




The large-scale community-based programme 'Suchana' improved maternal healthcare practices in north-eastern Bangladesh: Findings from a cluster randomized pre-post study

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Abstract

Adequate maternal healthcare practices are crucial to both maternal and infant nutrition outcomes. The Sylhet region of Bangladesh is vulnerable and performs poorly, as maternal and child health indicators are falling behind compared to other areas. *Suchana*, a large-scale intervention programme aims to improve the health and nutritional status of mothers and children in this region. The objective of the present analysis is to assess the changes in indicators related to maternal healthcare practices among *Suchana* beneficiaries. We obtained data from the *Suchana* baseline and endline evaluation survey. Descriptive statistics were employed to summarize data. The following maternal healthcare practices were considered: if a *Suchana* beneficiary mother received antenatal care (ANC) from skilled service providers, took day time resting during pregnancy, consumed additional diet during pregnancy, took at least 100 iron-folic acid (IFA) tablets during pregnancy and took a vitamin A capsule after delivery. Logistic regression analysis was performed to assess the impact of the *Suchana* intervention on maternal healthcare practices. The prevalence of the outcome variables at endline in the intervention area were as follows: 40% of mothers received at least four ANC from skilled service providers, 50% practiced daytime resting during pregnancy, 51% consumed additional diet during pregnancy, 41% took at least 100 iron-folic acid tablets during pregnancy, 39% received postnatal care and 30% took a vitamin A capsule after delivery. The *Suchana* intervention significantly, positively improved indicators related to maternal healthcare practices; these findings support future larger-scale programmes to improve maternal healthcare practices among vulnerable people in rural Bangladesh.

KEYWORDS

antenatal care, Bangladesh, food intake, food security, maternal public health, nutrition, postnatal care, *Suchana*, vitamin A

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1 | INTRODUCTION

Better population health and nutrition can play a critical role in economic development, particularly in low-income or low-resource settings. Evidence indicates better health can explain greater and more equitable distribution of wealth, with the ultimate outcome of improved human and social capital building, along with increased productivity (Ahmed et al., 2006; WHO Commission on Macroeconomics Health & World Health Organization, 2001). Maternal healthcare practices during pregnancy and after childbirth are critically important to both maternal and infant nutrition. Though currently in decline, the maternal mortality rate in Bangladesh still remains high enough to be acknowledged as a major public health concern. The prevalence of thin women (BMI < 18.5) is 11.9% while overweight/obese (BMI > 25.0) women is 32.4% reflecting maternal malnutrition status is common (National Institute of Population Research and Training (NIPORT) & ICF, 2020) and considered one of the major causes of the high burden of child undernutrition in Bangladesh. This problem is further complicated by the high frequencies of inappropriate healthcare-seeking behaviours during pregnancy. Current data suggest that the prevalence of not receiving appropriate antenatal care is 53% among the population (National Institute of Population Research and Training (NIPORT) & ICF, 2020). Due to lack of awareness of the value of the services provided by dedicated public facilities, the population often seek immediate medical attention from unqualified health practitioners (Yaya et al., 2017). Additionally, the cost of seeking medical attention from qualified medical practitioners in private settings is often unaffordable to vulnerable segments of the population (Pavel et al., 2016). Thus, a platform must be established to help mothers understand the importance of appropriate maternal healthcare practices and accept these services willingly.

Maternal healthcare practices have been confirmed to reduce maternal mortality, as well as child mortality. Such observations have been reported across many studies (Campbell & Graham, 2006; Lassi & Bhutta, 2015). Attending at least four antenatal care (ANC) sessions has been shown to enhance the utilization of skilled birth attendants as well as institutional delivery (Ryan et al., 2019). Even though ANC is a key platform for iron-folic acid (IFA) supplementation, evidence demonstrates that its coverage in Bangladesh is not as high as it should be. The Government of Bangladesh's countrywide vitamin A supplementation programme has been actively implemented for decades (Institute of Public Health Nutrition (IPHN), 2008), with the aim of enhancing women's access to high-potency vitamin A capsules within 6 weeks of delivery. Moreover, National Neonatal Health Strategy and Guidelines (NNHS) advocate the promotion of free postnatal care (PNC) provided by government health facilities in Bangladesh (Singh et al., 2017). Women's access to this health facility, as well as their adherence to it, must be improved in order to assure optimal maternal and child health care. Various large-scale surveys have indicated promotion of such quality healthcare services, as well as diversity in delivery of care, particularly for neonates and infants are critically required in Bangladesh (Chowdhury et al., 2011; Gai Tobe et al., 2019; General Economics Division, Planning Commission of

Key messages

- *Suchana* intervention significantly improved the proportions of pregnant women visiting a skilled service provider for at least four ANC, eating during pregnancy, resting during pregnancy, consumption of IFA tablets, PNC visits and taking a vitamin A capsule
- The findings imply that more emphasis on courtyard sessions should be given to increase women's access and adherence to such community-based health facilities
- The findings of this evaluation provide further support for implementation of large-scale interventions in rural Bangladesh

Government of the People's Republic of Bangladesh, & UNDP Bangladesh, 2014; Shahjahan et al., 2017).

Sylhet division contains the *Hills* and *Haor* (wetland) regions that comprise the vulnerable zone of north-eastern Bangladesh. All critical indicators of maternal healthcare practice are known to be poor in Sylhet division (Helen Keller International (HKI) and James P. Grant School of Public Health (JPGSPH), 2014), in contrast to the overall remarkable achievements in health improvements in other regions of the country (Yaya et al., 2017). If appropriate strategies are not implemented immediately, this scenario can only deteriorate further due to the prevailing marked inequalities in the socioeconomic profiles of the households in Sylhet. In contrast to the overall scenario in Bangladesh, indicators of women's nutrition and healthcare are lower in this region than national estimates. Compared to the country's average, Sylhet is also performing poorly in terms of critical indicators such as the infant mortality rate and the high unemployment status of women (National Institute of Population Research and Training-NIPORT/Bangladesh, Mitra and Associates, & ICF International, 2016). Therefore, it is very important to increase the status of healthcare practice after giving intervention to serve as linkage between mothers and community based health care facilities that are serving the catchment populations.

The *Suchana* programme for poor and very poor households in this region is expected not only to safeguard women and children against undernutrition but also enhance and diversify household income sources and reduce the gender gap and foster gender equality throughout the society. The programme provides both nutrition-specific and nutrition-sensitive interventions. Some of the critical interventions include household counselling, courtyard meetings, growth monitoring and promotion (GMP) sessions, and cooking and feeding demonstrations. *Suchana's* gender transformative approach encompasses a portfolio of technical training on agriculture and aquaculture and market development interventions, including challenging the gender barriers to agriculture, health and nutrition practices

among the beneficiary women, husbands and other household members. This gender transformative approach has been observed to effectively address gender inequality while its adoption encourages household members to work together to achieve better nutrition outcomes for the women and children in this programme (Choudhury et al., 2020). *Suchana* aims to improve maternal healthcare practices, including antenatal care (ANC), taking more rest during pregnancy, consuming additional food during pregnancy, receiving at least 100 (IFA) tablets during pregnancy, accessing (PNC) after delivery and taking a vitamin A capsule after childbirth. Thus, we assessed the changes in all of these attributes in endline relative to baseline.

