09
C08	আপনি কত ঘন ঘন দৈনিক খবরের কাগজ বা অন্যান্য পত্রিকা/ম্যাগাজিন পড়েন? প্রতিদিন পড়েন, নাকি সপ্তাহে কমপক্ষে একদিন পড়েন, নাকি আরও কম পড়েন? How often do you read newspaper or magazine?	প্রতিদিন Almost everyday..1 অন্তত সপ্তাহে একদিন At least once a week ....2 খুবই কম সপ্তাহে ১ দিনও না Less than once a week 3	
C09	আপনি কি রেডিও শোনেন? Do you listen to radio?	হ্যাঁ Yes..1 না No..2	 →C11
C10	আপনি কত ঘন ঘন রেডিও শোনেন? প্রতিদিন শোনেন, নাকি সপ্তাহে কমপক্ষে একদিন শোনেন, নাকি আরও কম শোনেন? How often do you listen to radio?	প্রতিদিন Almost everyday..1 অন্তত সপ্তাহে একদিন At least once a week..2 খুবই কম সপ্তাহে ১ দিনও না Less than once a week 3	
C11	আপনি কি টেলিভিশন দেখেন? Do you watch television?	হ্যাঁ Yes..1 না No..2	 →C14
C12	আপনি কত ঘন ঘন টেলিভিশন দেখেন? প্রতিদিন দেখেন, নাকি সপ্তাহে কমপক্ষে একদিন দেখেন, নাকি তারও কম দেখেন? How often do you watch television?	প্রতিদিন Almost everyday..1 অন্তত সপ্তাহে একদিন At least once a week..2 খুবই কম সপ্তাহে ১ দিনও না Less than once a week 3	
C13	আপনার TV তে কি কেবল / ডিশের সংযোগ আছে? Does the television you watch has a cable connection?	হ্যাঁ Yes..1 না No..2 প্রযোজ্য নয় Not Applicable..8	
C14	আপনার ধর্ম কি? What is your religion?	ইসলাম Islam..1 হিন্দু Hinduism..2 বৌদ্ধ Buddhism..3 খ্রীস্টান Christianity ....4 অন্যান্য Others______________________________________ ...... 7 (নির্দিষ্ট করুন Please specify)	
C15	ঘরের কাজের পাশাপাশি আপনি এমন কোন কাজ কি করেন যা থেকে আপনার আয় হয়? যেমন, কেউ জিনিসপত্র বিক্রী করেন, কেউ নিজের ছোট ব্যবসায় বা পারিবারিক খামারে বা ব্যবসায় কাজ করেন, কেউ গরু-ছাগল বর্গা নেন ইত্যাদি। As you know, some women take up jobs for which they are paid in cash or kind. Others sell things, have a small business or work on the family farm or in the family business. Are you doing any of this things or any work?	হ্যাঁ Yes..1 না No..2	 →C18

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
C16	প্রধানতঃ আপনি কি কাজ করেন? *[একাধিক পেশার সাথে জড়িত হলে প্রধান পেশার নাম নীচে লিখে ডান দিকের কোড বৃত্তায়িত করুন ।]* পেশাঃ (Occupation)_________________________________ What is your primary occupation, that is, what kind of work do (did) you mainly do?	**কায়িক পরিশ্রম Physical work** অদক্ষ (যেমন কামলা, মাটি কাটা) Unskilled laborer............................11 দক্ষ (যেমন কাঠের কাজ, মিস্ত্রি, সিমেন্টের কাজ, রিক্সা চালক) Skilled worker ....12 **বিনা কায়িক পরিশ্রম Non physical work** ব্যবসা Business/trade ....21 চাকুরী Service holder...22 পেশাজীবি (ডাক্তার/ ইনজিনিয়ার/শিক্ষক) Professional ....23 **অন্যান্য** Other ________________________________.........97 (নির্দিষ্ট করুন Please specify)	
C17	*[উল্লেখিত প্রধান পেশা কি কৃষিকাজ বা মাছ চাষাবাদের সাথে জড়িত] [Is the main occupation of the respondent involved agriculture, farming or fishing?]*	হ্যাঁ (Yes)...1 না (No)...2	
C18	আপনি বর্তমানে বিবাহিতা, বিচ্ছিন্না, পরিত্যক্তা, বিধবা না তালাকপ্রাপ্তা? Are you now married, separated, deserted, widowed, or divorced?	বর্তমানে বিবাহিত Currently Married .... 1 বিচ্ছিন্না Separated...2 পরিত্যক্তা Deserted..3 তালাকপ্রাপ্তা Divorced... 4 বিধবা Widowed 5	 →D01 →D01 →D01 → D01
C19	বর্তমানে আপনার স্বামীর বয়স কত? How old was your husband at his last birthday?	বয়স (পূর্ন বছরে) Age in completed years...........................|____|____| জানি না Don't know...99	
C20	আপনার স্বামী কি কখনও স্কুলে, মাদ্রাসায় বা উপানুষ্ঠানিক শিক্ষা স্কুলে (বয়স্ক শিক্ষা কেন্দ্র বা অন্যকোথাও) লেখাপড়া করেছেন? Did your husband ever study in school, madrasa or adult literacy school?	হ্যাঁ Yes...1 না No ....2 জানি না/ মনে নাই Don't know/Can't remember 9	 →C23 →C23
C21	আপনার স্বামী সর্বোচ্চ কোন ক্লাস/শ্রেণী পর্যন্ত লেখাপড়া করেছেন? *[কোন ক্লাস/শ্রেণী সম্পুর্ন করে না থাকলে "00" লিখুন যদি]*What is the highest grade/class or number of years of studies your husband have completed at that schooling?(Write '00' if no class completed)	সর্বোচ্চ কোন ক্লাস/শ্রেণী Highest Class/Grade....................|____|____| জানি না/ মনে নাই Don't know/Can't remember.................................99	
C22	আপনার স্বামী কোথায় কোথায় লেখাপড়া করেছেন? What type of institution/s have your husband attended?	স্কুল School/College/University ....A বোর্ড মাদ্রাসা "Board" madrasah ....B কওমী মাদ্রাসা "Qowmi" madrasah...C উপানুষ্ঠানিক শিক্ষা স্কুল Non Formal Education Program......................D অন্যান্য Others ______________________ ....X জানি না/ মনে নাই Don't know/Can't remember.................................Z	
C23	বর্তমানে আপনার স্বামী আয় রোজগারের জন্য কোন কাজ করেন কি? Does your husband do anything for living?	হ্যাঁ Yes...1 না No 2	 → D01
C24	প্রধানতঃ আপনার স্বামী কি কাজ করেন? *[একাধিক পেশার সাথে জড়িত হলে প্রধান পেশার নাম নিচে লিখে ডান দিকের কোড বৃত্তায়িত করুন ।]* পেশাঃ (Occupation)_________________________________ What is his primary occupation?	**কায়িক পরিশ্রম Physical work** অদক্ষ (যেমন কামলা, মাটি কাটা) Unskilled laborer............................11 দক্ষ (যেমন কাঠের কাজ, মিস্ত্রি, সিমেন্টের কাজ, রিক্সা চালক) Skilled worker ....12 **বিনা কায়িক পরিশ্রম Non physical work** ব্যবসা Business/trade ....21 চাকুরী Service holder...22 পেশাজীবি (ডাক্তার/ ইনজিনিয়ার/শিক্ষক) Professional ....23 **অন্যান্য** Other ________________________________.........97 (নির্দিষ্ট করুন Please specify)	
C25	*[উল্লেখিত প্রধান পেশা কি কৃষিকাজ বা মাছ চাষাবাদের সাথে জড়িত] [Is the main occupation of the respondent's husband involve agriculture, farming or fishing]*	হ্যাঁ (Yes)...1 না (No)...2	

