Effects of an integrated intervention on the nutritional status and IYCF practices under two years of children in the southern part of Bangladesh

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ABSTRACT: Objective: The significance of appropriate infant and young children feeding (IYCF) to ensure proper nutrition for children is well-documented. Although nutrition interventions with agricultural components have the potential, the evidence for this relationship is insufficient. The objective of this study was to evaluate the effects of an integrated health-based intervention on the dietary pattern and nutritional status of children under two years of age. **Methodology:** This study was a pre-post analysis of secondary data of the project titled "Integrated Agriculture and Health-Based Interventions for Improved Food and Nutrition Security in Selected Districts of Southern Bangladesh", which were collected from Barisal and Khulna district. We used data of 268 children aged 0-23 months from baseline and 554 children from endline which comprised the study population to assess socio-demographic, anthropometric and IYCF indicators. Further, horticulture, cooking and hygiene indices were created to analyze the effectiveness of the project interventions. **Results:** A significant reduction of stunting and underweight and insignificant reduction of wasting were observed from baseline to end line. Compared to baseline, the horticulture index, hygiene index and cooking index differ significantly between the baseline and end line surveys. Further, significant improvement of 6 months exclusive breastfeeding and insignificant improvement of continued breastfeeding up to 1 year were found from baseline to end line. **Conclusion:** This study shows that integrated agriculture and health-based interventions with nutrition components have a positive impact on stunting and underweight but exert a mixed effect on wasting and IYCF practices.

KEYWORDS: IYCF, agricultural intervention, malnutrition

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Introduction

Poor nutrition is being considered one of the greatest obstacles to the survival, development, and learning of children. Globally, in children under two years of age, 51 million suffer from stunting and 23 million from wasting (UNICEF, 2021a). Evidence suggests that, globally, 70% of the shortfall in height accumulated by the age of five is due to growth faltering occurring before the age of two (Leroy et al., 2014). Child Malnutrition and infectious diseases are found to be the prime reasons for 45% of the 5.9 million child death throughout the world (Sheikh et al., 2019). The Southern Asia sub-region experiences a significantly higher level of stunting and wasting compared to global malnutrition (WHO, 2021).

Infant and young child feeding practices (IYCF) that are suboptimal have a significant impact on undernutrition, and morbidity and mortality in children under the age of five (Black et al., 2008). Proper IYCF practices not only increase the chance of survival but also enhance optimal growth and development during the critical window period from birth to 2 years of age (BaSaleem and Al-Sakkaf, 2021). By ensuring optimal complementary feeding alone, we can prevent approximately 6% of deaths among under-fives (600,000 deaths per year) (Jones et al., 2003). A recent multi-country analysis involving 21 low-income countries reported that inadequate complementary feeding practices are associated with negative growth patterns (Onyango et al., 2014). Age-appropriate diet, diet quality in terms of energy and nutrient density, diet diversity, feeding time, and frequency are crucial for optimal child growth and development. Growth faltering is most likely to occur between 3-24 months of age (Na et al., 2018); thus, WHO recommends an evidence-based guideline for appropriate feeding and care practices of infants and young children aged between 0-24 months (WHO, 2010; Bloem et al., 2013). Despite impressive improvements in child health in Bangladesh, 31% of under-fives are still stunted, 8% are wasted, and 28% are underweight. In addition, in children aged 6-23 months, 38% were fed minimum diversified diets (MDD), 81% had a minimum meal frequency (MMF) and 35% had a minimum acceptable diet (MAD) (NIPORT, and ICF. 2019). To improve IYCF practices globally, several interventions, such as integrated child development services provided through community-based workers (Chaturvedi et al., 2014), peer counselling by mother support groups (Kushwaha et al., 2014), and social and behavioural change communication (Menon et al., 2016), have been implemented.

However, in Bangladesh, to improve IYCF practices and achieve the sustainable development goals related to child nutrition, the Second National Plan of Action for Nutrition (NPAN-2) set objectives to reduce stunting among under-5 children by 25% and increase the proportion of children aged 6-23 months receiving MAD to be over 40% by 2025. There are government and non-government organizations (NGOs) providing nutrition-sensitive and specific interventions at the community level for sustainable development (MOHFW, 2017). As a result, nutrition-sensitive agriculture has emerged as a means of defining agricultural investments to improve nutrition by working with a food system that is better equipped to produce good nutritional outcomes (FAO, 2015). Nutritional status is strongly influenced by feeding practices, so improving IYCF practices can play an important role in achieving NPAN-2 objectives. Nevertheless, introducing appropriate feeding practices and therefore combating child malnutrition requires a multidimensional approach, including food safety programmes, deworming programmes, and water, sanitation, and hygiene programmes at the community level (MOHFW, 2017). However, evidence for determining best practices combining agriculture and child health remains limited.