2 | METHODS

2.1 | Data sources

Data for this analysis were extracted from the baseline and endline cross-sectional surveys of the *Suchana* programme, a large-scale development programme that is currently ongoing in Sylhet division. The evaluation design of *Suchana* programme was a cluster randomized pre-post study. A total 157 unions in Moulvibazar and Sylhet districts of Sylhet division were implemented by *Suchana* programme. For evaluation purpose, 80 unions were selected randomly and assigned into two groups using simple randomization. One group received intervention and other group was control (Choudhury et al., 2020; Haque et al., 2020). For the purpose of implementation, villages in each union that were vulnerable were chosen based on how much they were at risk (e.g., poverty or household living conditions, remoteness or difficulty to reach, other development programmes providing low or no interventions, incidence of flooding

or submerging and prevailing superstitions or high social taboos) by the programme staff. This process of selection was determined after meeting and discussion with the elected councils, local leaders, local government officials and field visits (Haque et al., 2021). *Suchana* inclusion criteria for registration of enrolled as vulnerable households are given in the Table 1 and after screening based on the criteria, sampling frame was prepared for collecting data from mother-child pair. Two cross sectional studies (baseline and endline) were conducted among beneficiary women with at least one child aged <24 months old from randomly selected vulnerable households. The baseline survey was undertaken between November 2016 and February 2017 and the endline survey, between November 2019 and February 2020. The time interval between these two surveys was 3 years. Data for 5440 households from the baseline survey and 10,722 households from the endline survey were extracted and analyzed for this paper.

2.2 | Outcome variables

The outcome variables were indicators of maternal healthcare practices; specifically, at least four ANC visits by a skilled service provider, additional resting during pregnancy, additional food consumption during pregnancy, consumption of IFA tablets, receiving PNC after last delivery, and taking a vitamin A capsule.

2.2.1 | At least four ANC visits by a skilled service provider

The indicators defined as the women received antenatal care four or more times by a skilled service provider during her last pregnancy.

TABLE 1 *Suchana* inclusion criteria for registration of enrolling as vulnerable households

Vulnerable household verification questions	Inclusion criteria
<p>Step 1</p> <ul style="list-style-type: none"> Households currently participating/member of any livelihood, food security or asset transfer programme 	If 'NO' go ahead for next questions
<p>Step 2</p> <ul style="list-style-type: none"> Ability to afford three (3) full meals per day for all family members round the year Households monthly income BDT 7500 or more Household productive asset value worth BDT 15,000 or more (excluding land, pond and homestead) Ownership of homestead land 10 decimals or more Ownership of cultivable land 50 decimals or more (excluding homestead or pond) 	If anyone is 'NO' go ahead for next questions
<p>Step 3</p> <ul style="list-style-type: none"> Households have married women with in child bearing age (15 to 45 years) Households have pregnant women (including abandoned or widowed woman) Households have 0-23 months old children Households have adolescent girls (15-19 years) 	If anyone is 'yes' go ahead for registration of enrolling as vulnerable household
Sampling frame was prepared for collecting data from mother-child pair if the households had 0-23 months old children	

Skilled service providers included MBBS doctors, nurse/midwife/paramedic, family welfare visitor, community skilled birth attendant, and sub-assistant community medical officer (National Institute of Population Research and Training (NIPORT) & ICF, 2020).

2.2.2 | Additional resting during pregnancy

In our questionnaire, we received the information from women that she whether took rest more than usual or not while she was pregnant with her last child. We had three options as (i) more, (ii) as before and (iii) less. 'More' was considered as the indicator 'additional resting during pregnancy' (Helen Keller International (HKI) and James P. Grant School of Public Health (JPGSPH), 2014).

2.2.3 | Additional food consumption during pregnancy

Data of consuming food during pregnancy were collected using three categories as (i) more, (ii) as before and (iii) less; and only 'more' was considered as 'Additional food consumption during pregnancy' (Helen Keller International (HKI) and James P. Grant School of Public Health (JPGSPH), 2014).

2.2.4 | Consumption of at least 100 iron-folic acid tablets during pregnancy

Consumption of IFA tablets was appropriate if the mother consumed at least 100 IFA tablets during her last pregnancy.

2.2.5 | Receiving postnatal care after last delivery

Postnatal care is defined as a care given to the mother and her newborn baby within 42 days of the delivery (Wudineh et al., 2018).

2.2.6 | Taking a vitamin A capsule

Mothers received Vitamin A capsule after the last delivery (within 42 days).

2.3 | Covariates

A list of several covariates was developed through descriptive analysis as well as a literature review. The conceptual framework of this paper is provided in Figure 1.

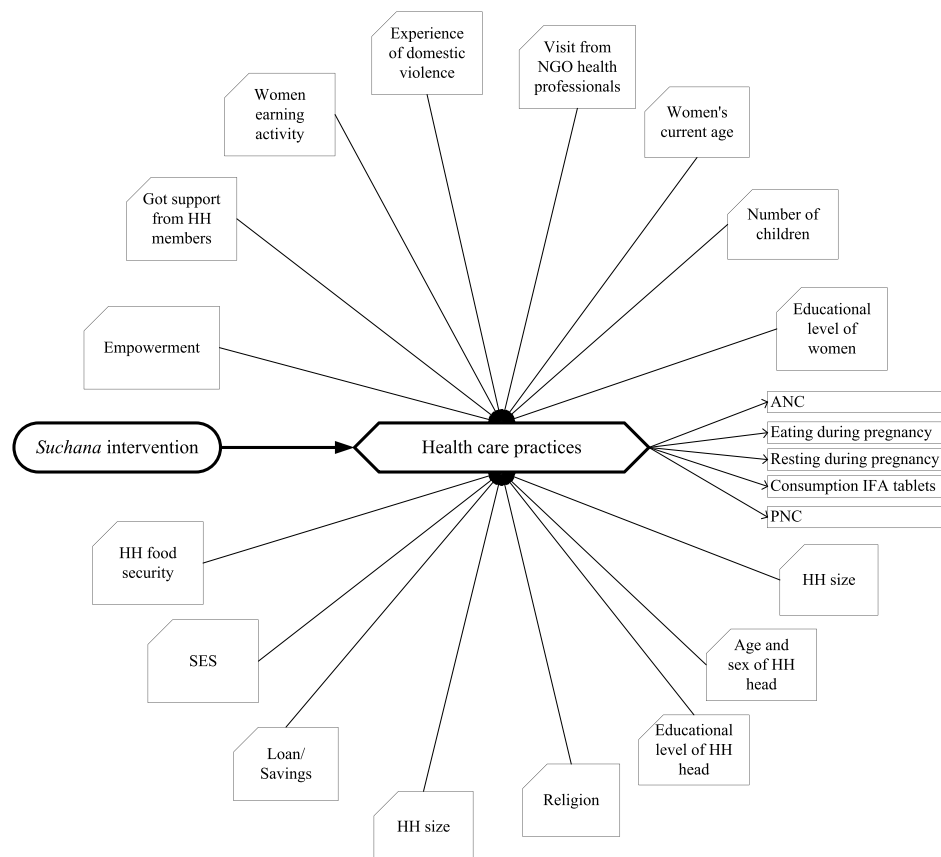


FIGURE 1 Conceptual framework for assessing the changes in indicators related to maternal healthcare practices among *Suchana* beneficiaries

2.3.1 | Household sociodemographic characteristics

Information on religion, the level of education and occupation of the head of the household and the number of family members were assessed as household demographic characteristics. Ownership of household assets, floor material, main roof material, external wall material, number of dwelling rooms, type of latrine, and sources of drinking water were the key indicators of socioeconomic status (SES). Factor analysis was employed via a principal factor method to create an asset index based on these factors to indicate SES. Variables used to construct asset index were ownership of cows, chickens/ducks/pigeons, goats/sheep, plough, boat, fishnet, rickshaw/van, sewing machine, radio/cassette player/DVD/CD player, television, electric fan, mobile phone, bicycle, chair, table, chouki (cot), sofa (any type), improved toilet, improved source of drinking water, floor, roof and wall material of the house and the type of fuel used for cooking.