Section D: বিবাহ এবং সন্তান জন্মদানের ইতিহাস (Marriage and Birth History)

এখন আমি আপনার বিবাহের ইতিহাস এবং আপনার জীবনে আপনি যতবার সন্তান জন্ম দিয়েছেন, সেই সব বিষয়ে আপনাকে কিছু প্রশ্ন জিজ্ঞাসা করতে চাই । Now I would like to ask about your marriage and all the births you have had during your life.

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
D01	আপনার স্বামী কি বর্তমানে আপনার সাথে থাকে নাকি অন্যত্র বসবাস করে? Is your husband living with you now or is he staying elsewhere?	মহিলার সাথে থাকে Living with her .... 1 অন্যত্র বসবাস করে Staying elsewhere 2	→D03
D02	গত ১২ মাসের ভিতর তিনি কতবার বাড়িতে এসেছেন? How often did he come home in the past 12 months?	মোট কতবার Number of times.................................. ☐☐ গত ১২ মাসের ভিতর বাড়িতে আসেননি Did not come in the last 12 months............................... 96	
D03	আপনি কি জীবনে একবার বিয়ে করেছেন নাকি একাধিকবার? Have you married once or more than once?	একবার Once... 1 একাধিকবার More than once.................................... 2	
D04	কোন মাস এবং সালে আপনাদের বিয়ে হয়েছিল? In what month and year did you marry him? একাধিকবার বিয়ের ক্ষেত্রে মহিলার প্রথম বিবাহের মাস এবং সাল লিখুন। If married more than once, write the month and year of her first marriage.	মাস Month.. ☐☐ সাল Year... ☐☐☐☐	
D05	আপনি যখন তাকে বিয়ে করেছিলেন তখন আপনার বয়স কত ছিল? How old were you when you marry him? একাধিকবার বিয়ের ক্ষেত্রে মহিলার প্রথম বিবাহের সময় তার বয়স কত ছিল লিখুন। If married more than once, write woman’s age at her first marriage.	বিয়ের সময় বয়স (পূর্ণ বছরে) Age at marriage in completed years...... ☐☐	
D06	আপনি প্রথমবার কোন সালে গর্ভবতী হয়েছিলেন? In which year have you become pregnant for the first time? প্রথম গর্ভের সাল লিখুন, এমনকি তিনি যদি আগের বিবাহিত জীবনে গর্ভবতী হয়ে থাকেন, তবুও। Write woman’s age at first conception even that was during her earlier marriage.	সাল Year... ☐☐☐☐	
D07	জীবনে প্রথমবার গর্ভবতী হওয়ার সময় আপনার বয়স কত ছিল? How old were you when you got pregnant for the first time? প্রথম গর্ভের সময় মহিলার বয়স লিখুন, এমনকি তিনি যদি আগের বিবাহিত জীবনে গর্ভবতী হয়ে থাকেন, তবুও (একাধিকবার বিবাহিত হলে)। Age at first conception even that was during her earlier marriage (if married more than once).	প্রথম গর্ভের সময় মহিলার বয়স (পূর্ণ বছরে) Age at first conception................................ ☐☐	
D08	আপনার কি কখনও কোন ছেলে মেয়ে হয়েছে? Have you ever given birth?	হ্যাঁ Yes ....1 না No...2	→D013
D09	আপনি জন্ম দিয়েছেন, এমন ছেলে অথবা মেয়ে কি এখন আপনার সাথে বসবাস করছে? Do you have any sons or daughters to whom you have given birth who are now living with you?	হ্যাঁ Yes ....1 না No...2	→D11
D10	কয়জন ছেলে আপনার সাথে বসবাস করছে? কয়জন মেয়ে আপনার সাথে বসবাস করছে? *[কোন ছেলে মেয়ে সাথে বসবাস না করলে, ’00’ লিখুন]* How many sons live with you? And how many daughters live with you?	বাড়ীতে থাকে এমন ছেলের সংখ্যা Sons at home ....|_____|_____| বাড়ীতে থাকে এমন মেয়ের সংখ্যা Daughters at home.........|_____|_____|	
D11	আপনি এমন কোন ছেলে বা মেয়ে এর জন্ম দিয়েছেন কি যারা জীবিত আছে কিন্তু আপনার সাথে বসবাস করে না? Do you have any sons or daughters whom you have given birth who are alive but do not live with you?	হ্যাঁ Yes ....1 না No...2	→D13