The southern districts of Bangladesh, geographically vulnerable, climate change, frequent natural disasters contribute to limited dietary diversity and create a significant burden of malnutrition (BRAC Institute of Global Health, 2013). Integrated agriculture and health-based intervention were combined along with nutrition education in the southern part of Bangladesh are to improve household food security and nutritional status, and strengthen synergies with health-based actions, especially focusing on mothers and young children in selected Upazilas of Khulna and Barisal in the southern region of Bangladesh. The overall goal of this study was to assess the impact of an integrated agriculture and health intervention program that aimed to improve IYCF practices and thereby reduce child malnutrition in low-income communities.

Methodology

Study Site and Participants: The present study is a pre-post analysis of secondary data, of "Integrated Agriculture and Health-Based Interventions for Improved Food and Nutrition Security in Selected Districts of Southern Bangladesh (IAHBI), multisectoral project, that was conducted in Barishal and Khulna district, the southern part of Bangladesh, and a disaster-prone area (Sarker et al., 2021) that have not yet blessed enough through development activities of the country, from September 2012 to September 2015 by the Government of Bangladesh, partners, and an NGO partner, Sheba Manab Kallyan Kendra. The project was supported by the Food and Agriculture Organization (FAO) and United Nations Children's Fund (UNICEF), funded by the United States Agency for International Development (USAID) and implemented by the different relevant ministries of Bangladesh. The project provided agricultural interventions focused on the provision of training on improved inputs and technologies for three subsectors, horticulture, livestock, and aquaculture, with explicit nutrition objectives and strategies. Integrated homestead food production gardens, training materials, nutrition education materials, cooking demonstrations, and community-based preservation and processing have all been delivered through the project (Saha et al., 2018). The study locations were Satkhira (Khajra, Anulia of Assasuni and Munshiganj and Bhurulia of Shyamnagar Upazila) and Khulna (Kamarkhola and Sutarkhali and Dakshin of Dacope and Bedkashi and Maharajpur of Koyra Upazila) and Barishal (Batamara and Shafipur of Muladi Upazila) districts (Figure 1). In assessing the effect of the project baseline data sets were collected from James P Grant School of Public Health, BRAC University on the baseline survey of the IAHBI project (BRAC Institute of global health, 2013). The endline survey data were collected from the Institute of Nutrition and Food Science (INFS), University of Dhaka.

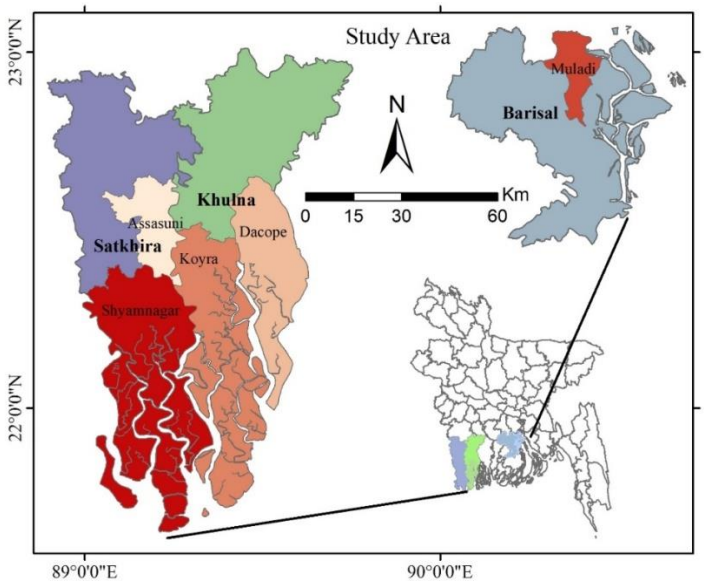

Figure 1. Study area

A two-stage sampling design was used. In the first stage of sampling, the cluster of villages was selected randomly from 10 unions, and in the second stage, households were selected systematically for interview. To be representative, a total of 1536 households were sampled from the ten unions according to their population size. For this study, we used data of 268 children of 0-23 months from the baseline dataset of 636 children, and 554 children of 0-23 months from endline dataset of 1536 children.

Dependent/Outcome variables

To assess children's feeding practices, we used three IYCF indicators-minimum dietary diversity (MDD), minimum meal frequency (MMF) & minimum acceptable diet (MAD) (WHO, 2021). Binary variables corresponding to each of the definitions of IYCF indicators were created following the WHO recommendations (WHO, 2010). These outcome variables were recoded according to the following definitions:

Minimum dietary diversity (MDD): MDD is identified as the proportion of children aged 6 to 23 months who ate foods from four or more food groups. The seven food groups were used to calculate this measure such as: 1) grains, roots, and tubers; 2) legumes and nuts; 3) dairy products (milk, yogurt, and cheese); 4) flesh foods (meat, fish, poultry, and liver/organ meats); 5) eggs; 6) vitamin-A-rich fruits and vegetables, and 7) other fruits and vegetables. The minimum dietary diversity variable was created from the diet diversity score of each child and coded as "1" if the child had eaten at least from 4 or more food groups the day before the interview and as "0" if less than four food groups (WHO, 2010).