2.3.2 | Household food insecurity access scale

Household food insecurity status was measured using the Food and Nutrition Technical Assistance's Guidelines and categorized using four levels: (a) food secure, (b) mildly food insecure, (c) moderately food insecure and (d) severely food insecure (Coates et al., 2007).

2.3.3 | Women's general characteristics

Several maternal characteristics were employed as covariates to adjust the multiple models to assess the independent effect of the intervention on maternal healthcare practices. These indicators were the women's current age, number of children, experience of any domestic violence, decision-making power, education level and involvement in earning activities. Domestic violence was defined if the husband or another family member physically or verbally abused the participant or if the husband threatened his wife with divorce or marriage to another woman at any point of time after marriage (Haque et al., 2020). Decision-making power was defined as if a woman had the ability to take decisions herself (or jointly with her husband) on all items such as children's healthcare, her own healthcare, food purchases, major household purchases, food preparation and visiting family and relatives.

2.3.4 | Other covariates

Household involvement in/or receiving loans, visits by NGO health professionals, membership of a co-operative/savings committee and receipt of any grant/allowance/stipend from the government were also employed as co-variables.

2.3.5 | Data management

Data collection was conducted using electronic tablet/personal digital assistants (PDA) on a custom Android application. Maximum validation rules were set in the data system to prevent errors during data entry. During the data entry period, quality control activities such as editing (after receiving any feedback from field staff members), updates, range checks, duplication checks, consistency checks, frequency checks and cross tabulation were performed regularly; any unusual issues were discussed and resolved. After completing data collection, the data were transferred to STATA software (Release 14; StataCorp, College Station, TX, USA) and variable labels and values were coded as per the questionnaire.

2.4 | Statistical analysis

Several statistical plots were used during data analyses for data visualization and bar diagrams was used to describe the outcome indicators. Descriptive statistics such as frequencies and proportions for categorical variables, means and standard deviations for normally distributed quantitative variables, and medians and interquartile ranges (IQR) for non-normally distributed quantitative variables were calculated. The outcome variables and covariates were segregated by the baseline/endline survey and by the intervention/control group.

2.4.1 | Explorative statistics

To test the hypothesis of interest that *Suchana* achieved a significant improvement in the tested outcomes, a simple logit model was assessed computing the bi-variate associations between each outcome variable and the intervention variables (using the *Suchana* control group as the reference category) in both baseline and endline surveys. To estimate the independent effect of the *Suchana* intervention as an exposure, multiple binary logistic regression models were computed after adjusting for *union* as a cluster and relevant co-variables. Cluster was adjusted for using *cluster-analysis commands* in the multiple logistic regression model in STATA. The covariates were primarily selected for including in the multiple model if the p value < 0.25 in simple logistic regression analysis (Bursac et al., 2008). Then the selected covariates were included in the multiple regression model using a stepwise forward selection method; some important indicators such as age, sex and other relevant variables were adjusted for, regardless of their p value. P values < 0.05 were considered significant.

2.5 | Ethical considerations

This study was approved by the Research Review Committee and Ethical Review Committee, the two obligatory components of the institutional review board of icddr,b. Informed written consent was obtained from study participants.

3 | RESULTS

3.1 | General characteristics

A total of 16,158 women were interviewed: 5440 (intervention: 2720; control: 2720) in the baseline study and 10,722 (intervention: 5282; control: 5440) in the endline study. The sociodemographic characteristics and general characteristics of the women are presented in Table 2.

At baseline, 13.4% of the mothers reported receiving at least four ANC from a skilled service provider (intervention: 14.6%, control: 12.2%), 26.3% indicated daytime resting during pregnancy (intervention: 26.8%, control: 25.7%), 36.3% had consumed additional diet during pregnancy (intervention: 36.4%, control: 36.2%), 10.7% took at least 100 IFA tablets during pregnancy (intervention: 10.4%, control: 11.0%), 33.5% received post-natal care (intervention: 33.9%, control: 33.1%), and 15.7% had taken a vitamin A capsule after delivery (intervention: 15.5%, control: 16.0%).

At endline, 26.0% of the mothers reported receiving at least four ANC visits from a skilled service provider (intervention: 36.1%, control: 16.2%), 41.1% practiced day time resting during pregnancy (intervention: 50.0%, control: 32.6%), 46.2% had consumed additional diet during pregnancy (intervention: 51.0%, control: 41.6%), 30.0% had consumed at least 100 IFA tablets during pregnancy (intervention: 41.1%, control: 19.3%), 35.6% had received post-natal care after delivery (intervention: 38.9, control: 32.4), and 29.7% had taken a vitamin A capsule after delivery (intervention: 38.4%, control: 21.3%; Figure 2).

3.2 | Factors associated with maternal healthcare practices

Adjusted odds ratios were calculated as measures of association between the indicators of maternal healthcare practice and their determinants using multiple binary logistic regression after adjusting for *union* as a cluster (Table 3). The women's current age, number of children, having visit(s) from NGO health professionals, maternal experience of any domestic violence, maternal decision-making power, educational level of the mother, maternal income-generating activity, educational level of the household head, the sex of household head, the age of household head, household size, the household food insecurity access scale (HFAS), asset index, household loans, the mother receiving support from household members, religion, household membership of a co-operative/savings society and the household being recipient of any grant/allowance/stipend from the government were the factors significantly associated with maternal healthcare practices.

3.3 | Explorative findings

To compare before-after and treatment-control group, analyses plan was to perform 'difference in differences' analysis if we find significant differences in the baseline survey. Since we did not find any

significant differences between intervention and control group at baseline survey therefore, we did not perform 'difference in differences' analyses. Hence, the inferential statements were done based on baseline-endline analyses. The adjusted odds ratios (aOR) were calculated using multiple logistic regression analysis to assess the strength of the associations between maternal healthcare practices and exposure to the *Suchana* intervention that are listed in Table 4. The model that we created was adjusted for several variables to identify the determinants of each of the outcome variables of interest (Table 3). As expected, no significant associations were observed between the intervention and any outcome variable at baseline, before initiating the intervention. However, at endline, highly significant and positive relationships were observed. The odds of being receiving at least four ANC given by a skilled service provider was 3.00-fold higher [aOR: 3.00 (95% CI: 2.29, 3.92), $p < .001$] for women in the intervention area. Additionally, day time resting during pregnancy [aOR: 2.01 (95% CI: 1.73, 2.34), $p < .001$], extra diet during pregnancy [aOR: 1.44 (95% CI: 1.24, 1.69), $p < .001$], consumption of at least 100 IFA tablets during pregnancy [aOR: 2.80 (95% CI: 2.30, 3.42), $p < .001$], delivery conducted by a skilled birth attendant [aOR: 1.52 (95% CI: 1.15, 1.99), $p < .05$], post-natal care (PNC) visits after delivery [aOR: 1.45 (95% CI: 1.13, 1.85), $p < .05$], and taking a vitamin A capsule after delivery [aOR: 2.29 (95% CI: 1.78, 2.93), $p < .001$] were also significantly associated with results of intervention.

