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Large-Scale Behavior-Change Initiative for Infant and Young Child Feeding Advanced Language and Motor Development in a Cluster-Randomized Program Evaluation in Bangladesh[1–3]

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Abstract

Background: Promoting adequate nutrition through interventions to improve infant and young child feeding (IYCF) has the potential to contribute to child development.

Objective: We examined whether an intensive intervention package that was aimed at improving IYCF at scale through the Alive & Thrive initiative in Bangladesh also advanced language and gross motor development, and whether advancements in language and gross motor development were explained through improved complementary feeding.

Methods: A cluster-randomized design compared 2 intervention packages: intensive interpersonal counseling on IYCF, mass media campaign, and community mobilization (intensive) compared with usual nutrition counseling and mass media campaign (nonintensive). Twenty subdistricts were randomly assigned to receive either the intensive or the nonintensive intervention. Household surveys were conducted at baseline (2010) and at endline (2014) in the same communities (n = ~4000 children aged 0–47.9 mo for each round). Child development was measured by asking mothers if their child had reached each of multiple milestones, with some observed. Linear regression accounting for clustering was used to derive difference-in-differences (DID) impact estimates, and path analysis was used to examine developmental advancement through indicators of improved IYCF and other factors.

Results: The DID in language development between intensive and nonintensive groups was 1.05 milestones (P = 0.001) among children aged 6–23.9 mo and 0.76 milestones (P = 0.038) among children aged 24–47.9 mo. For gross motor development, the DID was 0.85 milestones (P = 0.035) among children aged 6–23.9 mo. The differences observed corresponded to age- and sex-adjusted effect sizes of 0.35 for language and 0.23 for gross motor development. Developmental advancement at 6–23.9 mo was partially explained through improved minimum dietary diversity and the consumption of iron-rich food.

Conclusions: Intensive IYCF intervention differentially advanced language and gross motor development, which was partially explained through improved complementary feeding. Measuring a diverse set of child outcomes, including functional outcomes such as child development, is important when evaluating integrated nutrition programs. This trial was registered at clinicaltrials.gov as NCT01678716. *J Nutr* 2017;147:256–63.

Keywords: gross motor development, language development, interpersonal counseling, mass media, child undernutrition, cluster randomized trial, effectiveness evaluation, Bangladesh

Introduction

Suboptimal early childhood development is a critical public health problem globally, with 250 million children <5 y of age not fulfilling their developmental potential (1). Early childhood development depends on nurturing care (i.e., health, nutrition, security and safety, responsive caregiving, and early learning) that is provided by parents and other caregivers and that occurs through family interactions in a supportive environment (1). Nutrition is closely linked with development through both biology and behavior (2). Undernutrition may directly affect brain development and function, especially during the critical period of early life. Undernutrition can also indirectly affect child development

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by reducing physical growth, health, and activities; increasing child illness; and reducing child interaction with parents and the environment (3). Programs and interventions aimed at improving nutrition and development are considered most effective when they target and reach young and disadvantaged children (4, 5).

The integration of nutrition and development programs has received much attention, particularly because existing services for maternal and child health and nutrition potentially provide an affordable platform for interventions to promote nurturing care of young children (4). Because many of the large-scale nutrition programs in place may not have resources to include early childhood interventions, an important question is whether programs that are focused on improving nutrition through behavior change can contribute to child development, even without specific early childhood development interventions. One meta-analysis concluded that nutrition interventions on their own had small effects on development (6). A review of studies that tested the impact of integrated nutrition and development interventions concluded that an additive effect on nutrition and development was found in a few studies (7) and a synergistic effect on development outcomes was documented in a zinc supplementation and child stimulation program targeted to underweight children in Jamaica (8). Another review, although noting that synergistic effects were theoretically plausible, found little evidence of synergy (9). Most of the nutrition interventions in the studies reviewed included supplementation with food or micronutrients, and some of the studies targeted children who had marked nutritional and developmental deficits at baseline (7, 10, 11).

Some nutrition interventions that included food or nutrient supplementation have had an impact on child development (11–13). One randomized study in India that did not include food or nutrient supplementation found that a group who received education about complementary feeding through home visits did not show significantly improved mental and motor development scores compared with the control group, although the mean scores were slightly higher than those in the control group and slightly lower than in the third group who also received interventions on responsive feeding and play (14). Thus, although interventions aimed at improving infant and young child feeding (IYCF)[8], even without providing food or nutrient supplements, have the potential to contribute to preventing deficits in cognitive, motor, and social-emotional development through either nutritional or behavioral mechanisms, little information is available about the effectiveness of such interventions alone.

Despite improvements in socioeconomic and health indicators in recent years (15), undernutrition remains a substantial challenge in Bangladesh, with an estimated 36% of children <5 y of age being stunted and 14% being wasted in 2014 (16). Suboptimal IYCF practices contribute to child undernutrition, with only 26% of children aged 6–23 mo of age consuming adequately diverse diets (16). Traditional complementary foods in Bangladesh, as in many other parts of the developing world, have low energy and micronutrient density and poor protein quality (17–19). In Bangladesh, disadvantaged young children have low scores on measures of early childhood development (20).

Alive & Thrive (A&T), an initiative aimed at improving suboptimal IYCF practices, delivered a large-scale intensive package in 50 rural subdistricts in Bangladesh, through the existing health program of BRAC. The package went beyond typical nutrition education interventions by providing intensive counseling delivered by highly trained and closely supervised frontline workers who received incentives for quality of performance. The counseling intervention was delivered in the context of a national mass media campaign and social mobilization at the community level, both focused on strengthening the household environment for optimal IYCF. On the basis of the evaluation, which used a 2-group cluster-randomized design, we previously reported that the A&T intensive intervention package had a large, significant impact on IYCF practices and did not have a significant impact on stunting (21). This study tested the hypothesis that the intensive intervention package aimed at improving IYCF also advanced language and gross motor development and examined whether advancements in language and gross motor development were explained through improved complementary feeding.