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
D12	কয়জন জীবিত ছেলে আছে, যারা আপনার সাথে বসবাস করে না? এবং কয়জন জীবিত মেয়ে আছে, যারা আপনার সাথে বসবাস করে না? *[কোন ছেলে মেয়ে সাথে বসবাস না করলে, '00' লিখুন]* How many sons are alive but do not live with you? And how many daughters are alive but do not live with you?	অন্য কোথাও থাকে এমন ছেলে সংখ্যা Sons Elsewhere.......|_____|_____| অন্য কোথাও থাকে এমন মেয়ের সংখ্যা Daughters elsewhere|_____|_____|	
D13	আপনি কি কখনও এমন কোন ছেলে বা মেয়ে জন্ম দিয়েছেন, যে জীবিত জন্ম নিয়েছিলো কিন্তু পরে মারা গিয়েছিলো? *[যদি না হয়, যাচাই করুনঃ]* এমন কোন ছেলে বা মেয়ে, যে জন্ম নেয়ার পর কেঁদেছিলো বা যার মধ্যে জীবনের লক্ষণ দেখা গিয়েছিল, কিন্তু কয়েক মিনিট বা কয়েক ঘন্টা বা কয়েক দিন মাত্র জীবিত ছিল অর্থ্যাৎ পরে কোন সময় মারা গিয়েছিলো? Have you ever given birth to a boy or girl who was born alive but later died? (Any baby who cried or showed signs of life but did not survive?)	হ্যাঁ Yes ....1 না No...2	→D15
D14	সর্বমোট কয়জন ছেলে মারা গেছে? সর্বমোট কয়জন মেয়ে মারা গেছে? *[ছেলে মেয়ে মারা না গিয়ে থাকলে, '00' লিখুন]* How many boys have died? And how many girls have died?	ছেলে মারা গেছে Boys dead...|_____|_____| মেয়ে মারা গেছে Girls dead...|_____|_____|	
D15	কোন কোন গর্ভাবস্থা পূর্ন মেয়াদের আগেই গর্ভনষ্ট বা গর্ভপাত হিসাবে শেষ হয়ে যেতে পারে। আবার কোন কোন গর্ভাবস্থা মৃতজন্ম বা মৃত শিশুর জন্মও দিতে পারে অর্থাৎ যার জন্মের সময় জীবনের কোন লক্ষন থাকে না। আপনার জীবনে কি কখনও এ ধরনের কোন ঘটনা অর্থাৎ মৃত বাচ্চা জন্ম দেয়া অথবা গর্ভনষ্ট বা গর্ভপাত এর মত ঘটনা ঘটেছিল? Have you had any pregnancies that did not result in live births? Some pregnancies end before full term as miscarriage or an abortion, while others may result in a stillbirth.	হ্যাঁ Yes ....1 না No...2	→D17
D16	মোট কতগুলো গর্ভাবস্থার ক্ষেত্রে মৃত বাচ্চা জন্ম দেয়া অথবা গর্ভনষ্ট বা গর্ভপাত এর মত ঘটনা ঘটেছে? In all, how many pregnancies did not result in a live birth?	গর্ভ নষ্টের সংখ্যা (Pregnancy Loss)...................................... |____|____|	
D17	*[প্রশ্ন D03 , D05, D07 এবং D09 যোগ করুন এবং পাশের বক্সে লিখুন।]*	মোট গর্ভের ফলাফলের সংখ্যা (#of pregnancy outcomes)........... |____|____|	
D18	*[প্রশ্ন D17 দেখুন এবং জিজ্ঞাসা করুন: (CHECK D17 and ask)]* এখন এই হিসাবটি ঠিকভাবে করেছি কিনা তা নিশ্চিত হবার জন্য আপনাকে আবার জিজ্ঞাসা করছি: আপনার ______ জন সন্তান এখন জীবিত (D10+D12) আপনার _______ জন সন্তান মারা গেছে (D14), এবং আপনার _______ টি গর্ভাবস্থার পরে জীবিত সন্তান না হওয়ার মত ঘটনা ঘটেছে (D16) আমার এই হিসাব কি ঠিক? Just to make sure that I have this is correct: you have had ______# children still alive (D10+D12) ______# children have died (D014), and ______# pregnancies which did not result in a live birth (D16)? Is that correct?	হ্যাঁ ....1 না ....2 *[উত্তর যদি "না" হয় তবে প্রশ্ন করুন এবং D08 থেকে D17 শুদ্ধ করুন।]*	→Check D08-D17
D19	*[প্রশ্ন D17 দেখুন এং সঠিক কোড বৃত্তায়িত করুন]* [Check D17 and circle appropriate code]	মোট গর্ভের ফলাফলের সংখ্যা 01 বা তার অধিক (Total pregnancy 01 or more) ....1 মোট গর্ভের ফলাফলের সংখ্যা 00 (Total pregnancy 00)........................2	→End

Section E: খাদ্য নিরাপত্তাহীনতা মূল্যায়ন সম্পর্কিত মডিউল (Food Insecurity assessment module)

This Section seeks to obtain data of household food security status.
এই সেকশনটিতে আলোচনা করা হয়েছে খানার নিরাপদ খাদ্যাভাসের তথ্য সম্পর্কে

No	QUESTIONS AND FILTERS	Response	If yes, how often did this happen? কতো ঘন ঘন এরকম হয়েছে?
E 01	আপনাদের খানায় অভাবের কারনে যথেষ্ট খাবার থাকবেনা, বিগত ৪ সপ্তাহে এরকম কোন দুশ্চিন্তা হয়েছিল কি? In the past four weeks, did you worry that your household would not have enough food due to scarcity ?	না No....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)..........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে) Often (more than ten times in the past four weeks)..............3
E 02	আপনারা সাধারণত যে ধরণের খাবার খেয়ে থাকেন, গত ৪ সপ্তাহে অভাবের কারণে আপনি বা আপনাদের খানার কোনো সদস্য কি সে ধরণের খাবার খেতে পারেননি? In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	না No....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)..........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে) Often (more than ten times in the past four weeks)..............3
E 03	গত ৪ সপ্তাহে আপনি বা আপনাদের খানার কোনো সদস্যকে কি অভাবের কারণে সীমিত রকমের (Variety) খাবার খেতে হয়েছে, অর্থাৎ আগে যত পদ খেতেন গত ৪ সপ্তাহে অভাবের কারণে তার চেয়ে কম পদ খেতে হয়েছে?In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	না No....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)..........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে) Often (more than ten times in the past four weeks)..............3
E 04	গত ৪ সপ্তাহে আপনাকে বা আপনার খানার কোনো সদস্যকে, যে খাবার সাধারনত আপনারা খান না, অভাবের কারনে তা খেয়ে থাকতে হয়েছে কি?In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	না No....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)..........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে) Often (more than ten times in the past four weeks)..............3
E 05	গত ৪ সপ্তাহে আপনাকে বা আপনার খানার কোনো সদস্যকে কি সাধারনত প্রতিবেলা যে পরিমান খান, অভাবের কারনে তার থেকে কম খেয়ে থাকতে হয়েছে? In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	না No....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)..........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে) Often (more than ten times in the past four weeks)..............3
E06	গত ৪ সপ্তাহে আপনাকে বা খানার কোনো সদস্যকে, অভাবের কারনে কোনো বেলা না খেয়ে থাকতে হয়েছে কি?In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?	না No....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)..........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে) Often (more than ten times in the past four weeks)..............3
E07	গত ৪ সপ্তাহে এমনকি হয়েছে যে আপনার খানায় অভাবের কারনে খাওয়ার জন্য কোন খাবার ছিল না?In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	না No....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)..........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে) Often (more than ten times in the past four weeks)..............3
E08	গত ৪ সপ্তাহে আপনাকে বা আপনার খানার অন্য কোনো সদস্যকে কি ঘরে যথেষ্ট খাবার না থাকার কারনে ক্ষুধার্ত অবস্থায় রাতে ঘুমাতে হয়েছে?In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	না No....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)..........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে)