Minimum meal frequency (MMF): MMF is classified as the proportion of children both breastfed and non-breastfed aged 6-23 months who received solid, semi-solid, or liquid foods at least once or more before the day of interview (including milk feeds for non-breastfed children). The minimum meal frequency is two times for breastfed babies aged belongs from 6-8 months, 6 times for breastfed children aged from 9-23 months, and 4 times for non-breastfed children aged 6-23 months. "Meals" comprise all meals and snacks (except small amounts), and frequency is measured from caregiver reports (BBS and UNICEF, 2019).

Minimum acceptable diet (MAD): Proportion of children aged 6-23 months who received a minimum acceptable diet. This indicator is a composite of children fed with a minimum dietary diversity and a minimum meal frequency (WHO, 2010).

Early initiation of breastfeeding: Proportion of children born in the last 24 months who were put to the breast within one hour of birth: [No. of Children born in the last 24 months who were enrolled in the study were put to the breast within one hour of birth]/ [No. of Children born in the last 24 months who were enrolled in the study] (WHO, 2010)

Exclusive breastfeeding under 6 months: Proportion of infants 0-5.9 months of age who are fed exclusively with breastmilk [No of infants 0-5.9 months of age who received only breastmilk during the previous day]/ No of infants 0-5.9 months of age (WHO, 2010).

Independent Variables

Socio-demographic variables: Questions regarding socio-demographic variables including the age of the children was classified into the following groups: 6–11 months, 12–17 months, and 18–23 months (WHO, 2008). Educational qualification and occupation of household head (HH) and wealth index was also assessed in this study.

Wealth Index: Principal component analysis was used to create the wealth index. The wealth index was calculated based on the Demographic and Health Surveys (DHS) Working Papers series (Fort et al., 2008). In this analysis, the wealth index was constructed following the assets and services owned by the households (electricity, electronic devices, furniture, agricultural and other productive tools etc.), the main materials used to build the wall, roof and floor of their living house, number of rooms in the household. A weight was attached to each item from the first principal component. Households were divided into SES quintiles based on wealth index: quintile 1 (poorest), quintile 2 (poorer), quintile 3 (normal), quintile 4 (richer), and quintile 5 (richest). Moreover, the horticulture index, cooking technique index and hygiene index were classified into quintile 1 (very poor), quintile 2 (poor), quintile 3 (normal), quintile 4 (good), and quintile 5 (very good).

Anthropometric indicators: For under-five children, length/height-for-age, weight-for-age, and weight-for-height categories were created based on World Health Organization (WHO, 2006) in which stunting (low height-for-age), underweight (low weight-for-age), wasting (low weight-for-height) are defined as Z-scores of -2 standard deviations (Aziz et al., 2019).

Statistical Analysis: All the statistical analyses were performed on STATA, 14. Frequency and percentage were reported for categorical variables. The association between each of the independent variables and outcome variables were evaluated by chi-squared test. A P-value less than 0.05 was regarded as significant for this study.

Results

Socio-demographic characteristics of the respondents of the baseline and endline survey are presented in Table 1. It showed that half of the participants were having children aged between 0-11 months, and there was no significant difference in age-wise distribution between baseline and endline.

The male response rate was higher in the baseline survey (55.6% *vs.* 44.4%) but the response rates were almost similar in the endline survey (50.9% *vs.* 49.1%). More than 80% of the respondents were Muslims, and the educational level of the household head was also similar across the two surveys; about 30% of the household heads were found illiterate. Between baseline and endline, a significant occupational difference was observed for household heads ($p<0.001$), with casual workers representing the highest percentage of professional records, (36.6% in baseline *vs.* 46.2% in end line). The baseline survey had a higher proportion of agriculture/fishing workers (22.0%) and service providers (33.2%) compared to the endline survey. In terms of the wealth quintile, 22% of respondents in baseline and 17.1% in endline belonged to the poorest wealth quintile, however, no significant difference was observed between the survey periods.

