Article

Reduction in Lifetime Fertility Through MNCS in Rural Bangladesh

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Abstract

This study assesses the effect of a customised Maternal Neonatal and Child Survival (MNCS) intervention in the rural areas of Bangladesh. This study attempts to estimate the lifetime fertility rate and the proportion of live births ≥3, and the age-specific lifetime fertility patterns among the women of reproductive age. This quasi-experimental study used impact evaluation data from the MNCS intervention in 2013 and compared these with the baseline data collected in 2008. We used a multi-stage, cluster random sampling technique to include 6,000 and 4,800 women in 2008 and 2013, respectively. The respondents were either mothers who had alive/deceased infants or the mothers whose pregnancy was terminated or who had living children of 12–59 months without pregnancy outcomes in the preceding year of the surveys. Based on the mean difference of live births from baseline to endline year for each intervention union, and then we compared these two areas (intervention and control unions). Overall lifetime fertility rate declined significantly in high-performing intervention unions (from 2.6 to 2.2/woman, $p < .001$) or in control unions (from 2.4 to 2.2/woman; $p < .001$). The degree of reduction of fertility increased significantly with age, and such a change was most prominent in the case of women ≥35 years old. Multivariate analyses suggest that the likelihood of having live births ≥3 reduced significantly in high-performed intervention compared to control unions. In conclusion, the probability of reducing lifetime fertility over time increases with a higher level of access, degree and duration of the customised intervention.

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Lifetime fertility, IMNCS intervention, BRAC, rural Bangladesh

Introduction

Worldwide, the maternal deaths reduced satisfactorily over a period of time: 1990–2010 (WHO, 2019), and women have lower fertility rates, though the adolescent fertility remains relatively high across the developing world (PMNCH, 2015; Reher & Requena 2020). For decades, both the government and non-governmental organisations (NGOs) in Bangladesh have worked to improve the situation and fairly meet Millennium Development Goals (MDGs) 4 and 5 (The Dhaka Tribune, 2014; WHO, 2013, 2015a; WHO & UNICEF, 2012). However, the Independent Evaluation Group (IEG) of the World Bank (IEG, 2013a, 2013b) identified the limited success of MDGs. Of course, there have been claims that the MDGs cannot be fully achieved due to the way the goals were designed (Clemens et al., 2007). Additionally, there was a lack of focus and accountability, as well as a lack of interest in sustainable development' (UN, 2010). Thus set out as the target for Sustainable Development Goals 3 in improving maternal and child health in developing countries including Bangladesh (Fehling et al., 2013; IEG, 2013b; WHO, 2015b).

This study carries significance primarily because Bangladesh till continues to face significant challenges due to high maternal and neonatal death rates. Despite significant reductions over the last two decades, the maternal mortality ratio and neonatal mortality rate remain high, at 194 deaths per 100,000 live births and 37 deaths per 1,000 live births, respectively (Khatun et al., 2021; NIPORT, 2009). Bangladesh, with a high poverty rate in the world, is committed to achieve the MDGs by 2015. The promise of MDG 5 (improving maternal health) has influenced national policy and programme implementation. Beginning in 1994, the emergency obstetric care (EmOC) strategy dominated, with collaboration from many UN entities.

The approach was broadened in 2001 with the development of the National Maternal Health Strategy, which built on the rights-based approach to safer motherhood (Khatun et al., 2012). It was incorporated into the ongoing Health and Population Sector Programme and, later, the Health, Nutrition, and Population Sector Programme, which define government policies and programmes. At the primary healthcare level, interventions were delivered through a one-stop essential services package (ESP), with health and family planning cadres managed under a single management structure. While the ESP had five components, maternal health was prioritised, with an emphasis on EmOC to minimise maternal mortality and basic obstetric care to encourage best practices, early detection of issues and appropriate referral (Koblinsky et al., 2008).