			Often (more than ten times in the past four weeks)...............3
E09	গত ৪ সপ্তাহে আপনাকে বা আপনার খানার অন্য কোনো সদস্যকে কি যথেষ্ট খাবার না থাকার কারনে সারাদিন এবং সারারাত না খেয়ে থাকতে হয়েছে? In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	না No.....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)...........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে) Often (more than ten times in the past four weeks)...............3
E10	গত ৪ সপ্তাহে আপনার খানায় যথেষ্ট চাল না থাকার কারনে কি আপনাকে বা আপনার খানার অন্য কোনো সদস্য কে চাল ধার করে এনে খেতে হয়েছে? In the past four weeks, did you or any household member have to borrow rice because you did not have enough rice?	না No.....................0 হ্যাঁ Yes 1	কদাচিৎ (১-২ বার, গত ৪ সপ্তাহে) Rarely (once or twice in the past four weeks) ....1 মাঝে মাঝে (৩-১০বার, গত ৪ সপ্তাহে) Sometimes(three to ten times in the past four weeks)...........2 প্রায়ই (১০ এর অধিক, গত ৪ সপ্তাহে) Often (more than ten times in the past four weeks)...............3
E11	বছরের অন্যান্য সময়ের তুলনায় আপনার খানা কি কার্তিক/চৈত্র মাসে (মঙ্গাকালীন সময়) খাদ্যের অভাবে থাকে? Compared to other times, does your household face food deficiency during Kartik/chyatra (Monga)?	না No.....................0 হ্যাঁ Yes 1	কোনও পার্থক্য নাই No difference...1 গুণগত মান কম Reduced quality..2 পরিমাণে কম Reduced quantity 3
E12	আপনার খানার আয় ও খাদ্যের খরচ হিসেব করে আপনি আপনাদের অবস্থাকে কি বলবেন? What would you think is the status of your household in terms of food availability?		সবসময় ঘাটতি Always deficit...1 মাঝে মাঝে ঘাটতি Deficit sometimes ....2 ঘাটতিও না উদ্বৃত্তও না Adequate (Neither deficit nor surplus) ....3 খাদ্য উদ্বৃত্ত থাকে Food surplus..4

International Centre for Diarrhoeal Disease Research, Bangladesh [icddr,b]

Bundling of nutrition-specific interventions

Pregnancy outcome/Birth form

গর্ভাবস্থার পরিণতি/শিশুর জন্ম তালিকাভুক্তির ফর্ম

Cluster |___|___|

Address and identification information with codes মহিলার ঠিকানা এবং সনাক্তকরণ তথ্য কোডসহ

101	জেলা **District**		Pre-filled		Pre-filled			
102	উপজেলা **Upazila**		Pre-filled		Pre-filled			
103	ইউনিয়ন **Union**		Pre-filled		Pre-filled			
104	গ্রাম **Village**		Pre-filled		Pre-filled			
105	বাড়ি **House**		Pre-filled		Pre-filled			
106	খানা **Household**		Pre-filled		Pre-filled			

107	মহিলার আইডি নম্বর **Woman's ID**		P | r | e | - | f | i | l | l | e | d | |		
108	মহিলার নাম **Woman's Name**		Pre-filled		
109	স্বামীর নাম **Husband's Name**		Pre-filled		
110	খানা প্রধানের নাম **Household Head's Name**		Pre-filled		
111	যোগাযোগ করার জন্য এই খানার মোবাইল নম্বর **Contact phone number to communicate in this HH**		1. Pre-filled 2. Pre-filled		
112	ডিসি-এর নাম এবং কোড **Name & Code of DC**		**নাম Name**		**কোড Code** Pre-filled
113	ইন্টারভিউয়ের তারিখ **Date of interview**		|__|__| |__|__| |___|___| দিন মাস বছর		**Visit serial 1/2/3** |___|
114	সাক্ষাৎকারের রেসাল্ট কোড **Interview result code**	|___|	**1 = Measurement completed** **2 = Participant absent** **3 = Migration out** **4 = Partial refusal to take measurement/interview** **5 = Full refusal to take measurement/ interview** **6 = Death of participant** **7 = Mechanical problem** **8 = Others**____________________		
115	**Time of interview**	|___|___| : |___|___| **Hour : Minute**			