4 | DISCUSSION

The findings presented in this paper were derived from the *Suchana* baseline and endline surveys, which followed a pre-post design consisting of two cross sectional surveys. The primary objective of this work was to determine the factors associated with various outcome indicators of maternal healthcare practices. Additionally, we assessed whether the *Suchana* intervention significantly improved in the proportions of pregnant women visiting a skilled service provider for at least four ANC, eating during pregnancy, resting during pregnancy, consumption of IFA tablets, PNC visits, and taking a vitamin A capsule. There was no significant difference in any outcome in the baseline survey; however, the endline survey indicated the positive effect of *Suchana* intervention on all of these maternal healthcare outcomes.

The proportion of pregnant women receiving at least four ANC from a skilled service provider was 36% in the intervention area at baseline, and this proportion increased by 22 percentage points after intervention. The demographic characteristics of our study participants are comparable to other women from the lowest wealth quintile in rural areas of Sylhet, rather than the national findings. The proportion of women in the *Suchana* control area at endline (16%) and other lowest quintile data for Sylhet division (19%) are very similar. The 22 percentage point increase in the proportion of pregnant women receiving at least four ANC after 3 years' exposure to the intervention is truly a reflection of the programme's achievements among this specific population. Thus, the strategy followed by the *Suchana* programme to improve maternal health outcomes may successfully

TABLE 2 General characteristics of the households and women

Indicator, %(n)	Baseline			Endline		
	Intervention	Control	P value ^a	Intervention	Control	P value ^a
Household (HH) characteristics						
HH head sex was male	95.99 (2611)	96.80 (2633)	.273	92.41 (4880)	92.48 (5028)	.934
HH head education was no 'schooling'	49.02 (1333)	48.86 (1329)	.954	44.26 (2337)	40.68 (2212)	.212
HH size ^b	6.12 ± 2.31	6.48 ± 2.56	.002	6.13 ± 2.11	5.94 ± 2.27	.029
Religion was Muslim	89.62 (2438)	92.86 (2526)	.120	91.67 (4841)	92.44 (5026)	.662
Household food insecurity status						
Food secure	14.08 (383)	14.01 (381)	.974	26.64 (1407)	20.18 (1097)	.002
Mildly food insecure	11.21 (305)	10.96 (298)	.857	16.66 (880)	14.22 (773)	.041
Moderately food insecure	47.28 (1286)	45.48 (1237)	.330	43.40 (2292)	46.66 (2537)	.058
Severely food insecure	27.43 (746)	29.56 (804)	.433	13.29 (702)	18.93 (1029)	.001
Asset index						
1st quintile	20.26 (551)	19.74 (537)	.859	18.73 (989)	21.24 (1155)	.335
2nd quintile	20.92 (569)	19.08 (519)	.187	19.96 (1054)	20.08 (1092)	.930
3rd quintile	19.71 (536)	20.29 (552)	.613	20.58 (1087)	19.39 (1054)	.283
4th quintile	20.77 (565)	19.23 (523)	.320	20.98 (1108)	19.05 (1036)	.180
5th quintile	18.35 (499)	21.65 (589)	.197	19.75 (1043)	20.23 (1100)	.856
Involved with any loan	71.91 (1956)	71.43 (1943)	.835	79.47 (4197)	74.77 (4065)	<.001
Membership of a co-operative/savings committee	33.3 (905)	32.0 (869)	.707	50.75 (2680)	33.92 (1844)	<.001
Received any grant/allowance/stipend from the government	22.06 (600)	21.43 (583)	.763	27.81 (1468)	24.84 (1348)	.157
Women's general characteristics						
Current age ^b	26.87 ± 5.61	26.92 ± 5.67	.838	29.15 ± 5.31	27.27 ± 5.71	.000
Age at marriage ^b	19.24 ± 2.87	19.40 ± 2.94	.279	19.73 ± 3.12	19.79 ± 3.21	.738
Age at first pregnancy ^b	18.14 ± 2.65	18.34 ± 2.77	.209	18.68 ± 2.94	18.88 ± 3.08	.298
Number of children						
1	21.03 (572)	21.73 (591)	.644	3.52 (186)	21.39 (1163)	<.001
2–3	44.23 (1203)	41.36 (1125)	.122	51.73 (2732)	46.88 (2549)	.022
4+	34.74 (945)	36.91 (1004)	.421	44.75 (2363)	31.73 (1725)	<.001
Education						
No schooling	22.32 (607)	23.75 (646)	.665	17.91 (946)	14.66 (797)	.180
Primary incomplete	22.72 (618)	21.14 (575)	.285	23.37 (1234)	22.51 (1224)	.664
Primary complete	54.96 (1495)	55.11 (1499)	.969	58.72 (3101)	62.83 (3416)	.281
Not involved in any income-earning activities	97.06 (2640)	97.10 (2641)	.942	87.29 (4610)	93.80 (5100)	<.001
Did not get any support from HH members	5.44 (148)	5.77 (157)	.726	3.43 (181)	4.10 (223)	.499
Visit from NGO health professionals	27.50 (748)	17.1 (465)	.062	39.92 (2108)	20.05 (1090)	<.001
Domestic violence and abuse						
Husband threatening divorce	7.46 (203)	6.80 (185)	.428	9.35 (494)	11.44 (622)	.105
Husband threatening to take another wife	7.87 (214)	6.99 (190)	.343	10.68 (564)	12.31 (669)	.240
Verbal abuse by husband/other family member(s)	33.79 (919)	31.32 (852)	.272	43.14 (2278)	41.92 (2279)	.665
Physical abuse by husband/other family member(s)	13.75 (374)	13.38 (364)	.794	17.97 (949)	19.32 (1050)	.519
Experienced any domestic violence	36.07 (981)	33.27 (905)	.198	44.57 (2354)	43.65 (2373)	.747
Women have decision-making power on						
Food purchase	44.56 (1212)	43.42 (1181)	.635	74.66 (3943)	63.95 (3477)	<.001
Major household purchase	25.22 (686)	24.34 (662)	.722	55.77 (2945)	41.14 (2237)	<.001
Food preparation	78.13 (2125)	75.77 (2061)	.226	87.03 (4596)	80.38 (4370)	<.001

(Continues)

TABLE 2 (Continued)

Indicator, %(n)	Baseline			Endline		
	Intervention	Control	P value ^a	Intervention	Control	P value ^a
Child healthcare	51.25 (1394)	50.63 (1377)	.842	76.96 (4064)	67.56 (3673)	<.001
Own healthcare	58.86 (1601)	56.32 (1532)	.395	79.93 (4221)	71.07 (3864)	<.001
Visiting family and relatives	42.65 (1160)	42.90 (1167)	.925	66.50 (3512)	55.67 (3027)	<.001
All types of decision making	17.32 (471)	16.80 (457)	.782	45.26 (2390)	31.38 (1706)	<.001

^aThe variable, *union* was adjusted for as clustering effect during the *p* value calculations.

^bMean ± SD.