The average fertility in Bangladesh declined remarkably in the past four decades. From over six children per woman in the 1970s to over three children per woman in the 1990s, and it further declined by one child to 2.3 children per woman in 2011, and currently, however, the average fertility has remained

stable (NIPORT et al., 2016, 2019). The fundamental reason for the high population density in Bangladesh has been the widespread unawareness of maternal and child healthcare and their consequences (PRB, 2014; World Bank, 2018). In response to this situation, the health programme of BRAC, the largest national NGO in the world, introduced a project called Improving Maternal Neonatal and Child Survival (IMNCS) with aims to improve maternal and child health in rural areas of a few selected Northern districts of Bangladesh. The project ensured the curative and preventive services at the community level for the last six years and beyond.

Women and child health outcomes are determined by factors such as high education, low fertility rates, improved nutritional status and a low frequency of illness (Cleland et al., 2019; IEG, 2013b). It is well established that fertility and death rates are the summary outcomes for all health indicators, and that the lifetime fertility rate is determined by the total number of live births ever delivered by a woman of reproductive age (Ullah, 2000, 2004). Hence, the main indicator was considered to be lifetime fertility. The primary objective of this study was to statistically quantify the precise change that occurred between 2008 and 2013. This will, in the long run, generate evidence-based policymaking in operational planning. And in fact, there is no study done on a large sample to address the gaps of a health-related project implemented in South Asia, including Bangladesh (IEG, 2013b).

Under this backdrop, this study prioritises measuring the effectiveness of maternal, neonatal, and child health (MNCH) intervention of BRAC in the six Northern districts of Bangladesh. Therefore, this study attempts to estimate the lifetime fertility rate and the proportion of live births ≥3 and the age-specific lifetime fertility patterns among the women of reproductive age. Finally, it aims to determine the most effective factors responsible for variations in lifetime fertility rates amongst women of reproductive age living in intervention areas.

Background of BRAC-IMNCS Intervention in Bangladesh

With over four decades of experience implementing community-based health interventions through health programmes in rural and urban Bangladesh, BRAC's Health Nutrition and Population Program (HNPP) launched MNCH services in urban slums in 2007 under the banner of 'MANOSHI' (acronym for mother, neonate and child in Bangla) (Ahmed et al., 2010; Choudhury et al., 2012). BRAC-HNPP initiated its five-year MNCH services in rural areas of Nilphamari, Rangpur, Gaibandha and Mymensingh districts in 2008 to help meet the MDGs 4 and 5.

In raising awareness of core MNCH issues and ensuring the service provisions of essential medications are the key components of the IMNCS project. This project is also well-designed to address demand and supply side obstacles associated with establishing a continuum of care from home to hospital for MNCH separately, through the use of a group of trained community health workers (CHWs). They provide their phone numbers to pregnant mothers while visiting

their households. Mothers usually inform them as they face any complications (BRAC, 2006) and go to the patient's house immediately and try to contact or go with the patients the nearby community-based clinic (CBC). If they are refused from the CBC, they usually go to the upazila (sub-district) and district hospital for EmOC services. It depends on patient's physical condition.

Each emergency patient has access to a complete referral system, which provides cooperation between BRAC personnel and hospital doctors, as well as community engagement in decision-making and fund management issues. Additionally, the IMNCS project provides additional services to infants and children in mitigating acute pneumonia and diarrhoea and managing them through an extensive network of local women, known as Shasthya Sebikas, trained in maternal and child primary healthcare, amongst others, known as newborn health workers, involved in delivery care throughout the villages. The project includes secondary target population such as CHWs, BRAC staff, public and private health care providers, local government bodies, village elites, school teachers and other community influencers, the local NGOs and national and/or international agencies concerned with the improvement of MNCH. The project's impact evaluation is supported and arranged by a systematic planning process.

Data and Methodology

Data

This study mainly used the MNCH impact evaluation data sets of 2008 and 2013 surveys on married women of age 15–49, which aims to measure the impact of IMNCS intervention of BRAC on a summary level outcome focusing the maternal and child health. Thus, it measures the level of change from 2008 to 2013 surveys across the MNCH services. The leading outcome indicators are the lifetime fertility, that is, mean number of live births ever born per woman and the occurrence of live births ≥ 3.

