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Original Research Article

Specialized nutritious foods and behavior change communication interventions during the first 1000 d of life to prevent stunting: a quasi-experimental study in Afghanistan

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A B S T R A C T

Background: Considerable evidence supports the effectiveness of nutritional supplementation with or without nutrition education in preventing stunting in developing countries, but evidence from Afghanistan is scarce.

Objectives: This project aimed to assess the effectiveness of specialized nutritious food (SNF), social and behavior change communication (SBCC) intervention to prevent stunting among children under 2 y during the first 1000 d of life in Badakhshan, Afghanistan.

Methods: We used a community-based quasi-experimental pre–post study design with a control group. Pregnant and lactating women received a monthly ration of 7.5 kg of super cereal (250 g/d) during pregnancy and the first 6 mo of breastfeeding. Children aged 6–23 mo received 30 sachets of medium-quantity lipid-based nutrient supplement (50 g/sachet/d) monthly. We compared pre- and postintervention assessments of the intervention and control groups to isolate the effect of the intervention on key study outcomes at the endline by difference-in-differences (DID) estimates.

Results: A total of 2928 and 3205 households were surveyed at baseline and endline. DID estimates adjusted for child, maternal, and household characteristics indicated a significant reduction in stunting (DID: −5% (95% confidence interval [CI]: −9.9, −0.2) and underweight (DID: −4.6% (95% CI: −8.6, −0.5) among children <2 y of age. However, DID estimates for wasting among children in the intervention and control groups were not significantly different (DID: −1.7 (95% CI: −5.1, 1.6). Furthermore, exposure to the SBCC messages was associated with improvements in the early initiation of breastfeeding (DID: 19.6% (95% CI: 15.6, 23.6), exclusive breastfeeding under 6 mo (DID: 11.0% (95% CI: 2.3, 19.7), minimum meal frequency (DID: 23% (95% CI: 17.7, 28.2), and minimum acceptable diet (DID: 13% (95% CI: 9.8, 16.3).

Conclusions: The provision of SNF in combination with SBCC during the first 1000 d of life was associated with reduction in stunting and underweight and improvements in infant and young child feeding practices among children under 2 y of age.

This trial was registered at clinicaltrials.gov as NCT04581993.

Keywords: stunting, underweight, specialized nutritious foods, social and behavior change communication, Afghanistan

Introduction

Stunting is defined as a height-for-age *z*-score (HAZ) >2 SDs below the WHO Child Growth Standards median [1]. It results from many factors, including poor nutritional intake, frequent infections, and poor psychosocial stimulation [2]. Stunting is impaired growth and development of a fetus in the womb that continues during the child is 2 y of age ("the first 1000 days of life") and beyond [2–5]. Impaired

Abbreviations: ANC, antenatal care; AKF, Aga Khan Foundation; AKHS, Aga Khan Health Services; AKU, Khan University; CHW, community health worker; DID, difference-in-differences; HAZ, height-for-age *z*-score; IEC, information; education, and communication; IYCF, infant and young child feeding; LAZ, length-for-age *z*-score; MAD, minimal acceptable diet; MMF, minimum meal frequency; MoPH, Ministry of Public Health; MQ-LNS, medium-quantity lipid-based nutrient supplement; NSBCC, nutrition social behavior change communication; PBW, pregnant and breastfeeding women; SBCC, social and behavior change communication; SNF, specialized nutritious food; WAZ, weight-for-age *z*-score; WFP, World Food Programme; WLZ, weight-for-length *z*-score.

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growth and development during this critical time period and later in life may have multiple adverse consequences on children including lower cognitive development, lower IQ scores, increased risk of death from infectious diseases and reduced schooling attainment, low productivity, and increased risk of noncommunicable diseases [5–14]. Stunting not only has health consequences but also greatly impacts human capital and economic growth at the individual, household, and national levels [5]. Scientific evidence has shown that stunted children are 33% less likely to escape poverty in adulthood [15].

In Afghanistan, the prevalence of stunting among children under 5 y of age remains high, with majority of the provinces experiencing rates above the WHO alert threshold of ≥40% [16]. Nutritional interventions for children are usually implemented during the first 2 y of life, which is the peak incidence of growth faltering, micronutrient deficiencies, and infectious illnesses in developing countries including Afghanistan. After reaching 2 y of age, the challenge of reversing the consequences of malnutrition on stunting increases significantly, with the potential for some functional deficits to become permanent. To address stunting through "the first 1000 d window of opportunity," both global and regional experts have sought to reduce stunting through investment in proven nutrition interventions such as nutritional supplementation for pregnant and breastfeeding women (PBW), counseling mothers on infant and young child feeding (IYCF) practices, and nutritional supplementation for children 6–23 mo of age [17,18]. There is considerable evidence on the effectiveness of nutritional supplementation with and without nutrition education on preventing and managing stunting in developing countries [19–25]. However, these studies do not account for local factors and widespread nutrient deficiencies in Afghanistan. These studies are often conducted in controlled environments, where the results cannot be generalized to programs operating under field conditions.