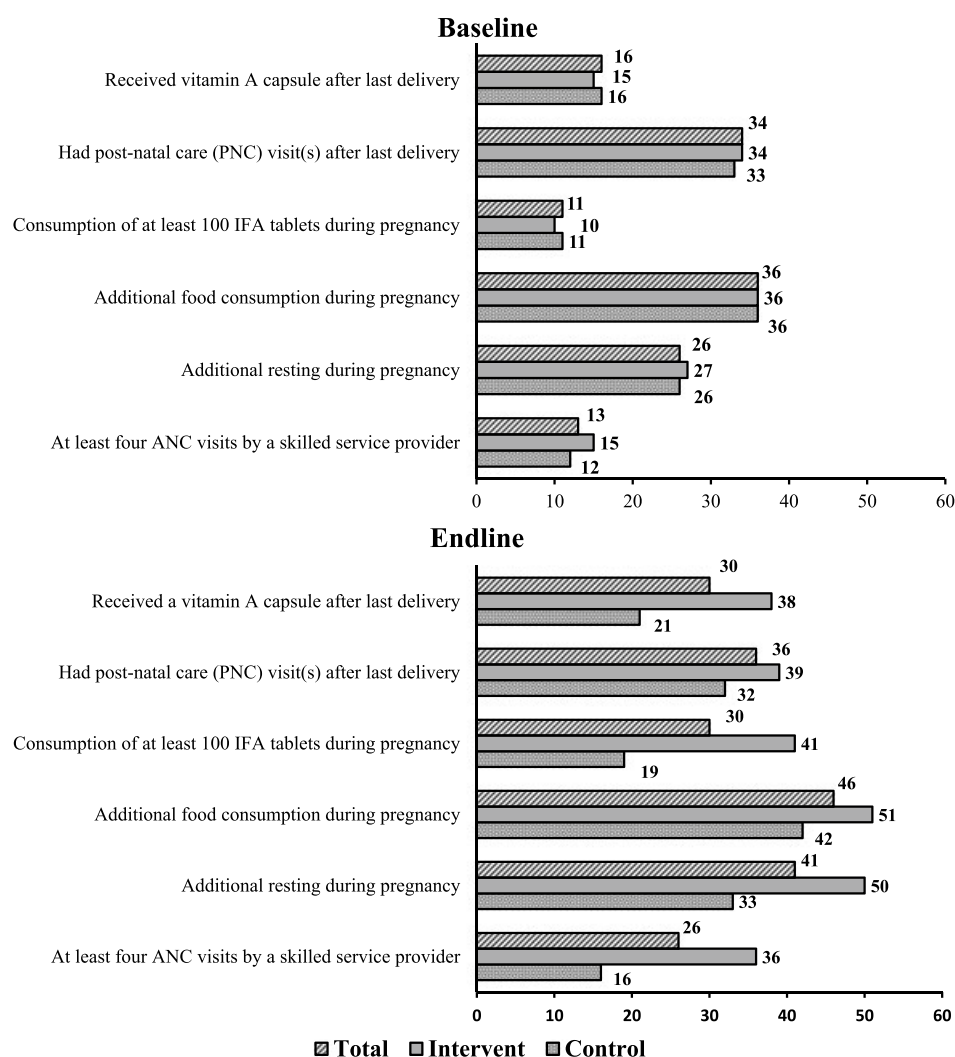


FIGURE 2 Prevalence of maternal healthcare practices overall and in the intervention and control unions

improve the uptake of ANC in other low-resource settings (National Institute of Population Research and Training (NIPORT) & ICF, 2020).

Around one third of mothers took more rest and one fourth of mothers consumed more food than usual in the baseline survey. Such practices increased to around 50% in the intervention group, with a 17% improvement in the proportion of women resting during the day time and 9% improvement in the proportion of women consuming

additional diet during pregnancy compared to the control group. The Food Security and Nutrition Surveillance Project (FSNSP) 2015 reported that 42% of women take extra food during pregnancy nationally (James P Grant School of Public Health and National Nutrition Services, 2016), with this rate remaining almost constant over time. Therefore, an intervention may be necessary to increase these maternal healthcare indicators in other regions of the country.

TABLE 3 Factors associated with maternal healthcare practices of at least four ANC visits by a skilled service provider, daytime rest during pregnancy, additional diet during pregnancy, and consuming at least 100 IFA tablets during pregnancy

Indicators	Adjusted OR (95% CI)						
	At least four ANC by a skilled service provider	Day time rest during pregnancy	Additional diet during pregnancy	Consumed at least 100 IFA tablets during pregnancy	Had post-natal care (PNC) visit(s) after last delivery	Received vitamin A capsule after last delivery	
Women's current age	1.02 (1.01, 1.03)	1.01 (1.00, 1.02)	1.00 (0.99, 1.01) ^a	1.03 (1.02, 1.04)	1.04 (1.03, 1.05)	1.04 (1.02, 1.05)	
Number of children	Reference	Reference	Reference	Reference	Reference	Reference	
1	Reference	Reference	Reference	Reference	Reference	Reference	
2-3	1.11 (0.97, 1.28) ^a	1.10 (0.99, 1.22) ^a	0.79 (0.71, 0.89)	1.23 (1.05, 1.45)	0.62 (0.55, 0.69)	0.93 (0.82, 1.04) ^a	
4-5	0.99 (0.81, 1.21) ^a	0.83 (0.73, 0.94)	0.74 (0.64, 0.85)	1.08 (0.88, 1.31) ^a	0.48 (0.42, 0.56)	0.77 (0.65, 0.91)	
6+	0.80 (0.63, 1.02) ^a	0.83 (0.69, 1.00) ^a	0.74 (0.61, 0.90)	0.83 (0.66, 1.06) ^a	0.45 (0.37, 0.54)	0.68 (0.55, 0.86)	
Visit from NGO health professionals	Reference	Reference	Reference	Reference	Reference	Reference	
No	Reference	Reference	Reference	Reference	Reference	Reference	
Yes	1.63 (1.44, 1.85)	1.63 (1.48, 1.8)	1.43 (1.30, 1.58)	1.59 (1.39, 1.82)	1.19 (1.06, 1.33)	1.57 (1.41, 1.75)	
Experience of any domestic violence	Reference	Reference	Reference	Reference	Reference	Reference	
Yes	Reference	Reference	Reference	Reference	Reference	Reference	
No	0.95 (0.86, 1.06) ^a	1.11 (1.02, 1.21)	1.17 (1.08, 1.27)	0.95 (0.86, 1.05) ^a	1.15 (1.06, 1.25)	0.96 (0.86, 1.09) ^a	
Educational level of women	Reference	Reference	Reference	Reference	Reference	Reference	
No schooling	Reference	Reference	Reference	Reference	Reference	Reference	
Primary incomplete	1.14 (0.97, 1.34) ^a	0.99 (0.87, 1.14) ^a	1.03 (0.92, 1.15) ^a	1.25 (1.10, 1.42)	1.14 (0.98, 1.31) ^a	1.33 (1.16, 1.53)	
Primary complete	1.55 (1.29, 1.86)	1.16 (1.04, 1.30)	1.12 (1.01, 1.25)	1.60 (1.40, 1.84)	1.64 (1.43, 1.88)	1.58 (1.39, 1.81)	
Women's income-earning activity	Reference	Reference	Reference	Reference	Reference	Reference	
Did not involve	Reference	Reference	Reference	Reference	Reference	Reference	
Involved	1.41 (1.21, 1.64)	1.09 (0.95, 1.24) ^a	1.01 (0.89, 1.15) ^a	1.60 (1.38, 1.84)	1.16 (1.02, 1.32)	1.29 (1.09, 1.53)	
Educational level of HH head	Reference	Reference	Reference	Reference	Reference	Reference	
No schooling	Reference	Reference	Reference	Reference	Reference	Reference	
At least 1 year of formal education	1.18 (1.08, 1.28)	1.06 (0.98, 1.15) ^a	1.07 (0.99, 1.16) ^a	1.10 (0.99, 1.22) ^a	1.16 (1.07, 1.27)	1.05 (0.95, 1.16) ^a	
Sex of HH head	Reference	Reference	Reference	Reference	Reference	Reference	
Male	Reference	Reference	Reference	Reference	Reference	Reference	
Female	1.27 (1.05, 1.53)	1.10 (0.99, 1.24) ^a	1.10 (0.96, 1.27) ^a	1.21 (1.03, 1.42)	1.06 (0.9, 1.25) ^a	1.14 (0.97, 1.34) ^a	
Age of HH head	1.00 (1.00, 1.01) ^a	1.00 (0.99, 1.00) ^a	1.00 (1.00, 1.00) ^a	1.00 (1.00, 1.01) ^a	1.00 (1.00, 1.01)	1.00 (1.00, 1.00) ^a	
HH size	0.93 (0.91, 0.95)	0.98 (0.96, 1.00)	0.95 (0.93, 0.97)	0.97 (0.95, 0.99)	0.92 (0.90, 0.94)	0.97 (0.95, 1.00)	
HFIAS	Reference	Reference	Reference	Reference	Reference	Reference	
Severely food insecure	Reference	Reference	Reference	Reference	Reference	Reference	
Food secure	1.54 (1.31, 1.80)	1.66 (1.43, 1.94)	1.52 (1.32, 1.74)	1.66 (1.42, 1.93)	1.19 (1.03, 1.37)	1.41 (1.24, 1.61)	