Methods

Intervention. A detailed description of the intensive intervention package of interpersonal counseling and community mobilization has been provided elsewhere (22, 23). Briefly, A&T used 3 different platforms—interpersonal counseling, community mobilization, and mass media campaign—to deliver interventions to targeted beneficiaries that promoted active, responsive feeding and strategies to manage poor appetite. For interpersonal counseling, nutrition-focused frontline workers (the new nutrition workers called Pushti Kormi together with the regular community health workers called Shasthya Sebika) conducted multiple household visits with pregnant women and mothers of children ≤2 y of age to counsel them on IYCF messages that were appropriate for their children's age, coach mothers as they tried out the practices, and engage other family members to support the behaviors. Frontline workers also counseled mothers on responsive feeding, such as permitting and encouraging child self-feeding, interacting with the child when feeding (making eye contact, speaking to and praising the child), and feeding when the child is awake and receptive. Frontline workers were highly trained and closely supervised and were provided incentives based on each eligible mother practicing the IYCF behaviors. The intent was to motivate the workers to counsel nearly all eligible women and help them solve problems for changing behaviors rather than just giving messages (22, 23); 92% of mothers were visited by the Pushti Kormi and 89% by the Shasthya Sebika (22, 23). In addition, for half of the sample, randomly allocated in both the intensive and nonintensive areas, the Shasthya Sebika offered micronutrient powder sachets containing iron, folic acid, zinc, and vitamins A and C for sale to mothers and received a small commission from the sales. Purchase was infrequent and of low volume, resulting in negligible levels of uptake.

The intensive interpersonal counseling began in 22 subdistricts in August 2010 and in another 28 subdistricts in August 2011. The

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[3] Supplemental Table 1 is available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at http://jn.nutrition.org.

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[8] Abbreviations used: A&T, Alive & Thrive; ARI, acute respiratory infection; DID, difference-in-differences; IYCF, infant and young child feeding.

community mobilization was operational in August 2011. The mass media campaign was launched in December 2010 and was intensified to reach national coverage by February 2011. All intervention components continued to the end of 2014. Parents were exposed to the mass media by watching the national broadcast of 7 television spots. In intensive areas that had low electricity and limited access to television, supplemental activities were conducted to air the television spots and other IYCF films produced by the project through local video screenings.

Study design and participants. The study design has been described in detail elsewhere (24). Briefly, a cluster-randomized, nonblinded, impact-evaluation design was used to compare the intensive and nonintensive A&T intervention packages in Bangladesh. The nonintensive package consisted of mass media and less intensive community mobilization along with the usual, routine home visits by the frontline workers during which they provided information on IYCF practices; in our sample, 15.5% of households were visited by frontline workers in the past 6 mo (22, 23). Twenty subdistricts were randomly assigned to receive either the intensive or nonintensive intervention package. Cross-sectional household surveys were conducted at baseline (2010) and at endline (2014) in the same communities. A total of 4365 and 4200 infants aged 0–47.9 mo were surveyed at baseline and endline, respectively. To obtain the samples, within each subdistrict, 5 unions and 2 villages within each union were randomly selected to yield a total of 200 villages. Villages had an average size of 250 households. Within each village, a household census was conducted at baseline and endline to list mothers and infants and infant date of birth. A list of all households with infants aged <6, 6 to <24, and 24 to <48 mo was created. We selected households for surveys by using systematic sampling beginning with a random seed start point to yield the desired sample size per cluster. We excluded only mothers who had an obvious mental disability that would prevent them from understanding and answering questions. The number of children needed was estimated for differences in the primary outcomes of complementary feeding practices among children 6–23.9 mo of age and stunting among children 24–47.9 mo of age, assuming 20 clusters, an α of 0.05, a power of 0.80, and an intraclass correlation of 0.01 (21).

Measurements. Language and gross motor development were measured with 21 and 29 items, respectively (**Supplemental Table 1**), which were adapted from previous work (25, 26). For language development, the mother was asked if her child could perform each of the milestones. One point was scored for each item that the mother reported the child could perform, and the sum was used as the measure of language development. For gross motor development, the items on achieved milestones were ordered from least advanced to most advanced. During the household survey, the interviewer asked mothers a series of questions on the gross motor milestones that they had seen their child perform to date. For some items, the milestones were assessed through observation in which the interviewer encouraged the child to demonstrate that behavior. One point was given for each milestone achieved, and the sum was used as the measure of gross motor development.

Child complementary feeding practices were assessed by using the WHO-recommended indicators of IYCF practices (27). The indicators were constructed on the basis of maternal recall of specific foods fed to the child in the previous day. The indicators were as follows: *1*) timely introduction of solid, semisolid, or soft food; *2*) minimum dietary diversity; *3*) minimum meal frequency; *4*) minimum acceptable diet; and *5*) consumption of iron-rich or iron-fortified food (27). Child-responsive feeding practices were measured by asking the mother what she usually does to encourage the child to eat when the child refuses to eat; mothers who reported ≥1 behavior consistent with responsive feeding (e.g., feed patiently, talk with child, reduce distractions, change what is fed, let child self-feed, encourage child) and did not force the child to eat were coded as 1, with 0 otherwise.