To explore ways to reduce risk of stunting in young children, the World Food Programme (WFP), Afghanistan, implemented a stunting prevention program in collaboration with the Ministry of Public Health (MoPH) through its Public Nutrition Department and partners in the province of Badakhshan, Afghanistan. The program emphasized appropriate nutrition support during the "first 1000 d, " focusing on proven, effective nutrition interventions such as appropriate breastfeeding, complementary feeding, nutritional supplementation, and social and behavior change communication (SBCC). The program was implemented through the existing health system involving monthly implementation and delivery of a package of interventions with the support of Aga Khan Health Services (AKHS), Afghanistan, and the Aga Khan Foundation (AKF), Afghanistan, who provided community-level support through community health workers (CHWs) and volunteers. The program included monthly distributions of specialized nutritious food (SNF) for PBW, and children aged 6–23 mo and counseling for their mothers and caretakers on the appropriate use of SNF and optimal IYCF practices. All the trainings and SBCC messages were developed based on formative research on the knowledge, attitudes, practices, and barriers to optimal IYCF practices.

The primary outcome was to assess the impact of the intervention package during the "first 1000 d" on the reduction in the prevalence of stunting among children under 2 y of age in the intervention group compared with the control group. Secondary study outcomes included the impact of the intervention package on the reduction in the prevalence of wasting and underweight in children under 2 y of age and improvement in IYCF practices.

Methods

Study design

A quasi-experimental pre–post study design with a control group was used to evaluate the study outcomes. We compared the intervention and control group on the pre- and postintervention assessments to isolate the effect of the intervention on study outcomes by difference at endline and difference-in-differences (DID) estimates. Cross-sectional baseline and endline surveys were conducted in both the intervention and control districts. The intervention districts were exposed to the nutrition intervention, which was monitored closely to ensure that the intervention was delivered consistently and accurately by the study staff and SBCC activities delivered by the health facility staff, CHWs, and community mobilizers. The control districts received the routine standard of care available in the area.

During project implementation, areas of emphasis included adaptation of locally formulated complementary foods, application of knowledge and practices promoted through the SBCC activities as part of the exit strategy and ensuring long-lasting project impact. The stunting prevention program was implemented between January 2021 and June 2022 in 2 districts of Badakhshan, Afghanistan. The quasi-experimental design with cross-sectional baseline and endline surveys was designed to assess the impact of the program interventions on a representative sample of households in the targeted areas of the Stunting Prevention Program (intervention districts) compared with control districts. In collaboration with the study partners, the Aga Khan University (AKU) conducted the baseline household survey between October and December 2020 and the endline survey between July and August 2022.

Setting

The intervention was implemented in 2 districts: Shuhada and Shari Buzurg in Badakhshan. Rustaq and Worsaj in Takhar Province served as the 2 control districts. Takhar Province was selected as the control location for the study because Rustaq and Worsaj were very similar in terms of accessibility, socioeconomic conditions, food consumption practices, geography, and ethnicity. Badakhshan was selected as an intervention area because Shuhada and Shari Buzurg were covered by implementing partners AKHS and AKF, with an additional layer of close monitoring provided by AKU, the WFP, and the MoPH. The Badakhshan Province was selected because the maternal child health characteristics were poor, but the province was generally less affected by the political instability affecting the rest of the country. We describe the design as quasi-experimental rather than experimental because the intervention was not randomly assigned among districts; the intervention was administered in places with strong need and then control districts were selected that would be as similar as practically possible.

Participants

All pregnant and lactating mothers with their children under 2 y of age were eligible to be enrolled in the baseline and endline surveys. Eligible participants were identified through 2 sources: *1)* a list of pregnant women who accessed antenatal care (ANC) services and breastfeeding mothers who accessed postnatal care and childcare services was prepared at health facilities. *2)* At the community level, a list of PBW and children was prepared through CHWs. These included those PBW and children not captured at the health facility.

The baseline and endline surveys used a 2-stage cluster sampling design. In the first stage, 30 clusters (villages) from each district (60 total) were randomly selected using probability-proportional-to-population-size sampling. In the second stage, households within these villages were chosen through systematic random sampling, with intervals of 100–200 m from a specified landmark, until the required sample size for each village was achieved. No replacements were made for any reason.

Interventions

The interventions focused on providing SNF and SBCC messages to eligible beneficiaries through existing health systems, mobile health teams, and CHWs at community levels. All children aged 6–23 mo received locally produced medium-quantity lipid-based nutrient supplement (MQ-LNS) and PBW received super cereal from January 2021 to June 2022.

Super cereal

The WFP prepared super cereal from heat-treated wheat and whole soya beans, sugar, vitamins, and minerals. This product was prepacked and available in 1.5 kg packets. The WFP food safety and quality control unit was responsible for the quality assurance of the product during the program period. A monthly ration of 7.5 kg of super cereal (250 g/d) was provided to pregnant women during pregnancy and to breastfeeding mothers for the first 6 mo of breastfeeding.

Medium-quantity lipid-based nutrient supplement

MQ-LNS was made with fresh, good-quality heat-treated oil seeds, pulses, cereals, milk powder, sugar, vegetable oils, vitamins, and minerals. MQ-LNS ingredients were free of foreign materials, infestations, and substances hazardous to health and did not contain any animal-origin ingredients except dairy products. A daily sachet of 50 g provided 255 kcal. A monthly ration of 30 sachets was provided to children 6–23 mo of age. The WFP food safety and quality control unit was responsible for ensuring product quality during the program period.