Q#	QUESTIONS AND FILTERS	CODING CATEGORIES		Skip
201	আপনার এই গর্ভে, অর্থাৎ যে গর্ভের কারণে তালিকাভুক্ত হয়েছেন, তাতে কয়জন বাচ্চা হয়েছে? How many birth you have had in this pregnancy?	একটি বাচ্চা One	1	
		একাধিক Multiple	2	
202	একাধিক হলে, কয়জন? In case of multiple birth, how many children do you have?	|__| জন Individual		
203	**Outcome serial** **[204-end to be repeated in case of multiple births]**	|__|		
204	শিশুর জন্মের তারিখ Child's date of birth	|___|___||___|___| |___|___| দিন Day মাস Month বছর Year		
205	জন্মের সময় Child's time of birth	|___|___| : |___|___| ঘন্টা Hour মিনিট Minute		
এখন আমি আপনাকে এই বাচ্চার ডেলিভারির সময়ের অবস্থা সম্পর্কে কিছু প্রশ্ন করবো Now I will ask you some questions about the condition of this baby's delivery time				
206	আপনার বাচ্চা এখন কেমন আছে? How is your baby now?	ভাল Good	1	
		অসুস্থ Unwell	2	
		মারা গেছে Died	3	
207	ডেলিভারির পর বাচ্চা কি সাথে সাথে শ্বাস নিয়েছিল? Did the baby breathe immediately after delivery?	হ্যাঁ Yes	1	
		না No	2	
		জানি না/ খেয়াল নাই Don't know/ Can't remember	9	
208	ডেলিভারির সময় বাচ্চাকে কি শ্বাস নিতে সাহায্য করতে হয়েছিল? Did the baby need help to breathe during delivery?	হ্যাঁ Yes	1	
		না No	2	
		জানি না/ খেয়াল নাই Don't know/ Can't remember	9	
209	ডেলিভারির পর বাচ্চাটি কি একটু হলেও/একবার-ও কি কেঁদেছিল? Did the baby cried at least for once after delivery?	হ্যাঁ Yes	1	
		না No	2	
		জানি না/ খেয়াল নাই Don't know/ Can't remember	9	
210	ডেলিভারির পর বাচ্চাটি কি একটু হলেও/একবার-ও কি নড়াচড়া করেছিল? Did the baby moved a least a bit after delivery?	হ্যাঁ Yes	1	
		না No	2	
		জানি না/ খেয়াল নাই Don't know/ Can't remember	9	
207, **209**, **210** যাচাই করুনঃ ৩টি কোডই 'না' হলে (বাচ্চা কখনো শ্বাস নেয়নি, কেঁদে উঠেনি, নড়াচড়া করেনি) 211 - তে যান; ৩টি কোডের যেকোন একটি 'হ্যাঁ' হলে সরাসরি **212**- তে যান Check **207, 209, 210**. If all three are coded as 'No' (The baby did not breathe, cry and moved), fill **211**. If any of the three are coded as 'Yes', skip to **212.**				
211	যদি বাচ্চাটি শ্বাস না নিয়ে থাকে, না কেঁদে থাকে বা নড়াচড়া না করে থাকে, তাহলে বাচ্চাটি কি মৃত জন্মেছিল? If the baby did not breathe, cry or move, was it still birth?	হ্যাঁ Yes	1	
		না No	2	
		জানি না/ খেয়াল নাই Don't know/ Can't remember	9	
212	বাচ্চা কি ছেলে না মেয়ে? Is the child a boy or a girl?	ছেলে Boy	1	
		মেয়ে Girl	2	
213	আপনার বাচ্চার ডেলিভারি/জন্ম কোথায় হয়েছে? Where was your baby delivered/born? প্রোব করুন Please probe **[বাচ্চার জন্ম এক জায়গায় আর নাড়ী কাটা/ফুল পড়া অন্য জায়গায় হলেঃ বাচ্চার জন্ম যেখানে হয়েছে সেটি বৃত্তায়িত করুন]** (If the baby is born in one place and	বাসায় **At home** নিজের বাসায় At own home	11	
		মহিলার মা-বাবার বাসায় At the participant's parents' house	12	
		মহিলার শ্বশুরবাড়িতে At the participant's in-laws' house	13	
		অন্য আত্মীয়ের বাড়িতে At relatives' house	14	

Q#	QUESTIONS AND FILTERS	CODING CATEGORIES		Skip
	cord is cut in another place, circle the place where the baby was born)	অনাত্মীয় বাড়িতে At unrelated persons' house	15	
		সরকারি প্রতিষ্ঠান Public sector সরকারি মেডিকেল কলেজ হাসপাতাল Medical college hospital	21	
		জেলা হাসপাতাল District hospital	22	
		মা ও শিশু কল্যাণ কেন্দ্র Maternal and Child Welfare Centre	23	
		উপজেলা স্বাস্থ্য কমপ্লেক্স Upazila Health Complex	24	
		ইউনিয়ন স্বাস্থ্য ও পরিবার কল্যাণ কেন্দ্র Health and Family Welfare Centre	25	
		স্যাটেলাইট ক্লিনিক/ইপি আই সেন্টার Satellite clinic/EPI centre	26	
		কমিউনিটি ক্লিনিক Community clinic	27	
		সরকারি অন্যান্য (উল্লেখ করুন) Other (Please specify)______________________	28	
		বেসরকারি সেক্টর NGO sector এনজিও স্থায়ী ক্লিনিক/স্বাস্থ্য কেন্দ্র NGO static clinic	31	
		এনজিও স্যাটেলাইট ক্লিনিক NGO satellite clinic	32	
		ব্র্যাক স্বাস্থ্য কেন্দ্র BRAC Health Center	33	
		এনজিও অন্যান্য (উল্লেখ করুন) Other (Please specify)____________________________________	36	
		প্রাইভেট মেডিকেল সেক্টর Private medical sector প্রাইভেট হাসপাতাল/ক্লিনিক Private hospital/Clinic	41	
		পাশ করা ডাক্তারের চেম্বার MBBS doctor (Qualified)	42	
		সনাতন চিকিৎসকের চেম্বার Traditional doctor	43	
		ফার্মেসি/ওষুধের দোকান Pharmacy	44	
		প্রাইভেট মেডিকেল কলেজ হাসপাতাল Private Medical College	45	
		অন্যান্য (উল্লেখ করুন) Other (Please specify)	96	
		জানি না Don't know	99	
214	বাচ্চা ডেলিভারিতে কে সাহায্য করেছিলেন? Who assisted with the delivery of your child? একটি মাত্র মানুষের কথা উল্লেখ করলে জিজ্ঞাসা করুনঃ অন্য কেউ? When referring to only one person, ask: Anyone else? [একাধিক উত্তর হতে পারে] There may be multiple responses যদি বলে থাকেন যে কেউ সাহায্য করেননি, তাহলে প্রোব করে বের করুন কোন প্রাপ্তবয়স্ক মানুষ উপস্থিত ছিলেন কি না। If the participant says no one helped, probe to see if an adult was present during delivery.	**স্বাস্থ্য পেশাজীবী** **Health Personnel** পাশ করা ডাক্তার Qualified Doctor	A	
		নার্স/ধাত্রী/প্যারামেডিক Nurse/Midwife/Paramedic	B	
		এফ ডব্লিউ ভি (পরিবার কল্যাণ পরিদর্শিকা) Family Welfare Visitor	C	
		কমিউনিটি ভিত্তিক দক্ষ ধাত্রী (CSBA) Community Skilled Birth Attendant	D	
		এম এ/সেকমো Sub-Assistant Community Medical Officer	E	
		স্বাস্থ্য সহকারী Health assistant (HA)	F	
		পরিবার কল্যাণ সহকারী FWA Family Welfare Assistant	G	
		সি এইচ সি পি Community Health Care Provider	H	
		অন্যান্য পেশাজীবী **Other Personnel**	I	