We measured several covariates at the child, mother, and household levels that we anticipated could be associated with child development. At the child level, the covariates were child age, sex, and morbidity. Information on child diarrhea and acute respiratory infection (ARI) was collected through maternal recall of symptoms in the 2 wk before the survey. Diarrhea was defined as ≥3 loose stools in a 24-h period (28), and ARI was defined as the presence (compared with absence) of cough or cold with fever (29). Mothers generally did not remember their child's birth weight. Instead, birth size was measured as the mother's perception that her child at birth was very small, smaller than average, average, bigger than average, or very big compared with average (score: 1–5). At the maternal level, the covariates were mother's age, education, employment outside the home, physical and mental health, engagement with the child (i.e., psychosocial stimulation), reported handwashing behavior with soap, and a hygiene score. Hygiene was measured via spot-check observations, a method that has been used widely for the assessment of markers of hygiene practices (30), to assess the cleanliness of the mother and her child (i.e., hair, hands, face, and clothing) and the cleanliness of inside and outside the household. Each aspect recorded as clean was given a score of 1 (compared with 0) and the sum of the total score was used as a hygiene score. Mother's weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively, and BMI was calculated as weight (kg)/height (m) squared. Mothers' symptoms of common mental disorders were measured by using the Self-Reporting Questionnaire 20, which has 20 items with a recall period of 30 d before the administration of the questionnaire (31). Child engagement was assessed by asking about the engagement of mothers, caregivers, or any household member >15 y of age with the child during the 3 d before the survey in various activities such as reading books or looking at picture books with the child, telling stories to the child, singing songs to the child, taking the child outside the home, and playing with the child (32, 33). At the household level, the covariates were household food security and socioeconomic status. Household food security was measured by using the Food and Nutrition Technical Assistance Project/US Agency of International Development's Household Food Insecurity Access Scale (34). The measure of socioeconomic status was created by principal components analysis with the use of a set of items related to ownership of property and land, household assets, housing conditions, and access to utilities (35).

Ethical approval. All of the interviewers were well trained in interviewing techniques, ethical issues, and administration of the questionnaires. Approval for the study was obtained from the institutional review board at the International Food Policy Research Institute, the Bangladesh Medical Research Council. All mothers of study children were verbally provided with detailed information about the study at recruitment. Verbal informed consent was obtained from mothers. The program evaluation is registered at clinicaltrials.gov as NCT01678716.

Statistical analysis. Baseline differences between the 2 intervention packages were tested by using ordinary least squares regression models for continuous variables or logit regression models for categorical variables, accounting for subdistricts as a random effect with the use of a cluster sandwich estimator (36). To examine the differential effects of the intervention packages, we derived difference-in-differences (DID) impact estimates by using regression models that assessed differences in changes over time between the 2 intervention packages (i.e., the time-by-package interaction), accounting for subdistricts as a random effect with the use of a cluster sandwich estimator. The interaction was tested by using the SE and denominator df that reflected the subdistrict level (37). One-tailed *P* values were used to test the hypotheses that the DIDs were positive. We present 3 models with DID results stratified by the age groups 6–23.9 and 24–47.9 mo. The first model was an intent-to-treat DID analysis not adjusted for covariates. The second model was adjusted for child age, age-squared, and sex. The third model was further adjusted for variables that differed in change by group between baseline and endline but not thought to be affected by the interventions (i.e., maternal occupation and child birth size). The intraclass correlation coefficients estimated from the third model were 0.00392 and 0.00562 for language and gross motor development, respectively, at ages 6–23.9 mo and were 0.0260 and 0.0465 for language and gross motor development, respectively, at ages 24–47.9 mo.

Path analysis was used to examine whether intervention differences in child development were mediated by improved complementary

feeding practices, adjusted for child, mother, and household covariates (38). The path-analytic models used endline data and were conducted in children 6–23.9 mo of age because complementary feeding indicators only applied to this age range. The indirect effect for each complementary feeding indicator was calculated as the product of the unstandardized regression coefficients for each path, and the Sobel test was obtained. Path-analytic models were also used to test if there were differences by intervention package in other factors (i.e., responsive feeding, mother's symptoms of common mental disorders, ARI, diarrhea, handwashing with soap, and caregiver engagement), and whether these factors were associated with child development. Data analysis was performed by using Stata 13 (StataCorp).

Results

Of the 100 subdistricts in 5 divisions, 20 were randomly selected (4 subdistricts from each division) for this evaluation (**Figure 1**). No evaluation clusters were lost to follow-up and none crossed from nonintensive to intensive during implementation. The cluster size varied little across clusters or over time.

The mean age of mothers was ~27 y (**Table 1**). More than one-quarter of mothers were illiterate and >90% of mothers did not complete high school. Mothers had a high prevalence of symptoms of common mental disorders (~31%), low BMIs (in kg/m^2; mean: ~20), and nearly one-third of them were underweight (BMI <18.5). Child engagement score was also low (mean: ~2.9 of 6). Symptoms of ARI in the 2 wk before the survey were reported for approximately one-third of children. Nearly one-third of households experienced food insecurity. The 2 intervention groups were well balanced for characteristics potentially associated with intervention effects, with the exception of small differences in the prevalence of child ARI symptoms.

Language and gross motor development differed by intervention package, with more advanced development seen for the intensive intervention in 2014 at endline relative to the nonintensive intervention (**Figure 2**). The DID in language development scores between intensive and nonintensive packages was 1.05 milestones (P = 0.001) among children aged 6–23.9 mo and 0.76 milestones (P = 0.038) among children aged 24–47.9 mo (**Table 2**). For gross motor development, the DID was 0.85 milestones (P = 0.035) among children aged 6–23.9 mo and was not significant among older children.