Social behavior change communication

The SBCC strategy was informed by a literature review and formative research. A cascade training approach was followed, involving an initial training of master trainers followed by training for health facility staff and CHWs. The minimum qualification for master trainers was a 14th grade education and 2–3 y of experience in maternal and child nutrition. The training covered information on IYCF practices, child and maternal nutrition, and nutritional supplements. Lead mothers worked as facilitators with support from CHWs. Guides that included information, education, and communication (IEC) materials were used to highlight key messages relevant to the nutrition issues in the intervention community. To create awareness in the community and at the household level, female and male support groups were strengthened in the catchment areas of CHWs. Monthly parents' group meetings were arranged with the assistance of the community support group and health workers to disseminate SBCC messages related to IYCF practices, child and maternal nutrition, and the use of nutritional supplements. Community mobilizers in the intervention group conducted separate sessions on health education for pregnant women, lactating mothers, mothers-in-law, fathers, and fathers-in-law using educational materials (flip charts) on IYCF practices and maternal and child nutrition. Because of their important role in decision making, male family members were encouraged to participate actively in these sessions. Six key SBCC messages included: *1)* Eat $\geq$5 different food groups every day (grains, white roots and tubers and plantains; pulses (beans, peas, and lentils); nuts and seeds; dairy products (milk, yogurt, cheese); meat, poultry, and fish; eggs; and dark green leafy vegetables; vitamin A-rich and other fruits and vegetables) during pregnancy and the breastfeeding period. *2)* Use 250 g (2 cups) of super cereal daily during pregnancy and the first 6 mo of breastfeeding and avoid sharing with family members. *3)* Initiate breastmilk to newborn within 1 h of birth, continue exclusive breastfeeding until 6 mo of age and introduce nutritionally adequate and safe complementary (semisolid and solid) foods at 6 mo together with continued breastfeeding $\leq$2 y of age or beyond. *4)* Give your child a variety of food groups every day (grains, roots and tubers; legumes and nuts; dairy products [milk, yogurt, cheese]; meat, fish, poultry, liver/organ meats; eggs; vitamin A-rich and other fruits and vegetables) during 6–24 mo of age. Do this at least twice for breastfed infants aged 6–8 mo, 3 times for breastfed children aged 9–23 mo and 4 times for non–breastfed children aged 6–23 mo. *5)*. Give 1 sachet of MQ-LNS to your child every day from 6 to 24 mo and avoid sharing with other children. *6)* Wash your hands with soap before preparing food, before eating, before feeding a child, after handling feces/diapers or using the latrine, and keep the cooking utensils clean to prevent frequent illnesses. The key messages were delivered through one-on-one sessions at the time of receiving supplements, as well as during parent groups and community sessions. The AKU monitoring and evaluation (M & E) team and study stakeholders assessed and monitored the SBCC messages using monthly post-distribution visits at health facility and household levels.

Data collection procedures

A structured household survey questionnaire was used to collect data on socioeconomic status; exposure to interventions; IYCF practices; and knowledge, attitudes, and practices regarding IYCF. In addition, height/length, weight of child was also collected. IYCF practices for children under 2 y of age were assessed using the WHO IYCF module for children under 2 y. The questionnaire was pre-tested in the field, and changes were incorporated in accordance with pre-test findings before the primary data collection commenced. The questionnaire was initially designed in English, translated to Dari, and then back translated by an independent person to check for inconsistencies.

Two trained staff gathered anthropometric measurements, which included the child's weight and length. Each measurer assessed and recorded each value independently with no knowledge of the values recorded by the other measurer. After collecting the data, the 2 measurers compared their measurements to ensure that the differences between their measurements fell within the standard maximum allowed differences (7 mm for length and 50 g for weight). Any pair of measurements falling outside the maximum permitted differences to be repeated independently by both measurers and entered on the recording sheet. If this second pair of measurement values again exceeded the standard limits for that measurement, the measurers repeated the measurement independently for a third and final time.

Child weight was assessed using a calibrated balance allowing double weighing (mother–child) and an automatic deduction of the mother's weight to obtain the child's weight. A SECA 874 U electronic scale brand weight machine was used for weight measurement with an accuracy of $\leq$50 g. The children's length was measured using a SECA length board with an accuracy of $\leq$0.1 cm.

At the endline survey, mothers were also asked about their exposure to SNF and key SBCC messages, participation in individual and group counseling sessions, and awareness of maternal diet and IYCF practices. Supplement distribution data were used to assess the number of months participants received supplements. The quantity of supplements consumed by participants and the extent to which supplements were shared with family members was assessed by maternal recall.

Before commencement of the data collection, the data collection teams received a 5-d hands-on training on study objectives, methods, data collection techniques, how to assess anthropometric measurements, and ethical issues by study investigators. A 1-d field testing session was carried out before the actual fieldwork. A survey manual was provided to each team leader, which included instructions, methodological details, and a description of the sampling strategy. The printed questionnaires used by data collectors were available in Dari.

A total of 8 teams from Badakhshan and Takhar provinces were hired locally. Each team comprised 2 female data collectors and 1 male or female team leader. Female data collectors were responsible for collecting data from the PBW and gathering anthropometric measurements. Sixteen female data collectors and 8 team leaders were involved in data collection.