Table 1. Sociodemographic characteristics of the respondents according to baseline and endline

Characteristics	Baseline (N=268)	Endline (N=554)	P-value
	n(%)	n(%)	
Children' age (months)			
0-5	63 (23.5)	127 (22.9)	0.942
6-8	36 (13.4)	81 (14.6)	
9-11	33 (12.3)	65 (11.7)	
12-17	69 (25.7)	132 (23.8)	
18-23	67 (25.0)	149(26.9)	
Gender			
Male	149 (55.6)	282 (50.90)	0.206
Female	119 (44.4)	272 (49.10)	
Educational qualification of HH's head			
No education	81 (30.2)	174 (31.4)	0.854
Primary	93 (34.7)	201 (36.3)	
Below S.S.C	64 (23.9)	126 (22.7)	
S.S.C and Higher	30 (11.2)	53 (9.6)	
Religion			
Muslim	222 (82.8)	484 (87.4)	0.080
Hindu/Christian/Buddhist	46 (17.2)	70 (12.6)	
Main occupation of the HH's head			
Agriculture/fishing	59 (22.0)	74 (13.4)	<0.001*
Casual worker	98 (36.6)	256 (46.2)	
Service/business/professional/technical work	89 (33.2)	99 (17.9)	
Other occupation	20 (7.5)	125 (22.6)	
Wealth quintiles			
Poorest	59 (22.0)	95 (17.1)	0.414
Poorer	44 (16.4)	90 (16.2)	
Middle	58 (21.6)	117 (21.1)	
Richer	53 (19.8)	116 (20.9)	
Richest	54 (20.1)	136 (24.5)	

Note. S.S.C.= Secondary School Certificate; HHs=Household heads; Other occupations = housewife, unemployed, retired, old, servant, tuition, handicraft, kabiraj, imam, beggar etc.*P<0.05

Table 2 depicts the performance of the intervention outcome in baseline and end line. The horticulture index differs significantly between the two surveys (p=0.001). The index was divided into five categories where the Very Poor index was 7.1% higher (baseline vs. end line: 25% *vs.* 17.9%), and the Very Good index was 11.3% lower in baseline (baseline vs. end line: 12.3% *vs.* 23.6%), compared to end line. Similarly, the hygiene index differed significantly in both surveys as well. Very poor hygiene was almost three times more prevalent among baseline participants compared to end line participants (baseline *vs.* end line; 34.3% *vs*. 13.5%), however, very good hygiene was around 7% more prevalent among end line participants (baseline *vs.* end line; 15.3% *vs.* 22.3%). About 77.2% of the study participants had Very Poor cooking practice and none had good cooking practice, whereas 36.1% of the endline participants had good cooking practices and the cooking practice index differed significantly (p<0.001).

In the end line, MDD was significantly (p<0.001) declined by around 10% (baseline *vs.* end line 30.7 % *vs.* 20.82%) Similarly, MMF and MAD also significantly (p<0.05) dropped by 7.7% and 11.5% in the end line. On the other hand, exclusive breastfeeding and practice were found significantly (p<0.05) higher in endline (63.8%) compared to baseline (44.4%). Initiation of breastfeeding also increased in endline (77.7%) compared to baseline (72.7%).

The prevalence of stunting and underweight was significantly (p<0.001) reduced by 6.7% and 5.2%, respectively in endline. The reduction in the prevalence of wasting was observed from baseline (12.7%) to endline (11.5%) although the difference was not significant.

Table 2. Performance of the intervention outcomes between baseline and endline

Indicators	Baseline (N=268)	Endline (N=554)	P-value
	n (%)	n (%)	
Horticulture Index			
Very Poor	67(25%)	99(17.9)	0.001*
Poor	61(22.8)	102(18.4)	
Normal	57(21.3)	108(19.5)	
Good	50(18.7)	114(20.6)	
Very Good	33(12.3)	131(23.6)	
Hygiene Index			
Very Poor	92(34.3)	75(13.5)	<0.001*
Poor	61(22.8)	105(19)	
Normal	42(15.7)	119(21.5)	
Good	32(11.9)	132(23.8)	
Very Good	41(15.3)	123(22.2)	
Cooking Technique Index			
Very Poor	207(77.2)	16(2.9)	<0.001*
Poor	53(19.8)	75(13.5)	
Normal	8(3.0)	146(26.4)	
Good	0(0.0)	200(36.1)	
Very Good	0(0.0)	117(21.1)	
Minimum dietary diversity (MDD)	63 (30.7)	89 (20.8)	<0.001*
Minimum meal frequency (MMF)	157(76.6)	294(68.9)	0.044*
Minimum acceptable diet (MAD)	60(29.3)	76(17.8)	0.001*
Initiation of breastfeeding	195(72.7)	427(77.1)	0.177
Exclusive breastfeeding	28 (44.4)	81 (63.8)	0.011*
Continue breastfeeding up to 1 year	50(98)	81(96.4)	0.598
Consumption of solid or semi solid food	50 (70.9)	63(100)	0.470
Anemia	121(68.2)	223(66.8)	0.712
Stunting	92(34.3)	107(22.4)	<0.001*
Wasting	34(12.7)	55(11.5)	0.633
Underweight	74(27.6)	88(17.2)	0.001*