(Continues)

TABLE 3 (Continued)

Indicators	Adjusted OR (95% CI)						
	At least four ANC by a skilled service provider	Day time rest during pregnancy	Additional diet during pregnancy	Consumed at least 100 IFA tablets during pregnancy	Had post-natal care (PNC) visit(s) after last delivery	Received vitamin A capsule after last delivery	
Mildly food insecure	1.53 (1.29, 1.81)	1.51 (1.33, 1.71)	1.48 (1.31, 1.68)	1.53 (1.28, 1.83)	1.17 (1.03, 1.33)	1.35 (1.18, 1.55)	
Moderately food insecure	1.26 (1.10, 1.45)	1.28 (1.17, 1.40)	1.22 (1.11, 1.35)	1.23 (1.08, 1.40)	1.08 (0.98, 1.2) ^a	1.14 (1.01, 1.29)	
Asset index							
1st quintile	Reference	Reference	Reference	Reference	Reference	Reference	Reference
2nd quintile	1.24 (1.05, 1.46)	1.11 (1.00, 1.23) ^a	1.02 (0.93, 1.12) ^a	1.16 (1.04, 1.30)	1.30 (1.17, 1.45)	1.09 (0.95, 1.25) ^a	
3rd quintile	1.55 (1.32, 1.80)	1.18 (1.05, 1.34)	1.11 (1.00, 1.23)	1.18 (1.04, 1.34)	1.44 (1.29, 1.61)	1.26 (1.09, 1.47)	
4th quintile	1.65 (1.41, 1.94)	1.19 (1.06, 1.32)	1.10 (1.00, 1.21) ^a	1.38 (1.21, 1.57)	1.69 (1.50, 1.90)	1.39 (1.19, 1.63)	
5th quintile	2.47 (2.07, 2.93)	1.27 (1.11, 1.46)	1.10 (0.97, 1.24) ^a	1.57 (1.33, 1.87)	2.77 (2.44, 3.14)	1.70 (1.42, 2.03)	
Had decision-making power							
No	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Yes	1.49 (1.31, 1.70)	1.18 (1.06, 1.30)	1.12 (1.02, 1.23)	1.43 (1.28, 1.60)	1.15 (1.03, 1.27)	1.26 (1.12, 1.42)	
Got any support from HH members							
No	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Yes	1.39 (1.11, 1.75)	1.45 (1.19, 1.76)	1.37 (1.15, 1.63)	1.03 (0.84, 1.26) ^a	1.42 (1.16, 1.75)	1.15 (0.95, 1.39) ^a	
Religion							
Muslim	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Non-Muslim	1.44 (1.16, 1.77)	0.88 (0.76, 1.02) ^a	0.83 (0.72, 0.95)	1.43 (1.19, 1.72)	1.50 (1.29, 1.75)	1.60 (1.37, 1.87)	
Membership of a co-operative/savings committee							
No	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Yes	1.57 (1.44, 1.72)	1.11 (1.02, 1.22)	1.17 (1.07, 1.27)	1.30 (1.17, 1.43)	1.21 (1.10, 1.34)	1.32 (1.20, 1.46)	
Received any grant/allowance/stipend from the government							
No	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Yes	1.11 (1.00, 1.23)	1.00 (0.91, 1.09) ^a	1.04 (0.96, 1.11) ^a	1.12 (1.01, 1.25)	1.21 (1.10, 1.32)	1.13 (1.02, 1.24)	

^aNot significant.

TABLE 4 Impact of the *Suchana* intervention on various indicators of maternal healthcare practices

Maternal healthcare practice	Adjusted OR (95% CI)		Adjusted OR (95% CI)	
	Baseline survey	P value	Endline survey	P value
At least four ANC visits by a skilled service provider	1.27 (0.92, 1.75)	.152	3.00 (2.29, 3.92)	<.001
Additional resting during pregnancy	1.00 (0.86, 1.15)	.953	2.01 (1.73, 2.34)	<.001
Additional food consumption during pregnancy	0.97 (0.82, 1.14)	.672	1.44 (1.24, 1.69)	<.001
Consumption of at least 100 IFA tablets during pregnancy	0.86 (0.70, 1.06)	.149	2.80 (2.30, 3.42)	<.001
Had post-natal care (PNC) visit(s) after last delivery	0.98 (0.80, 1.20)	.851	1.45 (1.13, 1.85)	.004
Received vitamin A capsule after last delivery	0.90 (0.70, 1.14)	.367	2.29 (1.78, 2.93)	<.001

Note: Adjusted for maternal current age, number of children, having visits from NGO health professionals, maternal experience of any domestic violence, maternal decision-making power, maternal education status, maternal income-generating activities, educational level of HH head, sex of HH head, age of HH head, HH size, HFIAS, asset index, HH loan, mother receiving support from HH members, religion, membership of co-operative/savings society and recipient of any grant/allowance/stipend from the government. Clusters were adjusted.

The Government of Bangladesh provides IFA supplement to pregnant women as part of regular ANC service within the health system. However, coverage and compliance to IFA supplementation is low due to a lack of awareness, poor practices of accessing services by women, and inadequate service delivery mechanisms (Institute of Public Health Nutrition, Ministry of Health and Family Welfare, & Government of the People's Republic of Bangladesh, 2007; James P Grant School of Public Health and National Nutrition Services, 2016). The FSNSP study showed that only 18% of women took at least 100 IFA tablets during their last pregnancy, and the proportions were similar in the control group in this study. However, the intervention led to improvement of around 20%. Improving maternal healthcare in Sylhet division is always challenging to any programme implementer. Most of the time, the poor performance of the lowest SES quintile beneficiaries is due to a lack of access to transport and education and high prevalence of superstition (National Institute of Population Research and Training (NIPORT) & ICF, 2020). However, the *Suchana* programme led to a positive change in consumption of IFA tablets among women from the lowest quintile. Since these women are one of the most vulnerable segments of society, this positive change needs to be sustained by proper support. Over the long term, this positive effect may help to improve the national estimates.

Around one-third of the mothers received a postnatal check-up after their last delivery at baseline, and this rate increased to 39% after the intervention. Despite the significant improvements in the proportions of women receiving ANC, taking rest, consuming more food during pregnancy and receiving at least 100 IFA tablets after 3 years of the intervention—along with improved household food security and socio-economic conditions—the expected improvement in the proportion of women receiving postnatal care was not observed, though a small but statistically significant improvement was detected as indicated by the multiple logistic regression model. The FSNSP-2014 reported that the prevalence of PNC slightly increased between 2011 and 2014 (22%–44%), and that the prevalence was 34% in the *Hills* and *Haor* zone in 2014, which is similar to the rate observed in our baseline study (Helen Keller International (HKI) and James P. Grant School of Public Health (JPGSPH), 2016).