The differential advancement in child development in the age group of 6–23.9 mo was explained, in part, through improved complementary feeding (**Figure 3**). The intensive package had a large, significant, positive impact on minimum dietary diversity (difference in proportion of 0.18), minimum meal frequency (difference in proportion of 0.19), and consumption of iron-rich food (difference in proportion of 0.31). Minimum dietary diversity, in turn, was associated with 0.64 higher language development, whereas both minimum dietary diversity and the consumption of iron-rich food were associated with higher gross motor development (0.70 and 0.57, respectively); minimum meal frequency was associated with neither language nor gross motor development. The indirect effects, obtained by adding the products of the regression coefficients for each path, were 17% of the total effect of the intensive intervention package for language [10% through minimum dietary diversity; P = 0.009 (Sobel test)] and 33% of the total effect for gross motor development [31% through minimum dietary diversity and the consumption of iron-rich food; P < 0.001 (Sobel test)], meaning that the advancement in child development at 6–23.9 mo was partially explained through improved complementary feeding practices.

To assess whether other factors could explain the differential effects of the intervention packages on development, we added into the path analyses responsive feeding, mother's symptoms of common mental disorders, ARI, diarrhea, handwashing with soap, and caregiver engagement. Compared with the nonintensive intervention, the intensive intervention significantly improved responsive feeding (β = 0.15, P < 0.0001), reduced maternal symptoms of common mental disorders (β = −0.11, P < 0.0001), and reduced child ARI (β = −0.12, P < 0.0001), but

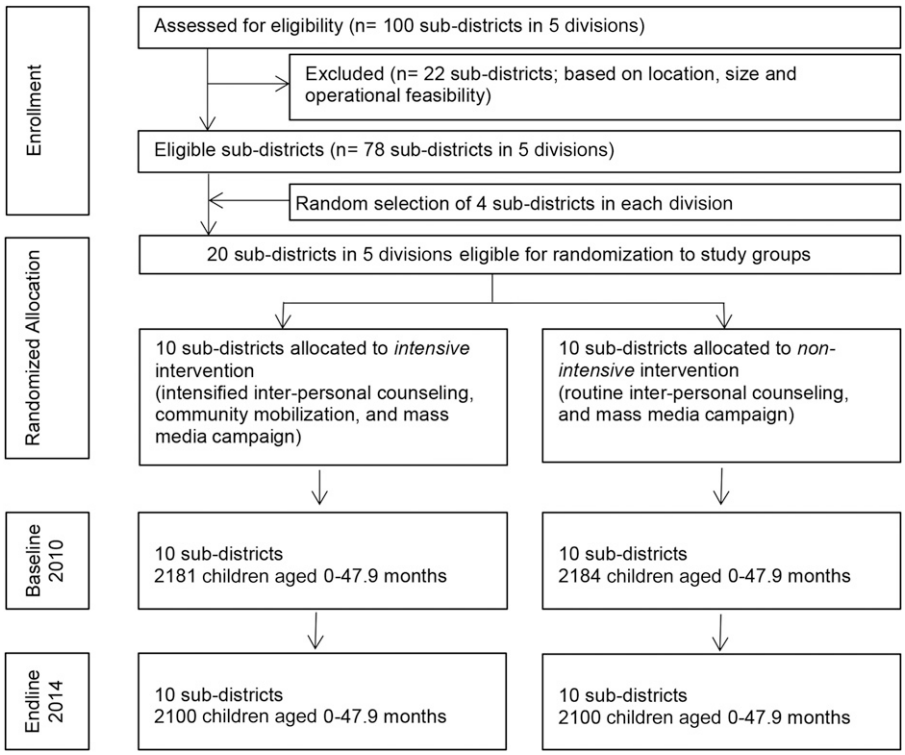

FIGURE 1 CONSORT diagram. CONSORT, Consolidated Standards of Reporting Trials.

TABLE 1 Selected characteristics of the study sample at baseline[1]

	Intensive (n = 2181)	Nonintensive (n = 2184)
Maternal characteristics		
Age, y	27.08 ± 6.21	26.58 ± 6.01
Education, %		
No schooling	27.24	26.33
Primary school	30.17	27.93
Secondary school	35.99	37.09
High school	6.60	8.65
BMI, %	20.29 ± 3.21	20.54 ± 3.16
<18.5 kg/m^2	31.60	27.80
SRQ-20 score (range: 0–20)	7.01 ± 5.38	6.72 ± 5.00
Common mental disorder (SRQ-20 ≥10), %	31.04	28.62
Hygiene score (range: 0–10)	7.18 ± 3.08	7.75 ± 2.69
Child engagement score (range: 0–6)	2.94 ± 1.77	2.97 ± 1.88
Responsive feeding, %	57.86	56.96
Child characteristics		
Age, mo	22.22 ± 14.21	22.41 ± 14.47
Female, %	47.27	49.36
ARI, %	30.54	35.71*
Diarrhea, %	7.52	7.60
Birth size score (range 1–5)	2.89 ± 0.89	2.90 ± 0.87
Household characteristics		
Household food insecurity,[2] %	32.14	31.91
Household SES index[3]	−0.0466 ± 0.91	0.0465 ± 0.99
Mother employed, %	5.18	7.42**

[1] Values are means ± SDs unless otherwise indicated. *,**Different from intensive (2-tailed test): **$P < 0.01$, *$P < 0.05$. P values were obtained from the model adjusted for clustering effect at the subdistrict level. ARI, acute respiratory infection; SES, socioeconomic status; SRQ-20, Self-Reporting Questionnaire 20.
[2] Household food security was measured by using the Food and Nutrition Technical Assistance Project/US Agency of International Development's Household Food Insecurity Access Scale.
[3] An SES index was constructed by using principal components analysis with variables on ownership and assets. It is a standardized score, with mean = 0 and SD = 1.

these did not translate into advanced child development. In contrast, caregiver engagement was not affected differentially by the intervention packages but was significantly associated with development ($\beta = 0.26$, $P < 0.001$). Diarrhea and handwashing with soap did not differ by intervention package nor were associated with development; handwashing with soap at endline was high in both intervention groups, at ~90%.