*p value <0.05

Table 3 represents, at the endline, there were significant ($p<0.05$) reductions in the prevalence of stunting among the participants of 6-17 months of age. At endline, stunting, wasting and underweight among female participants were 19.2%, 10.6% and 18.3%, respectively and were significantly ($p<0.001$) lower than from baseline. Education, occupation and wealth quintile of the household head affected the nutritional status of the children. Children whose household head had primary education showed a significant ($p<0.05$) reduction of stunting (from 33% at baseline to 20% at endline). Also, underweight was significantly ($p<0.05$) reduced in participants where the household head had primary (24.7% to 11.5%) and below the SSC (31.3% to 15.4%) education levels. Compared to non-Muslims, Muslims had a significant reduction in stunting and underweight. Children whose household head was a casual worker had a significant reduction in underweight ($p=0.005$). Furthermore, stunting ($p=0.026$) and underweight ($p=0.004$) were significantly reduced in the children who belonged to service holders. Additionally, children with middle ($p<0.001$) and richest ($p=0.013$) wealth quintiles showed a significant reduction in underweight and stunting.

Table 3. Percentage of under 2 children by nutritional status by background characteristics

Background Characteristics	Stunting			Wasting			Underweight		
	Baseline	Endline	p-value	Baseline	Endline	p-value	Baseline	Endline	p-value
Children's age in months									
0-5	13(20.6)	10(11.5)	0.125	5(7.9)	10(11.6)	0.459	13(20.6)	15(13.6)	0.229
6-8	9(25.0)	8(10.7)	0.049*	3(8.3)	5(6.7)	0.750	9(25.0)	9(11.7)	0.071
9-11	11(33.3)	9(15.3)	0.043*	2(6.1)	5(8.2)	0.706	7(21.2)	8(12.9)	0.290
12-17	28(40.6)	25(21.2)	0.004*	14(20.3)	21(17.5)	0.634	25(36.2)	25(20.2)	0.014*
18-23	31(46.3)	55(39.6)	0.361	10(14.9)	14(10.3)	0.336	20(29.9)	31(22.5)	0.251
Gender									
Male	47(31.5)	64(25.9)	0.226	10(6.7)	32(13.0)	0.049*	33(22.1)	48(18.2)	0.329
Female	45(37.8)	43(18.6)	0.001*	24(20.2)	23(9.9)	0.007*	41(34.5)	40(16.2)	*0.001
Educational qualification of household head									
No education	30(37)	38(26.2)	0.088	11(13.6)	21(14.6)	0.836	24(29.6)	40(25.6)	0.511
Primary	31(33.3)	36(20)	0.015*	10(10.8)	16(8.8)	0.598	23(24.7)	22(11.5)	0.004*
Below S.S.C	20(31.3)	21(20.2)	0.105	9(14.1)	14(13.3)	0.893	20(31.3)	18(15.7)	0.014
S.S.C and Higher	11(36.7)	12(24.5)	0.247	4(13.3)	4(8.5)	0.498	7(23.3)	8(16.3)	0.440
Religion									
Muslim	77(34.7)	93(22.4)	0.001*	34(15.3)	44(10.6)	0.081	65(29.3)	76(17.0)	<0.001
Others	15(32.6)	14(22.6)	0.244	00	11(17.7)	0.002*	9(19.6)	12(18.5)	0.883
Main occupation of the HH's head									
Agriculture/fishing	19(32.2)	12(21.8)	0.213	4(6.8)	5(9.1)	0.647	14(23.7)	8(13.3)	0.144
Casual worker	31(31.6)	52(22.2)	0.070	11(11.2)	21(9.1)	0.542	30(30.6)	42(17.1)	0.005*
Service/business/professional/technical work	33(37.1)	19(21.8)	0.026*	18(20.2)	10(11.5)	0.113	28(31.5)	13(14.0)	0.004*
Other occupation	8(40.0)	24(23.5)	0.125	1(5.0)	19(18.3)	0.139	2(10.0)	25(22.3)	0.208
Wealth quintiles									
Poorest	19(32.2)	28(32.2)	0.998	4(6.8)	15(17.6)	0.058*	15(25.4)	25(27.8)	0.751
Poorer	14(31.8)	17(19.8)	0.127	8(18.2)	10(11.8)	0.318	11(25.0)	18(20.9)	0.597
Middle	24(41.4)	18(17.3)	0.001*	9(15.5)	13(12.1)	0.543	18(31.0)	14(12.7)	0.004*
Richer	15(28.3)	24(25.0)	0.660	6(11.3)	10(10.2)	0.831	14(26.4)	15(13.5)	0.042*
Richest	20(37.0)	20(19.0)	0.013*	7(13.0)	7(6.8)	0.197	16(29.6)	16(14.0)	0.016*

*p value <0.05

Table 4 shows that reductions of underweight, stunting and wasting were found among all horticulture and hygiene index categories. Stunting was significantly reduced at endline with good horticulture (23.3%) and hygiene practices (18.8%).