Q#	QUESTIONS AND FILTERS	CODING CATEGORIES		Skip
		ব্র্যাক স্বাস্থ্যকর্মী BRAC Health Worker		
		ব্র্যাক স্বাস্থ্যসেবিকা BRAC Health Nurse	J	
		মামনি'র প্যারামেডিক/হেলথ কর্মী MAMONI's Paramedic/ Health Worker	K	
		অন্যান্য এন জি ও কর্মী Other NGO workers	L	
		প্রশিক্ষণপ্রাপ্ত ধাত্রী/দাই Trained TBA (TTBA)	M	
		সনাতন (প্রশিক্ষণবিহীন) ধাত্রী/দাই Untrained TBA	N	
		পাশ না করা ডাক্তার Unqualified Doctor	O	
		সনাতন ডাক্তার Traditional doctor	P	
		কলেরা হাসপাতাল স্বাস্থ্যকর্মী/ CHW	Q	
		হোমিওপ্যাথ/হোমিওপ্যাথ ওষুধের দোকান Homeopath/ Homeopathy pharmacy	R	
		আয়ুর্বেদিক চিকিৎসক/আয়ুর্বেদিক ওষুধের দোকান/হেকিম/কবিরাজ Ayurvedic doctor/ Ayurvedic pharmacy/ Hakim/ Kaviraj	S	
		গ্রাম্য ডাক্তার Village Doctor	T	
		ওষুধ বিক্রেতা/ফার্মেসি Pharmacy	U	
		ইমাম/ঝাড়-ফুঁক/ওঝা Imam/ Ojha	V	
		আত্মীয়-স্বজন Relatives	W	
		প্রতিবেশি/বন্ধু-বান্ধব Neighbours	Y	
		অন্যান্য (উল্লেখ করুন) Other (Please specify)____________________	X	
215	ডেলিভারির ধরণ Type of delivery: বাচ্চা কিভাবে ডেলিভারি হয়েছে? How was the baby delivered?	স্বাভাবিক Normal Delivery	1	
		এসিস্টেড ডেলিভারি Assisted delivery	2	
		সিজার Caesar	3	
216	যখন বাচ্চা/(নাম) জন্মেছিলো, তখন কি সে অনেক বড়/স্বাভাবিকের চেয়ে বড়/স্বাভাবিক/স্বাভাবিকের চেয়ে ছোট/অনেক ছোট হয়েছিল? What was the size of your baby according to you? **[শুধুমাত্র মায়ের নিজের ধারণা সংগ্রহ করুন] Only note mother's own opinion**	অনেক বড় Much larger than usual	1	
		স্বাভাবিকের থেকে বড় Larger than usual	2	
		স্বাভাবিক Normal/Usual	3	
		স্বাভাবিকের থেকে ছোট Smaller than usual	4	
		খুব/অনেক ছোট Much smaller than usual	5	
		জানি না/বলতে পারছি না/খেয়াল নাই Don't know/Can't remember	9	
217	বাচ্চা এখন কি খাচ্ছে? What the baby is being fed now?	বুকের দুধ Breast milk	1	→219
		বুকের দুধ ছাড়া অন্য কিছু Anything other than breast milk	2	→218
		বুকের দুধ, সাথে অন্য পানীয় Breast milk & other drinks	3	→218
		বাচ্চা এখন মৃত The Child is dead	4	→219
218	উত্তর 'অন্য কিছু' হলেঃ উল্লেখ করুন If the response is 'Anything else', please specify	____ ____ __________		
219	জন্মের পর প্রথম বাচ্চাকে মুখে কি দিয়েছিলেন? What was the first thing you fed the baby after birth? [পড়ে শোনাবেন না, মা যা বলে তাই লিখুন;	বুকের দুধ Breat milk	01	
		মধু Honey	02	
		মিশ্রি/চিনি/গ্লুকোজের পানি Misri/ Sugar/ Glucose water	03	
		চিনি-লবন-পানির শরবত Sugar-salt-water syrup	04	
		শুধু পানি/গরম পানি Only water/ hot water	05	

Q#	QUESTIONS AND FILTERS	CODING CATEGORIES		Skip
	খাবার জন্য বা অন্য যেকোন কারণে মুখে যা দিয়েছেন] Do not read the options	সরিষার তেল Mustard oil	**06**	
		সুজি/মাড় Semolina/Starch	**07**	
		ফলের রস Fruit juice	**08**	
		গরু-ছাগলের দুধ Cow/Goat milk	**09**	
		প্যাকেটের তরল দুধ Packaged liquid milk	**10**	
		কৌটার দুধ Powdered milk	**11**	
		ল্যাক্টোজেন Lactogen	**12**	
		বাচ্চা এখন মৃত, জীবিত অবস্থায় মুখে কিছুই দেয়নি The child is died before feeding anything	**13**	
		অন্যান্য (উল্লেখ করুন) Other (Please specify)____________________	**96**	
		জানি না/মনে নাই Don't know/Can't remember	**99**	
220	জন্মের পর প্রথম কখন বাচ্চাকে বুকের দুধ দিয়েছেন? When was the baby breast-fed for the first time after birth?	**1** ঘন্টা ... |__|__| ঘণ্টা পর Hour	**2** দিন ... |__|__| দিন Day	
		এখনো বুকের দুধ দেয়নি Yet not Breast-fed **96**	জানি না/মনে নাই Don't know/Can't remember........... **99**	

International Centre for Diarrhoeal Disease Research, Bangladesh

Bundling of nutrition-specific interventions

Questionnaire for IYCF Practice

দুই বছরের কম বয়সী শিশুর খাদ্য গ্রহণ এবং পুষ্টি বিষয়ক প্রশ্নপত্র

সাক্ষাতকার গ্রহণ শুরুর সময়: Interview start time ☐☐-☐☐

ঘন্টাHour **মিনিট** Minute

সনাক্তকরণ (Identification)

<table>
<tr><th></th><th>নাম Name</th><th>কোড Code</th><th></th></tr>
<tr><td>জেলা
District</td><td></td><td>☐</td><td rowspan="10">সাক্ষাৎকার শুরু হবার সময়:
Interview starting time:
|____|____|:|____|____|
ঘন্টা (Hour) মিনিট (Min)