Receiving vitamin A capsule within 6 weeks of delivery is an important indicator of maternal health. At baseline, the proportion of women receiving a vitamin A capsule was very low (15.5%). The BDHS-2014 reported that the rate of postpartum vitamin A supplementation among mothers was lower in Sylhet than other regions of Bangladesh. In the FSNSP-2013, close to one-fifth of the women in Sylhet region and the *Hills* and *Haor* zone reported receiving a vitamin A capsule within 6 weeks of delivery (Helen Keller International (HKI) and James P. Grant School of Public Health (JPGSPH), 2014), which is similar to our baseline findings. However, the proportion of women receiving a vitamin A capsule doubled after the intervention. We also found that the prevalence of taking a vitamin A capsule was higher among mothers who had knowledge of about intake of vitamin A capsules. Therefore, an intervention is necessary to increase awareness, as well as the proportion of women receiving a vitamin A capsule within 6 weeks of delivery.

The multiple logistic regression analysis indicated that current maternal age, number of children, having visits from NGO health professionals, maternal experience of any domestic violence, maternal decision-making power, education status of mothers, maternal income-generating activities, the educational level of household head, the sex of household head, the age of household head, household size, HFIAS, asset index, mother receiving support from household members, religion, household membership of co-operative/savings society and the household being a recipient of any grant/allowance/stipend from the government were significantly associated with the indicators of maternal healthcare. Among these indicators, improvements in household food security status and empowerment of women were key objectives of *Suchana*; the intervention was envisioned to increase household food security and women's decision-making power on all household issues. Our endline findings indicated that food security status improved slightly and decision-making power improved significantly, as expected. Our multivariable analyses revealed a dose–response relationship between the degree of household food insecurity and maternal healthcare practices; mothers who take decisions by themselves or jointly with their husband achieved relatively more encouraging maternal healthcare outcomes. Therefore, it is clear that improving household food security status and women's

empowerment may also improve maternal healthcare practices. Domestic violence also plays a vital role, as it was found to negatively influence maternal healthcare practices in this study.

SES is an important factor that influences maternal healthcare practices. The DHS survey and other studies in Bangladesh showed that households with higher SES have better performance in terms of maternal healthcare outcomes (Gai Tobe et al., 2019; National Institute of Population Research and Training (NIPORT) & ICF, 2020). Visits by NGO health professionals was highly and positively correlated with all maternal healthcare outcomes. Many studies demonstrated that NGOs can play an important role in delivery of healthcare services to mothers (Jo et al., 2019; Mercer et al., 2004). Moreover, in a previous paper, we showed that visits by NGO health professionals, the HFIAS and women's empowerment have significant effect on domestic violence (Haque et al., 2020). Therefore, interventions are necessary to reduce domestic violence as well as increase visits by health professionals. Moreover, improved household food security status and women's empowerment status may help to augment the increases in the indicators of maternal healthcare practices.

After controlling for relatively large number of significant covariates, we observed significant associations between the *Suchana* intervention and the maternal healthcare practices of the beneficiaries. Thus, our results suggest that the *Suchana* interventions, such as the courtyard sessions that included mother and child group discussions to explain the causes of undernutrition, the importance of growth monitoring, promotion of health and nutrition for children under two, pregnancy and lactation-related care and optimal IYCF (infant and young children feeding) practices, optimal hygiene practices, the care and feeding of sick children, and the role of other family members in maternal health and the empowerment of women may represent an effective strategy to improve ANC visits to skilled service providers, taking additional rest during pregnancy, consuming extra food during pregnancy, taking IFA tablets during pregnancy, receiving PNC visit(s) after delivery, and taking a vitamin A capsule post-partum among vulnerable rural populations in Bangladesh. Since appropriate and adequate healthcare practice is a major contributing factor for better nutritional status among children as well as mothers (Choudhury et al., 2017), awareness should be increased among this population through large-scale community based programmes.

4.1 | Strengths and limitations

The key strength of this paper is the cluster randomized pre-post design that provides strong evidence of the effects of the programme on the outcome indicators. The similar findings between the control and intervention groups at baseline indicate the homogeneity of the participants in terms of background characteristics and all maternal healthcare indicators. The large sample size and appropriate techniques of choosing poor and very poor households, as well the methodology of sampling and statistical analyses are strengths of this study. However, because the data were gathered from maternal responses, there is a possibility of recall bias pertaining the maternal

healthcare practice indicators. Verifying the antenatal visit to trained providers could be done by interviewing health workers, but due to resource constraints, this was not possible. The data that were collected from the mothers of the children were based entirely on their own recall. The large sample size and adjustment for numerous relevant covariates in the regression model, on the other hand, reduced the recall bias. The data collectors faced many issues as one of the inclusion criteria for this study was children aged 0–23 months; for example, sometimes they had to replace the pre-selected children using the randomly generated list of targeted households due to the time gap between verification/screening and the time of data collection. To survey the required number of households by phase and age group according to our randomly generated listing, when required, we replaced any household in the sampling frame by selecting the household immediately earlier in an anti-clockwise direction.

5 | CONCLUSIONS

The *Suchana* evaluation data indicate that all indicators of maternal healthcare during pregnancy and after child birth improved at endline in the intervention areas. A number of household characteristics—such as food security and education—and socioeconomic and maternal characteristics—such as women's decision-making power, income-generating activities, freedom from domestic violence, getting support from household members, and visits by NGO health professionals—must be improved to maintain better maternal healthcare practices. Women in rural communities are more likely to have less health literacy, as well as poor transportation facility to seek better health care from dedicated health facilities. Due to low patient volume and geographic isolation, rural areas often face challenges to support vital maternal and obstetric services. Our findings imply that more emphasis on courtyard sessions should be placed to increase women's access and adherence to such community-based health facilities. Indeed a range of health care professionals play an important role in providing maternal health care before, during and after pregnancy. Thus it is essential to strengthen the linkage between mothers and health-care providers serving in local facilities. Ultimately, the findings of this evaluation provide further support for implementation of large-scale interventions in rural Bangladesh.

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CONFLICT OF INTEREST

The authors have declared that no conflict of interest exists.