Children who had high MDD scores, received MMF and MAD, also showed a significant reduction of stunting and underweight but wasting was significantly reduced for the children who received MAD (p=.048) at endline as compared with baseline.

Children who had early initiation of breastfeeding had significantly ($p<0.05$) lower stunting in the end line. And those who consumed solid or semisolid food were significantly lower stunted and underweight in the endline ($p<0.05$). Both anaemic and non-anaemic children showed a reduction in stunting, but the only significant reduction in underweight was observed among non-anaemic ($p<0.05$) children.

Table 4. Percentage of under 2 children by nutritional status by indicators

Indicators	Stunting			Wasting			Underweight		
	Baseline	**Endline**	**p-value**	**Baseline**	**Endline**	**p-value**	**Baseline**	**Endline**	**p-value**
Horticulture Index									
Very Poor	24(35.8)	26(30.2)	0.464	7(10.4)	8(9.0)	0.759	20(29.9)	13(14.1)	0.015*
Poor	19(31.1)	24(26.7)	0.549	8(13.1)	12(13.2)	0.989	13(21.3)	23(24.0)	0.700
Normal	21(36.8)	22(25.6)	0.150	9(15.8)	13(15.3)	0.936	16(28.1)	20(20.4)	0.276
Good	19(38.0)	16(15.5)	0.001*	7(14.0)	9(9.0)	0.349	18(36.0)	16(15.2)	0.003*
Very Good	9(27.3)	19(16.8)	0.179	3(9.1)	13(11.5)	0.696	7(21.2)	16(13.3)	0.262
Hygiene Index									
Very Poor	31(33.7)	12(23.1)	0.181	19(20.7)	6(11.3)	0.152	27(29.3)	13(21.0)	0.244
Poor	25(41.0)	21(23.1)	0.018*	8(13.1)	10(11.4)	0.747	19(31.1)	18(18.8)	0.074
Normal	15(35.7)	22(20.8)	0.058*	7(16.7)	13(12.4)	0.493	10(23.8)	18(15.9)	0.257
Good	13(40.6)	26(21.8)	0.031*	00	12(10.0)	0.062	11(34.4)	23(18.5)	0.053*
Very Good	8(19.5)	26(23.6)	0.589	00	14(12.5)	0.017*	7(17.1)	16(13.8)	0.609
Cooking Technique Index									
Very Poor	76(36.7)	6(42.9)	0.645	34(16.4)	4(26.7)	0.309	60(29.0)	4(26.7)	0.848
Poor	14(26.4)	16(24.2)	0.786	00	6(9.1)	0.024*	13(24.5)	10(14.1)	0.138
Normal	2(25.0)	25(19.1)	0.681	00	20(15.5)	0.228	1(12.5)	23(16.7)	0.757
Good	0 (0)	34(20.7)	-	-	16(9.8)	-	-	28(15.6)	-
Very Good	-	26(25.2)	-	-	9(8.7)	-	-	23(21.3)	-
Minimum dietary diversity (MDD)									
<4	47 (33.1)	75(24.6)	0.060	17(12)	37(12.1)	0.971	37(26.1)	62(19.7)	0.125
>= 4	32(50.8)	22(25.6)	0.001*	12(19)	8(9.3)	0.084	24(38.1)	11(12.8)	0.001*
Minimum Meal Frequency (MMF)									
No	18 (37.5)	23 (20.7)	0.026*	7(14.6)	14(12.4)	0.705	12(25)	19(16.7)	0.218
Yes	61(38.9)	74(26.4)	0.007*	22(14.0)	31(11.1)	0.373	49(31.2)	54(18.8)	0.003*
Minimum acceptable diet (MAD)									
No	50 (34.5)	77(24.2)	0.021*	17(11.7)	39(12.2)	0.877	38(26.2)	63(19.2)	0.086
Yes	29(48.3)	20(27.4)	0.012*	12(20.0)	6(8.2)	0.048*	23(38.3)	10(13.7)	0.001*
Initiation of Breastfeeding									
No	29(39.7)	21(22.8)	0.019*	14(19.2)	14(15.4)	0.521	25(34.2)	21(22.3)	0.087
Yes	63(32.3)	86(22.3)	0.009*	20(10.3	41(10.6)	0.900	49(25.1)	67(16.1)	0.007*
Exclusive Breastfeeding									
No	8(22.9)	4(14.3)	0.389	3(8.6)	3(11.1)	0.737	9(25.7)	4(11.8)	0.138
Yes	5(17.9)	6(10.2)	0.313	2(7.1)	7(11.9)	0.499	4(14.3)	11(14.5)	0.980
Continue Breastfeeding Up to 1 year									
No	1 (100)	0 (0)	-	10(20.0)	11(14.3)	-	19(38.0)	15(19.2)	-
Yes	19 (38)	18 (23.4)	-	0(0)	00	-	00	00	-
Consumption of solid or semi-solid food									
No	-	-	-	2(7.7)	4(6.6)	0.848	5(19.2)	8(12.7)	0.427
Yes	9 (25)	7 (11.5)	-	32(13.2)	51(12.2	0.711	69(28.5)	80(17.9)	0.001*
Anemia									
Not Anemic	24(42.9)	31(27.9)	0.695	5(8.9)	8(7.2)	0.695	17(30.4)	14(12.6)	0.005*
Anemic	42(35)	45(20.5)	0.369	14(11.6)	33(15.1)	0.370	30(24.8)	45(20.1)	0.276