A baseline survey of this impact study was conducted in the six districts, four are intervention districts and two are control districts. Intervention districts are Nilphamari, Rangpur, Gaibandha, Mymensingh and the control districts are Naogaon and Netrokona. In 2013, the follow-up survey to select the same intervention and control districts was conducted. Nilphamari, Rangpur, Gaibandha, Mymensingh were called old intervention districts and Naogaon and Netrokona were called old control districts. Faridpur, Madaripur, Rajbari, Magura, Kurigram and Lalmonirhat were new intervention districts and Jhenaidah was the new control district (Figure 1). The respondents of this study were the women who were in their reproductive age (15–49 years). Inclusion of the women was conditional upon ever married and as being or having been a mother (in the case of a child death). The total number of respondents was 7,200 in 2008 and 3,600 in 2013 (Table 1 and Figure 2). The grand total of respondents was 10,800. Two groups of mothers were selected for the survey based on some criteria. Between

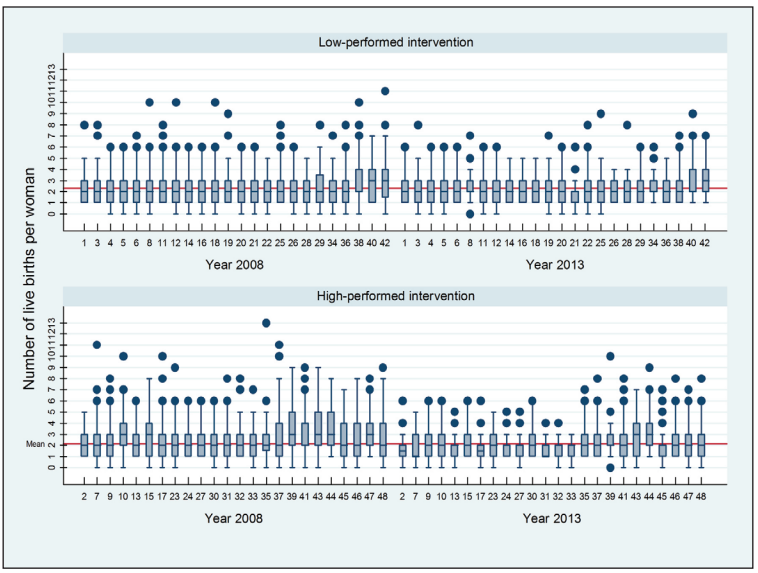

Figure 1. Variation in Number of Live Births by Union and IMNCS Area.

Source: The authors.

Note: Each box represents the variation in live births by IMNCS area and year at each union. The 75th, 50th (median) and 25th percentiles are presented within the box; outlier values are presented outside the box. The thick line at 2.3 represents the mean value for low-performed and 2.2 for high-performed IMNCS *unions* (n = 48). The numbers on X-axis refer to union codes.

Table 1. Number of Respondents by Study Area and Surveyed Year, 2008–2013.

	Baseline: 2008		Follow Up: 2013	
Respondent Characteristics	Intervention	Control	Intervention	Control
Group-1: Mothers who had any pregnancy outcome in the past year	2400	400	1,200	600
Mothers of infant living currently	1,995	984	974	485
Mothers of infant died in the past year	97	42	49	19
Mothers whose pregnancy was terminated by abortion/ menstrual regulation (MR)/ intrauterine device (IUD)/stillbirth	308	174	177	96
Group-2: Mothers of children 12–59 months	2,400	1,200	1,200	600
Total (Group-1 + Group-2)	4,800	2,400	2,400	1,200

Source: The authors.