CONTRIBUTIONS

TA and NC originated the idea for the study and led the protocol design. MAH, NC and ASGF conceptualized the manuscript. SMTA, SSR, MJR, MAH, NC, FDF and TA contributed on survey design. MAH performed statistical analysis and drafted the manuscript. NC and ASGF supervised the work, and critically reviewed and provided feedback for revising the manuscript. NC oversaw the statistical analysis and suggested necessary improvements from statistical point of view as well as public health perspective. MAH, NC, MJR, MA, FDF, FN, TJS, ASGF, TA and SSR contributed to the revision of the final draft for submission. All authors are responsible for the final content of the manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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REFERENCES

- Ahmed, S. M., Petzold, M., Kabir, Z. N., & Tomson, G. (2006). Targeted intervention for the ultra poor in rural Bangladesh: Does it make any difference in their health-seeking behaviour? *Social Science & Medicine*, 63(11), 2899–2911. <https://doi.org/10.1016/j.socscimed.2006.07.024>
- Bursac, Z., Gauss, C. H., Williams, D. K., & Hosmer, D. W. (2008). Purposeful selection of variables in logistic regression. *Source Code for Biology and Medicine*, 3, 17. <https://doi.org/10.1186/1751-0473-3-17>
- Campbell, O. M., & Graham, W. J. (2006). Strategies for reducing maternal mortality: Getting on with what works. *Lancet*, 368(9543), 1284–1299. [https://doi.org/10.1016/s0140-6736\(06\)69381-1](https://doi.org/10.1016/s0140-6736(06)69381-1)

- Choudhury, N., Raihan, M. J., Sultana, S., Mahmud, Z., Farzana, F. D., Haque, M. A., Rahman, A. S., Waid, J. L., Chowdhury, A. M. R., Black, R. E., & Ahmed, T. (2017). Determinants of age-specific under-nutrition in children aged less than 2 years-the Bangladesh context. *Maternal & Child Nutrition*, 13(3), e12362. <https://doi.org/10.1111/mcn.12362>
- Choudhury, N., Raihan, M. J., Ahmed, S. M. T., Islam, K. E., Self, V., Rahman, S., Schofield, L., Hall, A., & Ahmed, T. (2020). The evaluation of Suchana, a large-scale development program to prevent chronic undernutrition in north-eastern Bangladesh. *BMC Public Health*, 20(1), 744. <https://doi.org/10.1186/s12889-020-08769-4>
- Chowdhury, S., Banu, L., Chowdhury, T., Rubayet, S., & Khatoun, S. (2011). Achieving millennium development goals 4 and 5 in Bangladesh. *BJOG: An International Journal of Obstetrics & Gynaecology*, 118, 36–46. <https://doi.org/10.1111/j.1471-0528.2011.03111.x>
- Coates, J., Swindale, A., & Bilinsky, P. (2007). *Household food insecurity access scale (HFIAS) for measurement of food access: Indicator guide* (v. 3). Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development.
- Gai Tobe, R., Islam, M. T., Yoshimura, Y., & Hossain, J. (2019). Strengthening the community support group to improve maternal and neonatal health seeking behaviors: A cluster-randomized controlled trial in Satkhira District, Bangladesh. *PLoS ONE*, 14(2), e0212847. <https://doi.org/10.1371/journal.pone.0212847>
- General Economics Division, Planning Commission of Government of the People's Republic of Bangladesh, & UNDP Bangladesh. (2014). Millennium Development Goals Bangladesh Country Report 2013. Retrieved from
- Haque, M. A., Choudhury, N., Ahmed, S. M. T., Farzana, F. D., Ali, M., Rahman, S. S., Faruque, A. S., Raihan, M. J., & Ahmed, T. (2020). Factors associated with domestic violence in rural Bangladesh. *Journal of Interpersonal Violence*, 886260520922353.
- Haque, M. A., Choudhury, N., Farzana, F. D., Ali, M., Raihan, M. J., Ahmed, S. M. T., Rahman, S. S., Siddiqua, T. J., Faruque, A. S. G., & Ahmed, T. (2021). Determinants of maternal low mid-upper arm circumference and its association with child nutritional status among poor and very poor households in rural Bangladesh. *Maternal & Child Nutrition*, e13217. <https://doi.org/10.1111/mcn.13217>
- Helen Keller International (HKI) and James P. Grant School of Public Health (JPGSPH). (2014). State of food security and nutrition in Bangladesh 2013. Retrieved from HKI and JPGSPH:
- Helen Keller International (HKI) and James P. Grant School of Public Health (JPGSPH). (2016). State of food security and nutrition in Bangladesh 2014. Retrieved from HKI and JPGSPH:
- Institute of Public Health Nutrition (IPHN). (2008). National guidelines for vitamin A program in Bangladesh. Dhaka.
- Institute of Public Health Nutrition, Ministry of Health and Family Welfare, & Government of the People's Republic of Bangladesh. (2007). National strategy for anaemia prevention and control in Bangladesh. Dhaka.
- James P Grant School of Public Health and National Nutrition Services. (2016). State of food security and nutrition in Bangladesh 2015. Retrieved from James P Grant School of Public Health and National Nutrition Services:
- Jo, Y., Alland, K., Ali, H., Mehra, S., LeFevre, A. E., Pak, S., Shaikh, S., Christian, P., & Labrique, A. B. (2019). Antenatal care in rural Bangladesh: Current state of costs, content and recommendations for effective service delivery. *BMC Health Services Research*, 19(1), 861. <https://doi.org/10.1186/s12913-019-4696-7>
- Lassi, Z. S., & Bhutta, Z. A. (2015). Community-based intervention packages for reducing maternal and neonatal morbidity and mortality and improving neonatal outcomes. *Cochrane Database of Systematic Reviews*, (3), Cd007754. <https://doi.org/10.1002/14651858.CD007754.pub3>
- Mercer, A., Khan, M. H., Daulatuzaman, M., & Reid, J. (2004). Effectiveness of an NGO primary health care programme in rural Bangladesh: Evidence from the management information system. *Health Policy and Planning*, 19(4), 187–198. <https://doi.org/10.1093/heapol/czh024>
- National Institute of Population Research and Training (NIPORT), & ICF. (2020). Bangladesh Demographic and Health Survey 2017–18. Retrieved from NIPORT and ICF:
- National Institute of Population Research and Training-NIPORT/-Bangladesh, Mitra and Associates, & ICF International. (2016). *Bangladesh Demographic and Health Survey 2014*. Retrieved from NIPORT, Mitra and Associates, and ICF International:
- Pavel, M. S., Chakrabarty, S., & Gow, J. (2016). Cost of illness for outpatients attending public and private hospitals in Bangladesh. *International Journal for Equity in Health*, 15(1), 167. <https://doi.org/10.1186/s12939-016-0458-x>
- Ryan, B. L., Krishnan, R. J., Terry, A., & Thind, A. (2019). Do four or more antenatal care visits increase skilled birth attendant use and institutional delivery in Bangladesh? A propensity-score matched analysis. *BMC Public Health*, 19(1), 583. <https://doi.org/10.1186/s12889-019-6945-4>
- Shahjahan, M., Chowdhury, H. A., Al-Hadhrani, A. Y., & Harun, G. D. (2017). Antenatal and postnatal care practices among mothers in rural Bangladesh: A community based cross-sectional study. *Midwifery*, 52, 42–48. <https://doi.org/10.1016/j.midw.2017.05.011>
- Singh, K., Brodish, P., Chowdhury, M. E., Biswas, T. K., Kim, E. T., Godwin, C., & Moran, A. (2017). Postnatal care for newborns in Bangladesh: The importance of health-related factors and location. *Journal of Global Health*, 7(2), 020507. <https://doi.org/10.7189/jogh.07.020507>
- WHO Commission on Macroeconomics Health, & World Health Organization. (2001). Macroeconomics and health: investing in health for economic development: executive summary/report of the Commission on Macroeconomics and Health. In. Geneva: World Health Organization.
- Wudineh, K. G., Nigusie, A. A., Gesese, S. S., Tesu, A. A., & Beyene, F. Y. (2018). Postnatal care service utilization and associated factors among women who gave birth in Debretabour town, North West Ethiopia: A community-based cross-sectional study. *BMC Pregnancy and Child-birth*, 18(1), 508. <https://doi.org/10.1186/s12884-018-2138-x>
- Yaya, S., Bishwajit, G., Ekholuenetale, M., & Shah, V. (2017). Awareness and utilization of community clinic services among women in rural areas in Bangladesh: A cross-sectional study. *PLoS ONE*, 12(10), e0187303. <https://doi.org/10.1371/journal.pone.0187303>

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