Each team leader was responsible for checking data quality, ensuring correction of mistakes, retaking measurements if needed, and assessing teamwork. Each team leader conducted daily morning meetings. He was also responsible for reviewing questionnaires for completeness and quality of collected data. Once the fieldwork was completed, data collection teams submitted all completed questionnaires to their respective team leader. If errors and inconsistencies were identified, the questionnaires were returned to the data collectors for correction in the field. The field supervisor randomly visited 3%–5% of the households assessed by the data collection team to validate the data, in particular the anthropometric measurements and other vital indicators for quality assurance purposes. ENA SMART software was used for day-to-day monitoring and quality assurance of the anthropometric data.

The data were collected on paper forms and then entered on tablets. A customized application was developed using Java on SQLite backend for data storage. The key features of the data collection application included access control, onscreen consistency and range checks, onscreen tips, and quick reports. Range and consistency check as well as skip patterns were built into the program to minimize the entry of erroneous data. The database was configured to enforce referential integrity and ensure that all data tables were related.

The study was reviewed and approved by the Ethics Review Committee of Aga Khan University (ERC No. 2020-5028-14108), and the Institutional Review Board of the Ministry of Public Health, Afghanistan (IRB Code No. A.1020.0235). Participants were informed of the survey objectives and data collection procedures and were assured that their data would be kept private and confidential. Oral informed consent was obtained from all participants before completing the baseline and endline surveys. Mothers provided consent on behalf of their children who participated in the study.

Sample size

A total of 2912 children <2 y of age and their mothers (1456 per group per survey) were estimated to provide reasonable precision (80% power, 95% confidence interval [CI], design effect of 1.5, and response rate of 95%) for baseline and endline surveys based on a 13% relative reduction in the prevalence of stunting in children under 2 y of age in the intervention group compared with the control group at endline.

Statistical analysis

The analysis was designed to provide estimates of key indicators for the intervention and control groups. Initial analysis included examining the frequency distribution of all variables to identify possible errors. Final analyses were performed after data cleaning and implementation of quality assurance checks. Descriptive statistics for all study variables were estimated and reported as mean (±SD), median, ranges, and frequencies, as appropriate. Statistical significance was set at $P < 0.05$. Anthropometric measurements, together with the age and gender of the children were converted to z-scores and used to calculate weight-for-age (WAZ), length-for-age (LAZ), and weight-for-length (WLZ) z-scores. Biologically implausible values (BIVs, i.e., WAZ $-6 <$ WAZ $> +5$, LAZ $-6 <$ LAZ $> +5$, WLZ $-5 <$ WLZ $> +5$) were flagged and excluded from subsequent analyses. The prevalence of malnutrition in its different forms (underweight, wasting, and stunting) was calculated using the z-score cutoff point of <2 SD in accordance with WHO growth standards [1]. We used an additive DID modeling technique to test and quantify program impact and the associations between the integrated IYCF and MQ-LNS and program indicators between the pre- and postsurveys. The DID effects, their 95% CI, and P values were obtained from Generalized linear mixed models (GLMMs) that accounted for (intervention compared with control) areas and time (endline compared with baseline) and included an interaction term between targeted areas and time for quantifying program impact. It was determined a priori that the multivariable DID models would adjust for the following confounding covariates: child gender, age, maternal age, education, skilled birth attendant, facility births, IYCF indicators, maternal BMI, and household characteristics. All analyses were performed using Stata version 17.

Results

Demographic characteristics of study participants

Table 1 describes the key characteristics of the study participants; 2928 and 3205 households were surveyed at baseline and endline, from both intervention and control groups, respectively. Participation rates were high (>95%) and were similar at baseline and endline across both study areas (Figure 1). The distribution of study participants (pregnant women, breastfeeding mothers, and children aged 6–23 mo) was similar at baseline and endline in both study groups. Although the percentage of women seeking ANC during pregnancy improved in the intervention group between the 2 surveys (67.8% at baseline compared with 93.7% at endline), in the control group, there was little change (84.0% at baseline compared with 88.6% at endline) (Table 1).

Most households had access to improved drinking water (piped into dwelling, piped to yard/plot/neighbor, public tap/standpipe, tube well or borehole or suction pump, hand pump, protected well, rainwater, filtration plant, and bottled water) in both study groups (83.9% at baseline and 90.0% at endline in the intervention group and 93.0% at baseline and 84.9% at endline in the control group). The improved sanitation facilities (flush to piped sewer system, flush to septic tank, flush to pit latrine, ventilated improved pit latrine, and pit latrine with slab) in the intervention households were 69.0% at baseline and 57.2% at endline, whereas in the control households it was 43.4% at baseline and 72.1% at endline. Over half of the households in the intervention group (52.6% at baseline and 54.4% at endline) but slightly less than half of the control households reported owning agricultural land (40.6% at baseline; 48.1% at endline). Most households at both times across the study groups reported owning livestock, animals, or poultry (Table 1).

Impact on child nutritional status among children under 2 y in control and intervention groups by DID estimates

The impacts of nutritional supplementation during the "first 1000 d" on reduction in the prevalence of stunting, wasting, and underweight in children under 2 y of age are presented in Table 2.