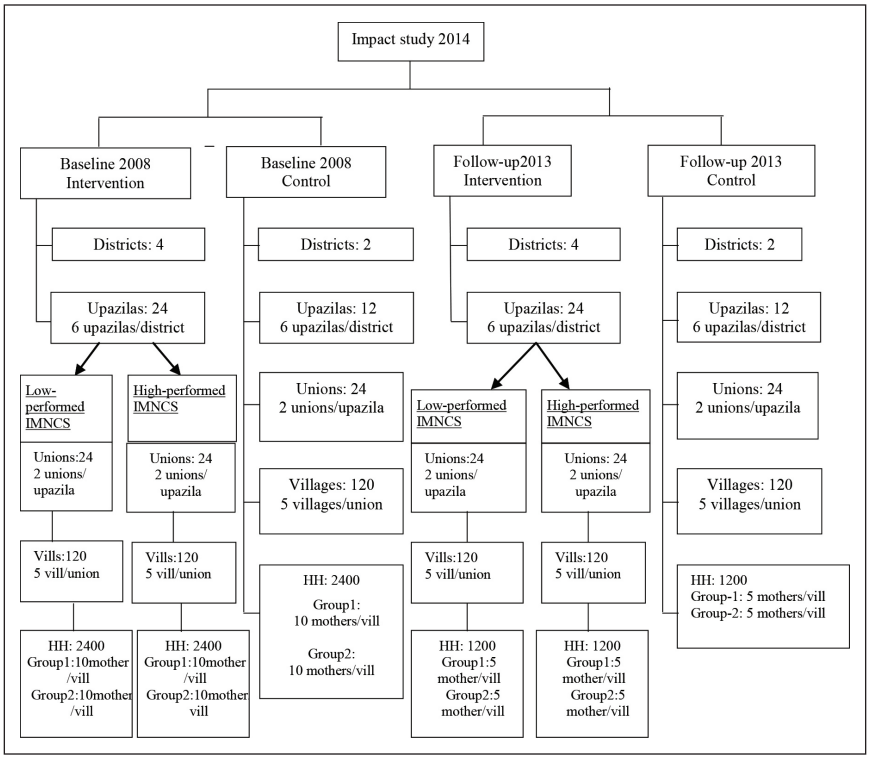

Figure 2. A Sampling Frame of the Study 2008–2013.

Source: The authors.

2008 and 2013, respondents were selected using a multistage cluster random sampling approach. The selection of intervention and control districts was made by a purposive sampling strategy. Geographically and culturally, the intervention and control districts were similar, as were the responder selection criteria (see BRAC, 2006, 2000a, 2008b for detail).

The sampling strategy for the endline survey was a multistage random sampling procedure consisting of districts, upazilas, unions, villages and households as the population strata. The selection of intervention districts was based on the presence of intervention. The control districts were selected on the basis of absence of intervention and considering the geographical and cultural similarities with the intervention districts. Simple random sampling was then performed for site selection at each successive stratum. If any mother was eligible for both the groups, she was preferred for the most recent pregnancy outcome; if more than one mother from a household were eligible for selection, the mother with the most recent pregnancy outcome was preferred. The listing of households was done clockwise and stopped as soon as they had 10 eligible mothers from Group-1 and 10 eligible mothers from Group-2. Finally, five mothers from Group-1 and five mothers from Group-2 were randomly selected from the

available eligible mothers. The sample sizes for the districts, which had less than six upazilas, were adjusted by increasing the number of respondents per village (Table 1 and Figure 2).

The Research and Evaluation Division of BRAC conducted a comprehensive quantitative baseline survey in 2008, and the follow-up in 2013, covered the issues of IMNCS intervention by choosing a suitable cut-off level, December 2012–January 2013, for ongoing intervention (see Figure 3 for sampling frame). A total of 10,800 mothers of reproductive age (15–49 years) were respondents. Ultimately two groups of mothers experienced a pregnancy outcome, and the mothers who had living children of 12–59 months without having any pregnancy outcome in the preceding year of the survey were interviewed (Salam et al., 2009; Ullah, 2010).

During the implementation of the baseline survey, 4,800 intervention households were visited from 240 villages, on the basis of five villages per union (an administrative boundary usually consists of 4–5 villages) and two unions per upazila, following a similar procedure for selecting 2,400 control households from 120 villages. The endline survey in 2013 followed the same rules of the baseline survey for selecting the respondents, 2,400 intervention households from 240 villages and 1,200 control households from 120 villages were visited. Therefore, 4,800 women from the intervention unions and 2,400 women from the control unions were interviewed during the baseline and 2,400 women from the intervention unions and 1,200 women from the control unions were interviewed during the endline survey.