Discussion

The intensive, large-scale intervention package aimed at improving IYCF in Bangladesh advanced development by ~1 milestone among children aged 6–23.9 and 24–47.9 mo for language development and among children aged 6–23.9 mo for gross motor development when compared with the nonintensive intervention package, in addition to the large, significant impact on IYCF practices (22). One milestone was equivalent to an ~2-mo advancement in language and a 1-mo advancement in gross motor development. The differences observed corresponded to age- and sex-adjusted effect sizes of 0.35 for language and 0.23 for gross motor development. These effect sizes were similar to those seen in Pakistan in children at 24 mo of age for the group who received nutrition education and multiple micronutrient powders (i.e., 0.4 for language and 0.2 for gross motor development) but were lower than for the group who also received responsive stimulation (i.e., 0.7 for language and 0.5 for gross motor development) (11). The effect size for infants with low birth weight who received micronutrient powders in Bangladesh was 0.39 for language development (10).

The advancement for children aged 6–23.9 mo was partially explained through improved complementary feeding as measured by minimum dietary diversity and the consumption of iron-rich food (the latter for gross motor development only). Theoretically, the advancement in development as a consequence of the intensive intervention package—whether or not explained through complementary feeding measures—could have resulted from better nutrition or better caregiver engagement or both. Better nutrition might have occurred because of greater dietary diversity, more frequent feeding, and/or better management of poor appetite, each of which could have improved nutritional intake. Better caregiver engagement might have occurred because of improved feeding and other caring behaviors that are reflected in factors such as the following: greater responsiveness, handwashing with soap, or activities with the child; reduced mother's symptoms of common mental disorders, ARI, or diarrhea; more positive feeding interactions; and/or fewer feeding problems. The path analysis provided evidence that the intensive intervention differentially affected several of these factors but not evidence that these effects translated into an advancement in development.

In addition to the randomized study from India (14) discussed earlier, 2 nonexperimental longitudinal studies examined the association between IYCF practices and child development. In Haiti, infants 6–11 mo of age were followed monthly for 1 y (39). Breastfeeding and complementary feeding frequencies, dietary

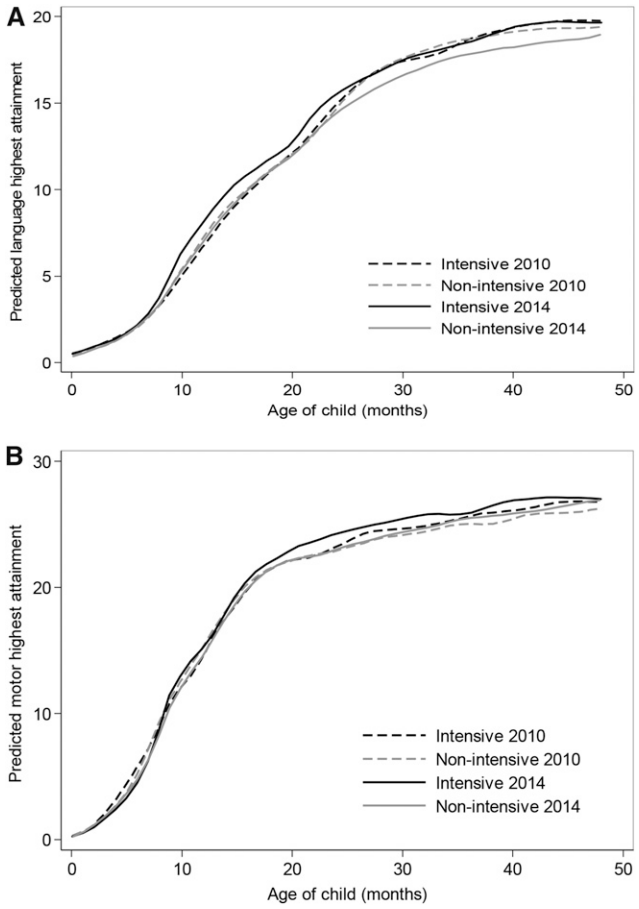

FIGURE 2 Language (A) and motor (B) development by age, stratified by intervention package and survey round.

diversity, and egg and oil intake—along with child anthropometric measurements and reduced morbidity—were associated with earlier achievement of language and motor development in longitudinal models. A long-term follow-up study in the United Kingdom found that better complementary feeding at 6 mo of age was associated with a healthier dietary pattern and higher total, verbal, and performance cognitive scores at 7–8 y of age (40). Although these longitudinal designs provide plausible evidence of the associations between feeding and development, there is still the potential for the association between feeding and development to be confounded by unaccounted time-invariant or time-varying factors. Our study, because of the 2-group cluster-randomized design with measures at baseline and endline, strengthens the evidence that promoting better complementary feeding practices results in advancement in development.

Our study used a cross-sectional design that was longitudinal at the cluster level but not at the child level. In addition to practical considerations, this design had the advantage of allowing us to make population comparisons of children who were at the same ages at both baseline and endline, but a disadvantage of not allowing us to measure how development unfolds in individual children over time. The measures of child development were limited to language and gross motor development in the large multidomain survey that was conducted at baseline and endline. These measures have been used previously but have not been validated (25, 26). Although the breadth of data collected was large, the data on potential caregiver paths and on stressors associated with complementary feeding were limited. Implementers or study participants were not blinded to the intervention package, and the measures used were based on maternal report, which raises concerns regarding potential reporting bias on practices covered by the behavior change communication interventions. We assessed social desirability with the use of a scale adapted for the study and found no intervention-specific differentials in socially desirable reporting for IYCF practices (21). Encouragement of mothers in the intensive package to attend to and talk with their child during feeding could have resulted in children talking more in response, but this also could have led mothers to notice and therefore report more expressions of child language. The study design does not allow separate assessment of components of the intervention nor of the impact of mass media campaign alone, which was implemented nationwide. Because the nonintensive intervention package provided some inputs about child feeding and care to mothers and other caregivers, the design does not allow assessment of the full impact of the intensive intervention package compared with a no-intervention group.