TABLE 1
Sociodemographic characteristics of study population and participants[1]

	Intervention		Control	
	Baseline	Endline	Baseline	Endline
	$N = 1461$	$N = 1601$	$N = 1467$	$N = 1604$
Mother's age (y) mean ± SD	27.7 ± 5.7	29.0 ± 6.0	28.8 ± 5.6	29.0 ± 5.8
Mother's education				
None	794 (54.3)	695 (43.4)	1,027 (70.0)	867 (54.1)
Primary	106 (7.3)	117 (7.3)	76 (5.2)	119 (7.4)
Middle	212 (14.5)	260 (16.2)	101 (6.9)	180 (11.2)
Secondary	80 (5.5)	113 (7.1)	90 (6.1)	92 (5.7)
Higher	269 (18.4)	416 (26.0)	173 (11.8)	346 (21.6)
Mother's occupation	97 (6.6)	367 (22.9)	4 (0.3)	217 (13.5)
Housewife	1461 (100.0)	1587 (99.1)	1463 (99.7)	1547 (96.4)
Working woman	0 (0.0)	14 (0.9)	4 (0.3)	57 (3.6)
Gender of household head				
Male	1447 (99.0)	1514 (94.6)	1457 (99.3)	1564 (97.5)
Female	14 (1.0)	87 (5.4)	10 (0.7)	40 (2.5)
Study participants				
Pregnant women	257	257	164	172
Breastfeeding mothers	1445	1617	1428	1568
Children 6–23 mo	1230	1309	1252	1377
Seek antenatal care during pregnancy				
Yes	990 (67.8)	1500 (93.7)	1233 (84.0)	1421 (88.6)
Source of drinking water				
Improved water	1226 (83.9)	1455 (90.9)	1365 (93.0)	1362 (84.9)
Unimproved water	235 (16.1)	146 (9.1)	102 (7.0)	242 (15.1)
Type of toilet/sanitation facility				
Improved sanitation facility	1008 (69.0)	916 (57.2)	637 (43.4)	1156 (72.1)
Unimproved sanitation facility	453 (31.0)	685 (42.8)	830 (56.6)	448 (27.9)
Own agricultural land	768 (52.6)	871 (54.4)	596 (40.6)	772 (48.1)
Own livestock, animals, or poultry	1252 (85.7)	1433 (89.5)	890 (60.7)	1307 (81.5)

Abbreviation: SD, standard deviation.
Values are presented as mean ± SD or *n* (%).
Improved water (piped into dwelling, piped to yard/plot/neighbor, public tap/standpipe, tube well or borehole or suction pump, hand pump, protected well, rainwater, filtration plant, and bottled water).
Unimproved water (unprotected well, protected spring, unprotected spring, tanker truck, cart with small tank, surface water (river/dam/lake/pond/canal/irrigation channel), other facility).
Improved sanitation facility (flush to piped sewer system, flush to septic tank, flush to pit latrine, ventilated improved pit latrine, and pit latrine with slab).
Unimproved sanitation facility (flush to somewhere else, pit latrine without slab/open pit, bucket toilet, no facility/bush/field, other facility).
[1] Figures in parentheses are percentages of respondents in the column.

DID estimates after adjustment for child gender and age, maternal age and education, skilled birth attendant, facility births, IYCF practices, maternal BMI, and household characteristics indicated a significant reduction in stunting (DID: −5.0% (95% CI: −9.9, −0.2); $P = 0.041$) and underweight (DID: −4.6% (95% CI: −8.6, −0.5); $P = 0.028$) among children under 2 y of age in the intervention group compared with control group. However, estimates were not significantly different for wasting among children in the intervention and control groups (DID: −1.7 (95% CI: −5.1, 1.6); $P = 0.315$).

Impact of SBCC intervention on IYCF practices in control and intervention groups by DID estimates

Table 3 shows the impact of SBCC messages on IYCF practices in the control and intervention groups. The DID estimates showed a significant improvement in children ever breastfed (DID: 4.7% (95% CI: 3, 6.5), $P < 0.001$), early initiation of breastfeeding within 1 h of birth (DID: 19.6% 95% CI: 15.6, 23.6), $P < 0.001$), exclusive breastfeeding under 6 months (DID: 11.0% (95% CI: 2.3, 19.7), $P = 0.014$), minimum meal frequency (MMF) (DID: 23.0% (95% CI: 17.7, 28.2), $P < 0.001$), minimal acceptable diet (MAD) (DID: 13.1% (95% CI: 9.8, 16.3), $P < 0.001$), in the intervention group compared with control group. However, the DID estimates were not significantly different in the intervention and control group for continued breastfeeding at 1 y, introduction of solid, semisolid, or soft foods between 6 and 8 mo and minimum dietary diversity among children under 2 y of age.

Compliance with food supplements by PBW and index child at endline

Table 4 shows the compliance with food supplements by the study participants across the study groups (Table 4). Overall, 86.7% (1388) of children aged 6–23 mo received MQ-LNS in the intervention group and 6.3% (101) in the control group. Likewise, super cereal was received by 94.8% (1518) PBW in the intervention group compared with 11.9% (191) in the control group. Approximately 53% of PBW from the intervention and 96% from the control groups reported sharing super cereal with family members.

On average, children in the intervention group consumed MQ-LNS for 4.9 ± 4.3 mo during the study period. Similarly, PBW in the intervention group consumed super cereal for 6.3 ± 3.8 mo.