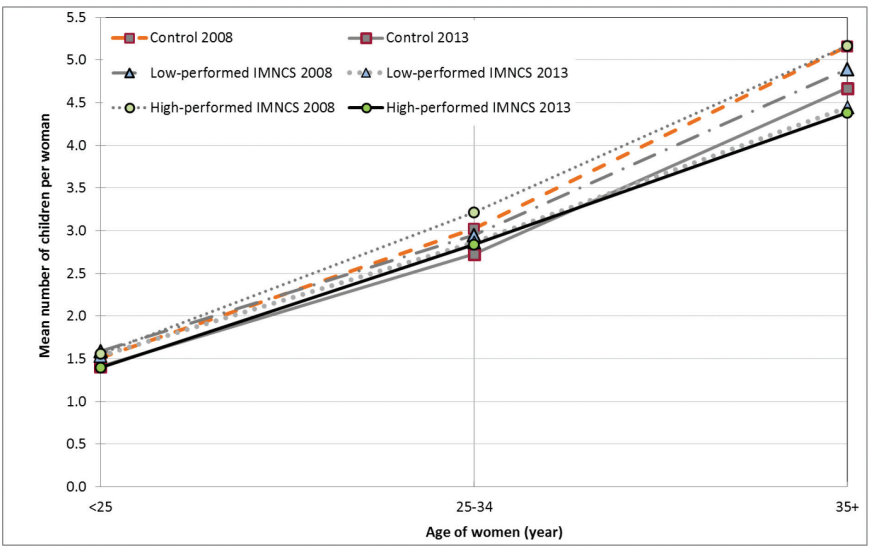

Figure 3. Age-specific Lifetime Fertility Rates by Study Area and Survey Year 2008–2013.

Source: The authors.

Two questionnaires were developed, one for the household and one for the individual. The household questionnaire contained information on household characteristics, household possessions and amenities, disability and death. The individual questionnaire contained information on adolescents' characteristics and their health, education and livelihood issues. The household wealth index was calculated according to Filmer and Pritchett (2000). Principal components analysis was used to produce a new set of linearly combined measurements for the household wealth scores, which were classified into quintile, such as poorest, second, third, fourth and richest. Also constructed variables such as lifetime fertility (mean number of live births ever born per woman by the childbearing age; Kpedekpo, 1982) and live births ≥3 (number of live births ever born per woman of the childbearing age and dichotomised as live births ≥3 and live births ≤ 2).

Estimation Method

The preliminary analysis indicates while selecting the intervention and control areas during surveys, socio-economic characteristics of the two areas were not completely matched. This has caused the problem in the final analysis (Gani, 2014). Besides, there may be an underestimate of the true effect of the intervention which may occur due to the closeness of the controls to intervention areas. In order to overcome this problem and unveil the effects of an intervention clearly, we applied the stratification theory of epidemiology in our analysis in controlling the potential confounders' effect (Rothman, 2002). Therefore, we ranked (low- and high-performed unions) based on the mean difference of live births from baseline to endline year for each intervention union, and then we compared the intervention and control unions. This is explained in Figure 3.

To compare the main outcome indicators (the lifetime fertility rate and the occurrence of live births ≥3) between high- or low-performed interventions and control areas, the mean and the odds ratio (OR) and their corresponding 95% confidence interval (CI) were calculated. Chi-square tests were conducted to analyse the differences in proportions between two groups from the baseline as well as the endline status over the period of intervention and the independent sample *t*-tests for mean differences were also performed to understand whether the interventions are actually effective. Net-effects of high-performed intervention for key indicators were calculated based on relative changes between the baseline and endline survey results for high-performed intervention or control unions (IEG, 2013b; Karim et al., 2001; Kpedekpo, 1982).

Bivariate logistic regression analysis was performed to calculate the odds ratios of the regression coefficients in exploring the relative decrease of the live births ≥3 per woman from the baseline year 2008 to the endline year 2013 by controlling all background variables in the model. Variables significant in the univariate analysis were included in the multivariate analysis to estimate the relative impact of the BRAC's IMNCS project on the number of live births ≥3 per woman of reproductive age.