In conclusion, the intensive IYCF intervention package, which provided mass media messages and community social mobilization along with intensive counseling delivered by trained and supervised frontline workers who received incentives for quality of performance, had a significant differential

TABLE 2 Effects of intensive compared with nonintensive programs on language and motor development[1]

	Baseline: 2010 (T1)		Endline: 2014 (T2)				
Impact indicators	Intensive	Nonintensive	Intensive	Nonintensive	Unadjusted DID (*P*)[2]	Adjusted DID (*P*)[3]	Fully adjusted DID (*P*)[4]
Age 6–23.9 mo, *n*	608	603	500	503			
Language development score	8.72 ± 4.70	8.88 ± 4.56	9.64 ± 4.65	8.51 ± 4.36	1.29 (0.005)	1.10 (0.001)	1.05 (0.001)
Motor development score	17.29 ± 6.08	17.57 ± 5.97	17.85 ± 6.25	16.72 ± 6.44	1.41 (0.025)	0.97 (0.024)	0.85 (0.035)
Age 24–47.9 mo, *n*	1086	1091	1099	1100			
Language development score	18.17 ± 3.27	18.16 ± 3.03	18.23 ± 2.92	17.29 ± 3.43	0.93 (0.017)	0.80 (0.033)	0.76 (0.038)
Motor development score	25.37 ± 2.61	24.79 ± 2.54	26.01 ± 2.60	25.08 ± 2.92	0.36 (0.222)	0.26 (0.287)	0.20 (0.336)

[1] Values are means ± SDs or coefficients unless otherwise indicated. A&T, Alive & Thrive; T, time; DID, differences in difference.
[2] Double-difference impact estimates with clustered SEs and 1-tailed *P* values comparing A&T intensive and nonintensive areas in 2010 and 2014 were used, accounting for geographic clustering only.
[3] Double-difference impact estimates with clustered SEs and 1-tailed *P* values comparing A&T intensive and nonintensive areas in 2010 and 2014 were used, accounting for geographic clustering, child age and age-squared, and child sex.
[4] Double-difference impact estimates with clustered SEs and 1-tailed *P* values comparing A&T intensive and nonintensive areas in 2010 and 2014 were used, accounting for geographic clustering, child age and age-squared, child sex, and variables that differed in change from baseline to endline but were not affected by the interventions (i.e., maternal occupation and child birth size).

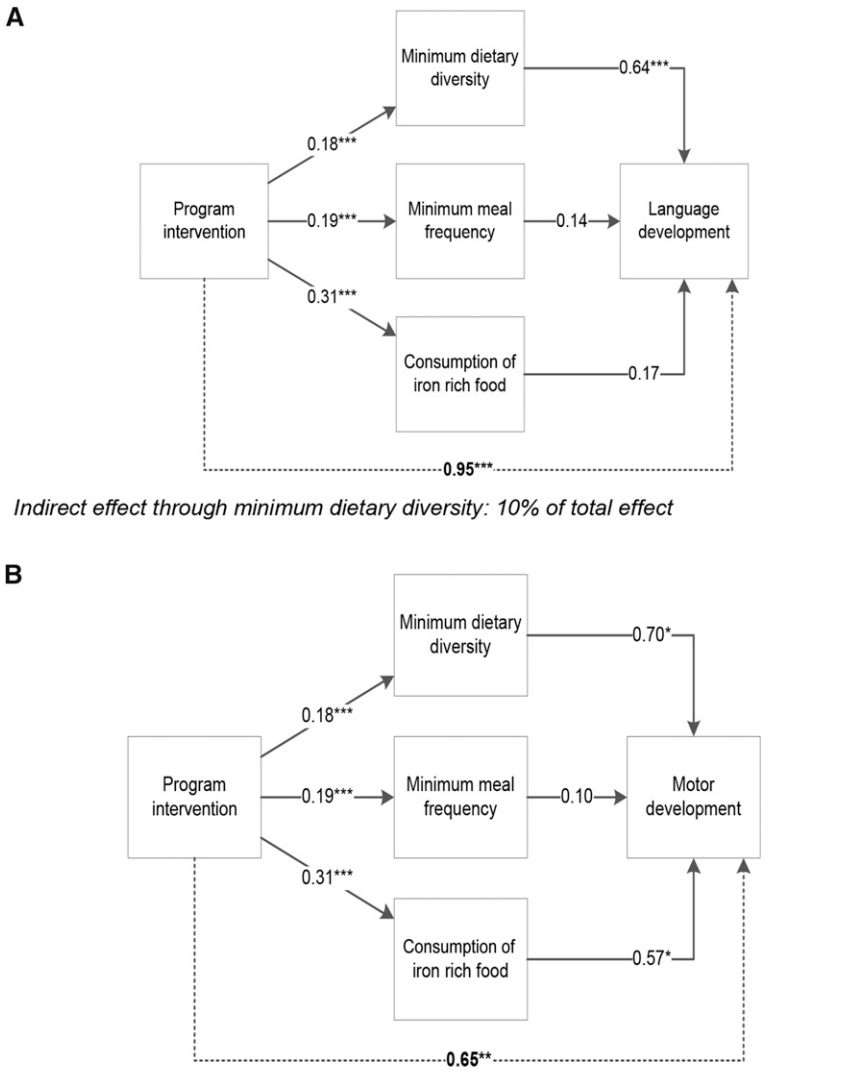

FIGURE 3 Path analyses for language (A) and motor (B) development among children 6–23.9 mo of age. Values are unstandardized regression coefficients from path analyses. Minimum dietary diversity was defined as the proportion of children aged 6–23 mo who received foods from ≥4 food groups during the previous day; minimum meal frequency was defined as the proportion of children aged 6–23 mo who received solid, semisolid, or soft foods the minimum number of times or more (2 times for breastfed infants aged 6–8 mo, 3 times for breastfed children aged 9–23.9 mo, and 4 times for non-breastfed children aged 6–23.9 mo). $***P < 0.001$, $**P < 0.01$, and $*P < 0.05$ (2-tailed tests).