*p value <0.05

Table 5 summarizes the results of bivariate logistic regression with a 95% confidence interval. The effects of stunting, underweight, MDD, MAD, and 3 IYCF practices were statistically significant when the other covariates/confounding variables were adjusted. The table identified that 50% stunting (AOR: 0.5; 95%CI 0.354-0.707) and 45% underweight (AOR: 0.544; 95%CI 0.379-0.780) had been significantly reduced from baseline to endline. In comparison with the baseline, the horticulture index was 2.16 times higher (AOR: 2.168; 95% CI 1.543-3.045) and the hygiene index 2.35 times higher (AOR: 2.354 95%CI: 1.670-3.319) in the endline. Further, exclusive breastfeeding and continued breastfeeding up to 1 year were found to be 3.24 times and 1.30 times higher in endline compared to baseline. In comparison to the baseline MDD and MAD were observed less likely to be practiced by 35.1% (AOR: 0.649; 95% CI 0.435-0.968) 44.4 and 44.4% (AOR: 0.565; 95% CI 0.373-0.854) respectively, in the endline participants.

Table 5. Binary logistic regression for intervention

Survey types	(%)	N	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)*	P-value
Stunted						
Baseline	34.3	92	Ref.		Ref.	
Endline	22.4	107	0.551 (0.396-0.768)	<0.001	0.500 (0.354-0.707)	<0.001*
Wasted						
Baseline	12.7	34	Ref.		Ref.	
Endline	11.5	55	0.894 (0.566-1.412)	0.633	0.857 (0.528-1.391)	0.534
Underweight						
Baseline	27.6	74	Ref.		Ref.	
Endline	17.2	88	0.545 (0.383-0.776)	0.001	0.544 (0.379-0.780)	0.001*
Horticulture Index						
Baseline	31	83	Ref.		Ref.	
Endline	44.2	245	1.767 (1.298-2.405)	<0.001	2.168 (1.543-3.045)	<0.001*
Hygiene index						
Baseline	27.2	73	Ref.		Ref.	
Endline	46.0	255	2.278 (1.659-3.126)	<0.001	2.354 (1.670-3.319)	<0.001*
Excusive breastfeeding						
Baseline	44.4	28	Ref.		Ref.	
Endline	63.8	81	2.201 (1.190-4.070)	0.012	3.240(1.559-6.731)	0.002*
MDD						
Baseline	30.7	63	Ref.		Ref.	
Endline	20.8	89	0.593 (0.329-.596)	0.007	0.649 (0.435-0.968)	0.034*
MMF						
Baseline	76.6	157	Ref.		Ref.	
Endline	68.9	294	0.675 (0.460-0.990)	0.045	0.718 (0.479-1.075)	0.109
MAD						
Baseline	29.3	60	Ref.		Ref.	
Endline	17.8	76	0.523 (0.354-0.772)	0.001	0.565 (0.373-0.854)	0.007*
Continued breastfeeding up to 1 year (%)						
Baseline	98	51	Ref.		Ref.	
Endline	96.4	84	0.540 (0.054-5.334)	0.598	1.303 (0.057-29.747)	0.868
Anemia						
Baseline	68.2	176	Ref.		Ref.	
Endline	66.6	335	0.929 (0.629-2.942)	0.712	0.919 (.616-1.369)	0.679

Note. Cooking technique index and consumption of solid and semisolid food were not included in the table as in baseline there were no value in 'good' and 'very good' criteria in cooking technique index and 'no' criteria in consumption of solid and semisolid food. *p value <0.05

Discussion

This study examined the effects of an integrated intervention, between baseline and endline, on the nutritional status of under two-year-old children in the climate-vulnerable southern part of Bangladesh. Study findings showed a significant reduction of stunting and underweight and an insignificant reduction of wasting from baseline to end line. Compared to baseline, the horticulture hygiene and cooking index improved significantly in the endline survey. In terms of feeding practices, a significant improvement of exclusive breastfeeding and an insignificant improvement of continued breastfeeding up to 1 year was observed. However, minimum dietary diversity (MDD), minimum acceptable diet (MAD) was significantly reduced in endline as compared to baseline. The study findings resemble a similar study from Ghana, suggesting that nutrition education is a potential strategy to reduce the high rates of child undernutrition in resource-poor communities (Awuuh et al., 2019) and several other studies t have also observed the impact on stunting after nutrition education intervention (Kumar et al., 2018).