In multivariate analysis, the outcome variables are the number of live births ever born per woman of childbearing age and the live births ≥3, as they are not continuous in measure and thus did not clearly meet the normal distribution criteria. Therefore, the logistic regression model (Menard, 1995) was suitably fitted with these data sets and used to explore the decrease in live births ≥3 per woman, controlling for survey years, demographic variables (age of women, age at marriage and first pregnancy, the experience of child deaths and the contraceptive uses), socioeconomic variables (women education, husbands occupation, women earning, wealth index, sale of labours and the households sanitation facilities) and cultural variables (family type and sex of household head). A total of 57 logistic regression analyses were conducted: 19 for low- and high-performed IMNCS intervention unions separately and 19 for control unions. In Table 6, for each area (i.e., low-performed, high-performed and control), at first three ORs show the overall change of lifetime fertility against the year 2013 compared to 2008 considering all explanatory variables in the models. Secondly, three ORs show the change among the women of age <25 years keeping all explanatory variables as usual. In this way in three areas, a total of 57 ORs were shown from 57 logistic regression equations. In Table 7, for each area, only three logistic regression equations were shown considering all explanatory variables in the models.

Results

Table 2 presents the demographic and socio-cultural characteristics of the women respondents. The mean age of women was around 25 years, and the mean age of their husbands was remarkably higher in all intervention or control unions. It is notable that the proportion of younger women (<25 years) in the high-performed IMNCS unions significantly increased in the year 2013 compared to 2008 (53.4% vs. 47.2%, $p < .001$). Mean age at marriage increased significantly, but their mean age at first pregnancy remained nearly the same in high-performed IMNCS or control unions; however, these characteristics decreased significantly in low-performed IMNCS unions. The proportion of women experienced with child deaths decreased significantly in all areas; on the other hand, use of contraceptives increased considerably only in IMNCS unions and stayed constant in control unions.

The mean year of schooling among women and their husbands improved significantly in three areas. Husbands' occupation of service status, wage earner including unemployed/disabled/beggar somehow increased and the agriculture or business occupation decreased remarkably. The proportions of the poorest households decreased significantly, and the richest increased. The proportion of improved sanitation coverage increased substantially, and the landowning trends declined gradually in all study unions. However, all of these background characteristics of women respondents varied during the period 2008–2013.

Table 3 presents the lifetime fertility rates among the women by study areas and year 2008 and 2013. Overall lifetime fertility rates, that is, mean number of

Table 2. Background Characteristics in Low and High IMNCS and Control Areas in 2008 and 2013.