সাক্ষাৎকার শেষ করার সময়:
Interview end time:
|____|____|:|____|____|
ঘন্টা (Hour) মিনিট (Min)</td></tr>
<tr><td>উপজেলা
Sub-district</td><td></td><td>☐☐</td></tr>
<tr><td>ইউনিয়ন
Union</td><td></td><td>☐☐☐</td></tr>
<tr><td>গ্রামের নাম ও কোড
Name of village & code</td><td></td><td>☐☐☐☐</td></tr>
<tr><td>বাড়ির নাম ও নং
Name of the house & number</td><td></td><td>☐☐☐</td></tr>
<tr><td>খানা প্রধানের নাম ও খানা নং
Name of household head & HH #</td><td></td><td>☐☐</td></tr>
<tr><td>শিশুর মায়ের নাম ও নং
Name & number child’s mother</td><td></td><td>☐</td></tr>
<tr><td>দুই বছরের কম বয়সী শিশুর নাম ও নং
Name & number child’s mother</td><td></td><td>☐</td></tr>
<tr><td>সাক্ষাৎকার গ্রহনকারীর নাম ও কোড
Interviewer’s Name and code</td><td></td><td>☐☐</td></tr>
<tr><td>সাক্ষাৎকার গ্রহণের তারিখ
Interview Date</td><td colspan="2">|____|____|-|____|____|-|____|____|
দিন - মাস - বছর</td></tr>
</table>

Feeding practice 0-23 মাস বয়সী শিশুর তথ্য

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
01	<নাম> কে কখনও বুকের দুধ খাইয়েছিলেন কি ? Have you ever breastfed <Name>?	হ্যাঁ Yes...1 না No...2	 →03
02	<নাম> কি এখনও বুকের দুধ খায়? Are you still breast-feeding <Name>?	হ্যাঁ Yes...1 না No...2	 →03
03	আপনার শিশুটিকে কখনও কাপে, বোতলে বা চামচে বুকের দুধ খাওয়ানো হয়েছে কি? Has (NAME) ever consumed breastmilk in spoon, cup or bottle?	হ্যাঁ Yes...1 না No...2	 →05
04	গতকাল সারাদিন (সকাল ও রাত) আপনার শিশুকে (নাম) এমন কোন উপায়ে বুকের দুধ খাইয়েছেন কি? Did (NAME) consume breast-milk in any of these ways yesterday during the day or at night?	হ্যাঁ Yes...1 না No...2	
05	<নাম> -এর জন্মের পর কত মাস পর্যন্ত তাকে বুকের দুধ খাইয়েছিলেন ? *[1 (এক)মাসের কম হলে মাসের ঘরে 00 লিখুন]* How many months after birth have you breastfed your child?	মাস month |_____|_____|	
06	<নাম> কে গতকাল 24 ঘন্টার মধ্যে দিনে বা রাতে যেসকল তরল বা শক্ত খাবার খেতে দিয়েছিলেন সে সম্পর্কে আমি এখন জানতে চাই। <নাম> কে কি নিম্নলিখিত পানীয় বা খাবারগুলো খেতে দিয়েছিলেন? এমন কি অন্যান্য খাবারের সাথে সংমিশ্রনে হলেও? যেমন: Now I would like to ask you about liquids or foods that <NAME> had yesterday during the day or at night. I am interested in whether your child had the item I mention even if it was combined with other foods.		

7	**পানীয়ের নাম Name of the drink**	**হ্যাঁ Yes (1)**	**না No (2)**	**জানিনা/মনে নাই Don't know/Can't remember (9)**
A	শুধু পানি Only water	1	2	9
B	মধু Honey	1	2	9
C	চিনি/মিশ্রীর পানি Sugar/ Rock-sugar mixed water	1	2	9
D	ফলের রস (বাসায় ফল থেকে বানানো) Fruit juice (Homemade)	1	2	9
E	ফলের রস (দোকান থেকে কেনা বা প্যাকেটজাত জুস) Fruit juice (Readymade / packaged juice)	1	2	9
F	গুঁড়া দুধ (ফ্রেশ, মার্ক্স, ডানো, এঙ্কোর, রেড কাউ ইত্যাদি) Powdered milk (Fresh, Marks, Dano, Anchor, Red Cow etc.)	1	2	9
G	ইনফ্যান্ট ফর্মুলা/শিশুদের জন্য বিশেষ গুঁড়া দুধ (ল্যাক্টোজেন, মাই বয়, বায়োমিল ইত্যাদি) Infant formula/ Special milk powder for babies (Lactogen, My Boy, Biomil etc.)	1	2	9
H	গরুর দুধ/দই Cow milk/curd	1	2	9
I	ছাগল/মহিষের দুধ/দই Goat/Buffalo milk or curd	1	2	9
J	প্যাকেটজাত তরল দুধ (প্রাণ,আড়ং, মিল্কভিটা, ফার্মফ্রেশ ইত্যাদি) Packaged liquid milk (Pran, Arong, Milk Vita, Farm Fresh etc.)	1	2	9
K	অন্য কোন তরল খাবার (ডাবের পানি, সুপ, চা ইত্যাদি – উল্লেখ করুন) Any other liquid food (Coconut water, Soup, Tea etc.- Please specify) ____________________________	1	2	9
207 a	F, G, H, I, J চেক করুন, যেগুলো 'হ্যাঁ' হয়েছে, জিজ্ঞাসা করুন গতকাল দিনে ও রাতে কতবার এই পানীয়গুলো খেয়েছে। 'জানিনা/মনে নাই' বললে '99' কোড করুন। Check F, G, H, I, J. For the response "Yes", ask how many times have these drinks been consumed during the day and night yesterday. For the response 'Don't know/Can't remember', use code 99.			
F	গুঁড়া দুধ (ফ্রেশ, মার্ক্স, ডানো, এঙ্কোর, রেড কাউ ইত্যাদি) Powdered milk (Fresh, Marks, Dano, Anchor, Red Cow etc.)	|___|___| বার Times		
G	ইনফ্যান্ট ফর্মুলা/শিশুদের জন্য বিশেষ গুঁড়া দুধ (ল্যাক্টোজেন, মাই বয়, বায়োমিল ইত্যাদি) Infant formula/ Special milk powder for babies (Lactogen, My Boy, Biomil etc.)	|___|___| বার Times		
H	গরুর দুধ/দই Cow milk/curd	|___|___| বার Times		
I	ছাগল/মহিষের দুধ/দই Goat/Buffalo milk or curd	|___|___| বার Times		
J	প্যাকেটজাত তরল দুধ (প্রাণ,আড়ং, মিল্কভিটা, ফার্মফ্রেশ ইত্যাদি) Packaged liquid milk (Pran, Arong, Milk Vita, Farm Fresh etc.)	|___|___| বার Times		
এখন মনে করে বলুন গতকাল (নাম) কি খাবার স্যালাইন এবং ওষুধ খেয়েছে? Now please try to recall, if <Name> had consumed any Orsaline or medicine yesterday?				
208	**ওষুধের নাম Name of the medicine**			
A	খাওয়ার স্যালাইন Oral saline	1	2	9