In the end line, a significant decrease in stunting among children of 6-17 months of age was observed. In a study, moderate stunting and underweight among older children were reported whose complementary foods (CF) were introduced after six months of age (Das and Gulshan, 2017). Child stunting during 6–11 months can be due to the late initiation of complementary feeding (Anin et al., 2020). Female children were less likely to undergo malnutrition than male children from baseline to end line. According to a study carried out in Benin, stunting and underweight were less prevalent among the female population (Care International, 2018), and the effect was larger in male infants than females (Bhandari et al., 2004). According to this study, children with parents who have primary education are less likely to be stunted and underweight than parents with higher levels of education, which contrasts with a study where parents of children with high education are at lower risk of malnutrition (Vollmer et al., 2017). One explanation might be the low sample size in a higher level of education categories. As the integrated intervention had home visits and intensive face-to-face communication with practical demonstrations, this might lead to behavioural changes and changes in diet composition and diversity, ultimately leading to growth regardless of their educational qualification (Martinez et al., 2018).

The study found a significant relationship between wealth and nutritional status, and that stunting and underweight declined as wealth improved the accessibility to foods and health care. These findings are in agreement with the study that reported children from poorer households (44%) were more likely to be stunted than those from the richest households (17.6%) (Papatheodorou et al., 2021).

The intervention included the promotion of horticulture, hygiene, cooking techniques as well as nutrition education including a practical demonstration to improve IYCF practices. This study exhibited that education led to significant improvements in horticulture, hygiene, and cooking indexes, which significantly reduced the prevalence of malnutrition in children. Similarly, Rosenberg et al. (2017) found that the RAIN project significantly impacts food production diversity and positively impacts productive assets and incomes in Zambia (Rosenberg et al., 2018). Additionally, similar findings were found in The NOURISH Project, which was designed to address a wide range of underlying and interrelated factors that could lead to childhood malnutrition. Moreover, the cooking demonstration was also found to have a profound impact on children's growth in another study (Mutiso et al., 2018). On the other hand, improved hygiene and sanitation were also reported to improve linear growth (Esrey et al., 1992). A variety of contextual and environmental factors, poor hygiene and sanitation, and water and food contamination, are also important determinants (Ahmed et al., 2014) as environmental enteropathy (EE) appears to have an important effect on stunting (Korpe and Petri, 2012).

The nutritional intervention improved exclusive breastfeeding, early initiation of breastfeeding, and the introduction of complementary feeding practices among the study participants, which have shown a positive impact in reducing malnutrition, similar to a study that showed exclusive breastfeeding would reduce growth faltering (Thakur et al., 2012).

However, the IYCF indicators MDD, MMF, MAD decreased significantly from baseline to end line. The probable reason for discrepancies in MDD, MMF and MAD findings, selection of households in the baseline were from villages close to market place or roadside location whereas, endline study samples were randomly selected to cover the whole area of intervention and also included from remote areas rather selection based on convenience. In addition, the significant reduction of stunting and underweight among the study children raised the question of reliability or comparability between the baseline and end-line. Some IYCF indicators do not correlate well with child anthropometric measures, which could be due to a lack of sensitivity (Jones et al., 2014). Moreover, the translation of acquired knowledge into actual practice for IYCF among older infants is therefore challenging. The evaluation of a program among ethnic minorities in Vietnam did not find evidence of impact on MAD and MMF, early initiation of breastfeeding, nor on exclusive breastfeeding (Rana et al., 2018). Other studies, however, have reported improvements in dietary diversity and overall energy and nutrient intake in Malawi (Kuchenbecker et al., 2017) and in Indonesia (Dewey and Adu-Afarwuah, 2008) following interventions.

Conclusion

The integrated intervention had a significant impact on reducing stunting and underweight but an insignificant effect on wasting. The key interventions components such as horticulture, hygiene, and cooking indexes, and nutrition education, along with practical demonstrations, exclusive and initiation of breastfeeding, have positive effects. Additionally, there was progress across programmatic indicators. However, in the intervention area, the dietary pattern did not increase significantly. This could be due to a smaller sample size or a lack of sensitivity of the indicators, or to the difficulty of transforming knowledge into practice for most among the older infants. Future studies should evaluate this type of integrated intervention on nutritional outcomes with larger sample sizes to replicate the findings and generate evidence for programmatic actions in resource-poor settings.

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