impact on language and gross motor development in comparison to the nonintensive intervention package. The path from the intensive intervention to advanced development was partially explained through improved complementary feeding and could have resulted from both biological (i.e., nutritional) and behavioral (i.e., caregiving) mechanisms. Further research may be helpful in understanding and potentiating these mechanisms. The intensive intervention package had a significant differential impact on child development but not on stunting. The findings highlight the importance of measuring a diverse set of child outcomes, including functional outcomes such as child development, when evaluating interventions and programs (32), given that the A&T initiative, which primarily aimed to improve IYCF and stunting, also advanced language and gross motor development. Furthermore, the findings reinforce efforts to develop and evaluate integrated nutritional and developmental interventions (9) that efficiently and effectively support parents and other caregivers to provide optimal, holistic care for their infants and young children, which will lead to physical, cognitive, and socio-emotional development. Providing such interventions at scale is challenging given the current limitations in resources, systems, and political commitment (5). The A&T initiative in collaboration with BRAC in Bangladesh has shown that the package of interventions to support IYCF could be delivered at scale by building on an existing platform (41). This study shows that the documented impacts go beyond IYCF on 2 relevant developmental outcomes for young children, adding to the evidence for investments in large-scale, high-quality interventions to support IYCF.

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References

1. Black MM, Walker SP, Fernald LC, Andersen CT, DiGirolamo AM, Lu C, McCoy DC, Fink G, Shawar YR, Shiffman J, et al. Early childhood development coming of age: science through the life course. Lancet 2016 Oct 3 (Epub ahead of print; DOI: 10.1016/S0140-6736(16)31389-7).
2. Walker SP, Wachs TD, Gardner JM, Lozoff B, Wasserman GA, Pollitt E, Carter JA; International Child Development Steering Group. Child development: risk factors for adverse outcomes in developing countries. Lancet 2007;369:145–57.
3. Prado EL, Dewey KG. Nutrition and brain development in early life. Nutr Rev 2014;72:267–84.
4. Engle PL, Fernald LC, Alderman H, Behrman J, O'Gara C, Yousafzai A, de Mello MC, Hidrobo M, Ulkuer N, Ertem I, et al. Strategies for reducing inequalities and improving developmental outcomes for young children in low-income and middle-income countries. Lancet 2011;378:1339–53.
5. Richter LM, Daelmans B, Lombardi J, Heymann J, Boo FL, Behrman JR, Lu C, Lucas JE, Perez-Escamilla R, Dua T, et al. Investing in the foundation of sustainable development: pathways to scale up for early childhood development. Lancet 2016 Oct 3 (Epub ahead of print; DOI: 10.1016/S0140-6736(16)31698-1).
6. Larson LM, Yousafzai AK. A meta-analysis of nutrition interventions on mental development of children under-two in low- and middle-income countries. Matern Child Nutr 2015 Nov 26 (Epub ahead of print; DOI: 10.1111/mcn.12229).
7. Ruel MT, Alderman H; Maternal and Child Nutrition Study Group. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? Lancet 2013;382:536–51.
8. Gardner JM, Powell CA, Baker-Henningham H, Walker SP, Cole TJ, Grantham-McGregor SM. Zinc supplementation and psychosocial stimulation: effects on the development of undernourished Jamaican children. Am J Clin Nutr 2005;82:399–405.
9. Grantham-McGregor SM, Fernald LC, Kagawa RM, Walker S. Effects of integrated child development and nutrition interventions on child development and nutritional status. Ann N Y Acad Sci 2014;1308:11–32.
10. Singla DR, Shafique S, Zlotkin SH, Aboud FE. A 22-element micronutrient powder benefits language but not cognition in Bangladeshi full-term low-birth-weight children. J Nutr 2014;144:1803–10.
11. Yousafzai AK, Rasheed MA, Rizvi A, Armstrong R, Bhutta ZA. Effect of integrated responsive stimulation and nutrition interventions in the Lady Health Worker programme in Pakistan on child development, growth, and health outcomes: a cluster-randomised factorial effectiveness trial. Lancet 2014;384:1282–93.
12. Grantham-McGregor SM, Powell CA, Walker SP, Himes JH. Nutritional supplementation, psychosocial stimulation, and mental development of stunted children: the Jamaican study. Lancet 1991;338:1–5.
13. Engle PL, Fernández PD. INCAP studies of malnutrition and cognitive behavior. Food Nutr Bull 2010;31:83–94.
14. Vazir S, Engle P, Balakrishna N, Griffiths PL, Johnson SL, Creed-Kanashiro H, Fernandez Rao S, Shroff MR, Bentley ME. Cluster-randomized trial on complementary and responsive feeding education to caregivers found improved dietary intake, growth and development among rural Indian toddlers. Matern Child Nutr 2013;9:99–117.
15. Chowdhury AM, Bhuiya A, Chowdhury ME, Rasheed S, Hussain Z, Chen LC. The Bangladesh paradox: exceptional health achievement despite economic poverty. Lancet 2013;382:1734–45.