7	**পানীয়ের নাম Name of the drink**	**হ্যাঁ Yes (1)**	**না No (2)**	**জানিনা/মনে নাই Don't know/Can't remember (9)**
B	ভিটামিন ড্রপ বা অন্য কোন ওষুধ ড্রপ হিসাবে Vitamin or any other medicine's drop	1	2	9
C	অন্য কোন ওষুধ Any other medicine	1	2	9

209	**খাবারের নাম**	**হ্যাঁ (1)**	**না (2)**	**জানিনা/মনে নাই (9)**
A	সুজি/চালের সুজি Samolina	1	2	9
B	সেরেল্যাক বা এরকম চাল/গমের গুঁড়ার বাচ্চাদের কেনা খাবার Any commercially fortified baby food like Cerelac?	1	2	9
C	ভাত/জাউ rice/ porridge	1	2	9
D	খিচুড়ি khicuri/mixed rice	1	2	9
E	অন্য শস্যজাতীয় (চাল, গম, ভুট্টার তৈরি) খাবার (রুটি, মুড়ি, চিড়া, নুডলস, চাপাতি ইত্যাদি) Bread, puffed rice, noodles, or other foods made from grains?	1	2	9
F	আলু, ভেতরে সাদা মিষ্টি আলু, কাঁচকলা, কাসাভা potatoes, sweet potato, casava, green banana, white yams, , or any other foods made from roots?	1	2	9
G	মিষ্টি কুমড়া (মিষ্টি লাউ), গাজর, ভেতরে কমলা/গাঢ় হলুদ মিষ্টি আলু ইত্যাদি যেসব সব্জির ভেতরে কমলা/গাঢ় হলুদ Pumpkin, carrots, squash that are yellow or orange inside?	1	2	9
H	পাকা পেঁপে/আম/বাঙ্গি/তাল/ডেউয়া (ভেতরে কমলা/গাঢ় হলুদ), কালোজাম ripe papaya, mango, honey melon, black berry, fruits that are yellow or orange inside other Vitamin A rich fruits	1	2	9
I	যেকোন সবুজ শাকপাতা, লালশাক Any dark green, leafy vegetables like spinach, poi sag, methi, kolmi, kochu, palak?	1	2	9
J	অন্য যেকোন সবজি (কাঁচা কুমড়া/পেঁপে, পটল, শিম, ঢেঁড়স, চিচিঙ্গা, বেগুন, টমেটো, করল্লা, বরবটি, শশা, মুলা ইত্যাদি) other vegetables such as green pumpkin, bean, okara, eggplant, tomato, cucumber, long beans etc	1	2	9
K	ডিম (হাঁস/মুরগি/অন্য পাখির ডিম) Egg	1	2	9
L	মাছ (যেকোন ধরণের ছোট বা বড় মাছ, বা মাছের ডিম) Fish	1	2	9
M	শুঁটকি মাছ (যেকোন ধরণের) Dried fish	1	2	9
N	হাঁস/মুরগি/কবুতর বা অন্য কোন পাখির মাংস chicken/duck or other bird meat	1	2	9

209	**খাবারের নাম**	**হ্যাঁ (1)**	**না (2)**	**জানিনা/মনে নাই (9)**
O	হাঁস/মুরগি/কবুতর বা অন্য কোন পাখির কলিজা chicken/duck or other bird liver	1	2	9
P	গরু/ছাগল/ভেড়া/অন্য প্রাণীর মাংস animal meat meat, such as beef, lamb, goat or other animal	1	2	9
Q	গরু/ছাগল/ভেড়া/অন্য প্রাণীর কলিজা cow/goat/lamb or other animal liver	1	2	9
R	ডাল (যেকোন ধরনেরঃ মুগ, মসুর, অড়হর, খেসারি, ছানার ডাল, মটর ডাল, কলাই ইত্যাদি) peals, lentils	1	2	9
S	বাদাম ও বীজ-জাতীয় (চিনাবাদাম, শাপলা বা পদ্মের গোটা, শিমের বীচি, কাঁঠালের বীচি ইত্যাদি) nuts or seeds	1	2	9
T	পনির, ঘন দই ইত্যাদি দুধের খাবার cheese, yougart	1	2	9
U	খাবারে দেয়া তেল বা চর্বি (সয়াবিন, সরিষার তেল, চর্বি, মাখন, ঘি ইত্যাদি) oil, butter, animal fat	1	2	9
V	মিষ্টি খাবার (চকলেট, মিষ্টি, লজেন্স, কেক, বিস্কুট ইত্যাদি) sweets (cokolates, sweets, lolies, cake, biscuits etc.)	1	2	9
W	খাবারে দেয়া কোন মশলা (লবণ,আদা,পেঁয়াজ,রসুন,হলুদ, কাঁচামরিচ,তেজপাতা,দারচিনি,এলাচ,জিরা,ধনে,শুঁটকির গুঁড়া ইত্যাদি) spices used in food such as salt, ginger, onion, garlic, bayleaf, cardamom, corriender, cumin etc	1	2	9
X	অন্য কোন খাবার যেটা এখানে উল্লেখ নাই (_____________) others specify	1	2	9
Z	কোন ধরনের পুষ্টিকণা/সাপ্লিমেন্ট (মনিমিক্স, সাপ্লিমেন্ট) nutrient supplement	1	2	9
XXa	খেয়ে থাকলেঃ কতবার খেয়েছে? [জানিনা/মনে নাই - 9] how many times name was fed liquid, semi-solids or solid foods? [dont know/can not remeber-9]	|__| বার times		