Over 90% of PBW in the intervention group and 60% in the control group received messages regarding the intake of 5 different food groups every day. Nearly all PBW (97.4%) reported receiving the

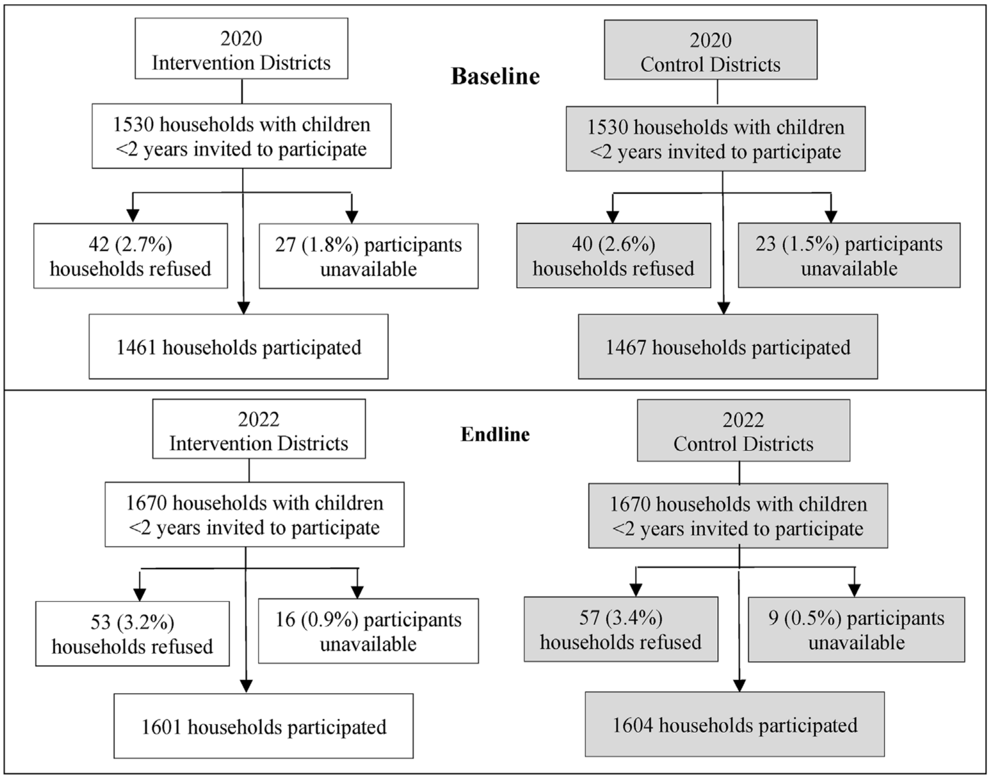

FIGURE 1. Participant flow diagram and surveys response rates across intervention and control districts.

message regarding super cereals compared with 20.3% of PBW in the control group. Compared with PBW in the control group, a higher percentage of PBW in the intervention group reported receiving messages about initiating breastfeeding within the first hour of birth, continued exclusive breastfeeding, and introduction of age-appropriate complementary foods along with breastfeeding (97.0% compared with 63.3%).

Messages regarding the provision of a variety of foods 2–4 times and a sachet of MQ-LNS every day to 6- to 23-mo-old children were received by higher percentages of PBW in the intervention group compared with the control group (93.4% compared with 52.2%) and (89.6% compared with 14.2%), respectively. Nearly all PBW in the intervention group (97.2%) reported receiving the message regarding good hygiene practices (handwashing, sanitation, cleanliness) compared with 72.1% of PBW in the control group (Table 4).

Discussion

This study showed that an 18-mo intervention involving the provision of SNF in combination with SBCC during the first 1000 d of life was associated with significant reductions in stunting and underweight among children under 2 y of age. However, study results were not significantly different for wasting among children in the intervention and control groups. The study findings also suggest that exposure to the SBCC interventions (nutrition-oriented messages and counseling sessions) was associated with improvements in multiple IYCF practices, including early initiation of breastfeeding, exclusive breastfeeding for children under 6 mo, minimum meal frequency, MAD, and whether a child was ever breastfed.

A recent systematic review and meta-analysis showed a significant positive effect of nutrition social behavior change communication

TABLE 2
Impact on child nutritional status among children under 2 y in control and intervention groups by DID estimates

	Intervention		Control		Unadjusted difference-in-difference in % (95% CIs)[1]	*P* value	Adjusted difference-in-difference in % (95% CIs)[1,2]	*P* value
	Baseline	Endline	Baseline	Endline				
Stunting	418 (28.6)	383 (24.2)	327 (22.3)	372 (23.5)	−5.7 (−10, −1.3)	0.010	−5.0 (−9.9, −0.2)	0.041
n	1461	1584	1467	1582				
Wasting	121 (8.4)	82 (5.2)	207 (14.2)	190 (12.1)	−1.1 (−4.1,1.9)	0.455	−1.7 (−5.1,1.6)	0.315
n	1447	1592	1458	1567				
Underweight	217 (14.9)	211 (13.2)	222 (15.1)	309 (19.3)	−5.8 (−9.5, −2.2)	0.002	−4.6 (−8.6, −0.5)	0.028
n	1461	1596	1467	1598				

Abbreviations: BMI, body mass index; CI, confidence interval; DID, difference-in-differences.
[1] Unadjusted and adjusted differences in difference were obtained from mixed linear regression models with an interaction term between health area (intervention vs. control) and time (endline vs. baseline).
[2] Multivariable models adjusted for child gender, age, maternal age, education, skilled birth attendant, facility births, infant and young child feeding practices, maternal BMI, and household characteristics.