16. National Institute of Population Research and Training; Mitra and Associates; ICF International. Bangladesh demographic and health survey 2014. Dhaka (Bangladesh) and Rockville (MD): National Institute of Population Research and Training; 2015.
17. Allen LH. Adequacy of family foods for complementary feeding. Am J Clin Nutr 2012;95:785–6.
18. Dewey KG. The challenge of meeting nutrient needs of infants and young children during the period of complementary feeding: an evolutionary perspective. J Nutr 2013;143:2050–4.
19. Kimmons JE, Dewey KG, Haque E, Chakraborty J, Osendarp SJ, Brown KH. Low nutrient intakes among infants in rural Bangladesh are attributable to low intake and micronutrient density of complementary foods. J Nutr 2005;135:444–51.
20. Hamadani JD, Baker-Henningham H, Tofail F, Mehrin F, Huda SN, Grantham-McGregor SM. Validity and reliability of mothers' reports of language development in 1-year-old children in a large-scale survey in Bangladesh. Food Nutr Bull 2010;31:S198–206.
21. Menon P, Nguyen PH, Saha KK, Khaled A, Sanghvi T, Baker J, Afsana K, Haque R, Frongillo EA, Ruel MT, et al. 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. J Nutr 2016;146:2075–84.
22. Menon P, Nguyen PH, Saha KK, Khaled A, Kennedy A, Tran LM, Sanghvi T, Hajeebhoy N, Baker J, Alayon S, et al. Impacts on breastfeeding practices of at-scale strategies that combine intensive interpersonal counseling, mass media, and community mobilization: results of cluster-randomized program evaluations in Bangladesh and Viet Nam. PLoS Med 2016; 13:e1002159.
23. Sanghvi T, Haque R, Roy S, Afsana K, Seidel R, Islam S, Jimerson A, Baker J. Achieving behaviour change at scale: Alive & Thrive's infant and young child feeding programme in Bangladesh. Matern Child Nutr 2016;12(Suppl 1):141–54.
24. Menon P, Rawat R, Ruel M. Bringing rigor to evaluations of large-scale programs to improve infant and young child feeding and nutrition: the evaluation designs for the Alive & Thrive initiative. Food Nutr Bull 2013;34:S195–211.
25. Stoltzfus RJ, Kvalsvig JD, Chwaya HM, Montresor A, Albonico M, Tielsch JM, Savioli L, Pollitt E. Effects of iron supplementation and anthelmintic treatment on motor and language development of preschool children in Zanzibar: double blind, placebo controlled study. BMJ 2001;323:1389–93.
26. Olney DK, Kariger PK, Stoltzfus RJ, Khalfan SS, Ali NS, Tielsch JM, Sazawal S, Black R, Allen LH, Pollitt E. Development of nutritionally at-risk young children is predicted by malaria, anemia, and stunting in Pemba, Zanzibar. J Nutr 2009;139:763–72.
27. WHO. Indicators for assessing infant and young child feeding practices. Part 2: measurements. Geneva (Switzerland): World Health Organization; 2008. [cited 2016 Aug 15]. Available from: http://whqlibdoc.who.int/publications/2010/9789241599290_eng.pdf.
28. WHO/UNICEF. Diarrhea: why children are still dying and what can be done. Geneva (Switzerland): World Health Organization; 2009.
29. WHO. Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care. WHO interim guidelines. Geneva (Switzerland): World Health Organization; 2007. Report No.: WHO/CDS/EPR/2007.6.
30. Ruel MT, Arimond M. Spot-check observational method for assessing hygiene practices: review of experience and implications for programmes. J Health Popul Nutr 2002;20:65–76.
31. WHO. A user's guide to self-reporting questionnaires. Geneva (Switzerland): Division of Mental Health, World Health Organization; 1994.
32. Frongillo EA, Tofail F, Hamadani JD, Warren AM, Mehrin SF. Measures and indicators for assessing impact of interventions integrating nutrition, health, and early childhood development. Ann N Y Acad Sci 2014;1308:68–88.
33. Kariger P, Frongillo EA, Engle P, Britto PM, Sywulka SM, Menon P. Indicators of family care for development for use in multicountry surveys. J Health Popul Nutr 2012;30:472–86.
34. Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for measurement of household food access: indicator guide (v. 3). Washington (DC): Food and Nutrition Technical Assistance Project, Academy for Educational Development; 2007.
35. Vyas S, Kumaranayake L. Constructing socio-economic status indices: how to use principal components analysis. Health Policy Plan 2006;21:459–68.
36. Hayes RJ, Moulton LH. Cluster randomized trials. Boca Raton (FL): Chapman & Hall/CRC Press; 2009.
37. Gertler PJ, Martinez S, Premand P, Rawlings LB, Vermeersch CMJ. Impact evaluation in practice. Washington (DC): International Bank for Reconstruction and Development/World Bank; 2011.
38. Kline R. Principles and practice of structural equation modeling. 3rd ed. New York: Guilford Press; 2011.
39. Iannotti L, Dulience SJ, Wolff P, Cox K, Lesorogol C, Kohl P. Nutrition factors predict earlier acquisition of motor and language milestones among young children in Haiti. Acta Paediatr 2016;105:e406–11.
40. Golley RK, Smithers LG, Mittinty MN, Emmett P, Northstone K, Lynch JW. Diet quality of U.K. infants is associated with dietary, adiposity, cardiovascular, and cognitive outcomes measured at 7–8 years of age. J Nutr 2013;143:1611–7.
41. Britto PR, Lye SJ, Proulx K, Yousafzai AK, Matthews SG, Vaivada T, Perez-Escamilla R, Rao N, Ip P, Fernald LC, et al. Nurturing care: promoting early childhood development. Lancet 2016 Oct 3 (Epub ahead of print; DOI: 10.1016/S0140-6736(16)31390-3).