TABLE 3
Impact of SBCC interventions on IYCF practices in control and intervention groups by DID estimates[1]

IYCF practices	Intervention		Control		DID (%)	P value
	Baseline	Endline	Baseline	Endline		
Children ever breastfed	1358 (93.0)	1568 (97.9)	1435 (97.8)	1573 (98.1)	4.7 (3, 6.5)	<0.001
Early initiation of breastfeeding within 1 h	759 (52.0)	1172 (73.2)	1294 (88.2)	1442 (89.9)	19.6 (15.6, 23.6)	<0.001
Exclusive breastfeeding under 6 mo	198 (82.2)	292 (87.4)	274 (80.4)	250 (74.6)	11.0 (2.3, 19.7)	0.014
Continued breastfeeding at 1 y	263 (93.3)	277 (96.9)	258 (95.6)	285 (97.9)	1.2 (−3.4, 5.8)	0.607
Introduction of solid, semisolid, or soft foods	136 (52.9)	157 (61.3)	121 (51.5)	116 (52.3)	7.6 (−4.9, 20.2)	0.232
Minimum meal frequency	354 (29.0)	898 (70.9)	342 (30.4)	625 (49.3)	23.0 (17.7, 28.2)	<0.001
Minimum acceptable diet	61 (5.0)	250 (19.7)	63 (5.6)	92 (7.2)	13.1 (9.8, 16.3)	<0.001
Minimum dietary diversity	236 (19.3)	302 (23.8)	79 (7.0)	127 (10.0)	1.5 (−2.5, 5.5)	0.459

Abbreviations: DID, difference-in-differences; IYCF, infant and young child feeding; SBCC, social and behavior change communication.
[1] Figures in parentheses are percentages of respondents.

(NSBCC) on the anthropometric outcomes (HAZ, WHZ, and WAZ) within the first 1000 d [26]. These are encouraging and significant findings for low- and middle-income countries and reinforce that in addition to supplementation, there are other contributing factors such as childhood infections such as diarrhea, poor water, sanitation, and hygiene practices are contributing to poor growth [27] indicating that the NSBCC interventions need to incorporate multisectoral health and hygiene interventions to accelerate progress and to achieve optimal nutrition outcomes.

The 7 trials utilizing MQ-LNS for 6 or more months were conducted in developing countries. In most of these trials, children started receiving MQ-LNS at 6 mo of age, and the supplementation period lasted between 12 and 18 mo and mostly cluster randomized trials. In all these trials, the intervention group involved children receiving MQ-LNS (40–54 g per ration), whereas control groups received standard care [28–34]. The other 2 trials encompassed a study in Malawi [29] where comparison groups received either SQ-LNS or a fortified maize–soy flour, and a study in Mali [31] where all households received a package of interventions, including the blanket provision of a fortified blended flour for children aged 6–23 mo. In a trial conducted in Pakistan [33], the intervention included wheat–soya blend for pregnant and lactating women in addition to providing MQ-LNS to children

TABLE 4
Compliance with food supplements and exposure to SBCC messages by PBW and index child during the study duration[1]

Compliance with food supplements and exposure to SBCC messages	Intervention	Control
	N = 1601	N = 1604
Received super cereal by PBW	1518 (94.8)	191 (11.9)
Number of times/months received: mean ± SD	7.9 ± 3.6	2.5 ± 1.4
Months super cereal used: mean ± SD	6.3 ± 3.8	1.8 ± 1.3
Shared super cereal with family/others	798 (53.4)	162 (95.9)
N	1494	169
Months super cereal with family/others, mean ± SD	6.3 ± 3.9	2.4 ± 1.4
Received MQ-LNS by index child during 6–23 mo of age	1388 (86.7)	101 (6.3)
Number of times/months received: mean ± SD	7.1 ± 4.2	2.5 ± 2.5
Children 6–23 mo used MQ-LNS in months, mean ± SD	4.9 ± 4.3	1.1 ± 1.1
Shared MQ-LNS with family/others	479 (41.4)	42 (59.2)
N	1157	71
Months did you share MQ-LNS with family/others, mean ± SD	5.4 ± 4.1	2.1 ± 2.2
Received message to eat ≥5 different food groups every day during your pregnancy and breastfeeding period	1473 (92.0)	958 (59.7)
Received message on the use of 250 g or 2 cups of super cereal during your pregnancy and breastfeeding period and avoid sharing with family/others	1559 (97.4)	325 (20.3)
Received WHO recommended message on early initiation of breastfeeding, exclusive breastfeeding, and age-appropriate complementary feeding to child during 2 y of age	1553 (97.0)	1016 (63.3)
Received message to give a variety of foods every day between 2 and 4 times for your child aged 6–23 mo	1495 (93.4)	838 (52.2)
Received message to give one sachet of MQ-LNS to your child every day from 6-23 mo and avoid sharing with other children	1434 (89.6)	228 (14.2)
Received message on WASH	1556 (97.2)	1157 (72.1)

Abbreviations: MQ-LNS, medium-quantity lipid-based nutrient supplement; PBW, pregnant and breastfeeding women; SBCC, social and behavior change communication; WASH, water, sanitation and hygiene,
Values are presented as mean ± SD or n (%).
[1] Figures in parentheses are percentages of respondents.

during 6–23 mo of age. There were positive effects of MQ-LNS on child stunting in 6 studies [28–30,32–34], but no such effects were observed in a study conducted in Mali [31].

In rural Bangladesh, ready-to-use foods (chickpea and rice-lentil based) and a fortified blended food (wheat–soy blend++, WSB++) compared with Plumpy'doz, all with nutrition counseling compared with nutrition counseling alone, provided for a year in addition to nutrition counseling, reduced −2.2% to −6.2% of stunting at 18 mo of age [28].

A cluster randomized controlled trial conducted in Pakistan reported that children who received MQ-LNS during 6–23 mo of age were found to have a significantly reduced risk of stunting (RR = 0.91, 95% CI: 0.88, 0.94, $P < 0.001$) as compared with children who received the standard government health services [32].

Similar to our study, a 1000-d cohort study in Pakistan evaluated the effectiveness of wheat–soya blend+ provided during pregnancy and the first 6 mo postpartum and MQ-LNS for their infants from 6 to 24 mo of age found a significant reduction in the prevalence of stunting among children at 24 mo of age in the intervention compared with the control group [33].

Another 4-arm study using an unconditional cash transfer (UCT) combined with MQ-LNS and/or SBCC in Pakistan reported that children who received UCT + MQ-LNS (RR: 0.85; 95% CI: 0.74, 0.97; $P = 0.015$) and UCT + MQ-LNS + SBCC (RR: 0.86; 95% CI: 0.77, 0.96; $P = 0.007$) had a significantly lower risk of being stunted compared with the UCT arm [34].

Similar to our study, 7 studies reported a significant positive impact on stunting and used interpersonal counseling through IEC materials and cooking demonstration sessions to promote locally available foods [32–38]. Similarly, 4 cluster randomized trials that provided food supplements or food assistance and counseling on maternal and child nutrition reported a statistically significant positive impact on reducing underweight [33,36,37,39].

Enhancing access to dietary diversity and nutritional supplements during the first 1000 d of life is also essential for optimal IYCF practices. Our key 6 messages emphasized on intake of 5 different food groups every day along with super cereal (250 g/d) during pregnancy and breastfeeding period for PBW, WHO recommended IYCF practices for the child under 2 y, use of recommended daily dose of MQ-LNS and messages on water, sanitation and hygiene. Our study results showed a statistically significant positive impact on early initiation of breastfeeding, exclusive breastfeeding for children under 6 mo, minimum dietary diversity, MAD, and whether a child was ever breastfed. Our findings are supported by existing literature, which indicates that behavior change communication interventions significantly improve the IYCF practices [40–44].

DID estimates for our study were not significantly different for wasting among children in the intervention and control groups. Similar results were reported in other studies conducted in India and Vietnam [45,46].

Our study introduces new evidence that combining SNF with SBCC over 18 mo can significantly reduce stunting and underweight in children under 2 y of age, while also improving key IYCF practices. Unlike previous studies that often focused solely on supplementation, our integrated approach underscores the synergistic benefits of pairing SNF with targeted SBCC. This approach not only supports the findings of recent systematic reviews highlighting the positive effects of NSBCC on anthropometric outcomes but also emphasizes the importance of comprehensive, multisectoral interventions. Our results suggest that to achieve optimal nutrition outcomes, strategies must include both direct nutritional support and behavior change efforts, offering a more holistic model for addressing child malnutrition in low- and middle-income countries.

Our study has several noteworthy strengths. Both survey instruments asked about a wide range of maternal and child health outcomes, some targeted by the intervention and others not. Secondly, data collection was done in the local language.

This study also has limitations that constrain our ability to attribute changes in the outcome measures to the interventions definitively. Although the individual participants selected for data collection were randomized, the districts were not, and this introduces the possibility of spillover effects, where elements of the intervention reached the control group, making it difficult to isolate the true impact of our interventions. Furthermore, additional nutritional supplementation with ready-to-use therapeutic food for severely malnourished children was provided in intervention and control districts during the study period. Although this intervention primarily targeted a different group (severely malnourished children), it still presents a potential confounding factor that could have influenced our results. Notably, a small percentage of participants in the control group (6.3% of children and 11.9% of PBW) also reported receiving this additional supplement. Finally, although a high proportion of women in the intervention group reported exposure to the SBCC messages, a substantial number of women in the control group reported exposure. This unexpected crossover exposure further reduces the impact of intervention.

In conclusion, our study provides compelling evidence for the positive impact of a combined nutrition-based supplementation and SBCC approach. Children receiving the intervention have a significant reduction in stunting and improvement in IYCF practices. These findings suggest the need for policy changes, such as prioritizing integrating SBCC strategies with nutritious supplementation. Investing in the critical first 2 y of life can unlock the potential for lifelong health and well-being for every child.

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Author contribution

The authors' responsibilities were as follows – SBS: study conceptualization and funding acquisition; MS: data analysis and data management; GNK, SBS: project administration; GNK, MAH, SIS, SA, MN: project supervision; AH, IA: software; SBS; GNK: writing original draft; SBS, GNK, SIS, MS, CO, MU, IH, SA: writing—critical review and editing; and all authors: read and approved the final manuscript.

Conflict of interest

The authors report no conflicts of interest.

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Data availability

Data described in the manuscript, code book, and analytic code will be made available upon request to the corresponding author.

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