Background Characteristics	Low-performed IMNCS		High-performed IMNCS		Control	
Demographic Status	2008	2013	2008	2013	2008	2013
Age (in year) (%)						
<25	53.8	53.5	47.2	53.8$^{\psi}$	51.8	53.5
25+	46.2	46.5	52.8	46.2	48.3	46.5
Mean age of women	25.1	24.9	25.7	24.6$^{\psi}$	25.2	25.1
Mean age of husbands	32.7	32.3	33.4	31.7$^{\psi}$	33.3	32.9
Marriage age ≤17 years (%)	77.6	83.4$^{\psi}$	81.1	80.6	77.0	74.0
Mean age of marriage	15.6	15.4$^{\psi}$	15.3	15.6$^{\psi}$	15.8	16.0*
First pregnancy age ≤19 years (%)	81.1	85.3‡	82.1	82.8	81.1	79.8
Mean age at first pregnancy	17.6	17.1$^{\psi}$	17.4	17.4	17.5	17.6
Use any contraceptives (%)	64.0	69.5‡	62.5	67.4‡	65.6	65.5
Experience of child deaths (%)	17.8	14.8*	18.6	14.3‡	14.8	12.3*
Mean household size	5.0	5.0	5.1	4.9*	5.1	5.0
Cultural Status						
Muslim religion (%)	86.6	85.8	94.0	91.6*	88.9	88.6
Joint family (%)	30.7	35.3‡	28.0	36.3$^{\psi}$	35.9	40.3*
Female headed household (%)	2.2	1.5	2.9	1.8	2.5	1.4*
Socioeconomic Status						
No schooling of women (%)	33.3	19.7$^{\psi}$	36.0	18.8$^{\psi}$	33.7	22.9$^{\psi}$
Mean year of school (women)	4.3	5.0$^{\psi}$	3.9	5.3$^{\psi}$	4.0	4.9$^{\psi}$
No schooling of husbands (%)	45.4	34.3$^{\psi}$	47.9	33.9$^{\psi}$	46.3	36.5$^{\psi}$
Occupation of husbands (%)						
Service	9.5	12.5‡	11.0	16.3$^{\psi}$	7.9	9.5
Agriculture	46.8	35.0$^{\psi}$	44.0	30.7$^{\psi}$	53.5	49.9*
Business	16.6	15.6	16.9	19.8*	15.8	18.9*
Wage earner	25.6	34.3$^{\psi}$	27.0	31.6‡	22.0	20.3
Others$^{¥}$	1.5	2.6*	1.2	1.7	0.8	1.4
Wealth index (quintile) (%)						
Poorest	32.2	11.2$^{\psi}$	31.5	11.2$^{\psi}$	34.2	18.5$^{\psi}$
Richest	11.2	19.3	13.6	26.3	14.4	24.8
Improved sanitation (%)§	63.8	73.3$^{\psi}$	63.2	79.7$^{\psi}$	54.4	64.8$^{\psi}$
Number of respondents (*n*)	2,400	1,200	2,400	1,200	2,400	1,200

Source: The authors.

Notes: $^{¥}$others-unemployed, beggar, disabled, student, non-response (NR), etc.
§ring slab with or without water seal and sanitary latrine.
χ^2 for test of heterogeneity, student's *t* for mean test and the significant differences between 2008 and 2013 are $^{*}p < .05$; $^{\ddagger}p < .01$; $^{\psi}p < .001$.

live births ever born per woman reduced significantly from the year 2008 to 2013 in high-performed IMNCS and control unions (absolute change: −0.48, $p < .001$ vs. −0.24, $p < .001$), but the degree of reduction had yielded the highest precision in high-performed IMNCS unions (relative change: −18.4%, $t = 8.58$) compared to control (relative change: −10.1%, $t = 4.29$). Therefore, high-performed intervention had a net effect in reducing lifetime fertility rate by 8.3%.

Figure 3 and Table 4 depict the age-specific lifetime fertility pattern, that is, the distribution of fertility rates at childbearing ages tends to increase steadily with age. The data revealed a general downward trend in the relative percentage change of lifetime fertility rates from 2008 to 2013 in all areas. Specifically, the degree of declining effects in age-specific fertility rates increased gradually with age, and that was much higher for high-performed intervention unions, in contrast to control or low-performed intervention unions (low IMNCS: −9.1%, $p < .05$; high IMNCS: −15.1%, $p < .01$; and control: −10.6%, ns). The 35-years or above ages had appeared as a significantly most effective cohort of the IMNCS intervention in reducing lifetime fertility from the base-year to endline comparing to other age groups, followed by the 25–34 years age group (low IMNCS: −2.8%; high IMNCS: −11.7%, $p < .001$; and control: −11.0%, $p < .001$) and the below 25 years age group (low IMNCS: −3.2%; high IMNCS: −10.4%, $p < .001$; and control: −7.2%, $p < .01$). In all age groups, the 35-years or above in the high-performed intervention unions had revealed as the most influencing ages in changing the lifetime fertility rate among the women respondents (Figure 3).

As with the lifetime fertility rate, the frequency of live births ≥3 demonstrated the similar patterns of effectiveness of the intervention union (Table 4). The results indicated that the occurrence of live births ≥3 reduced significantly with the greatest precision in high performed IMNCS unions (relative change: −29.0%, $\chi^2 = 52.0$, $p < .001$) from 42.8% in 2008 to 30.4% in 2013 compared to control unions (relative change: −18.5%, $\chi^2 = 15.2$, $p < .001$) or low-performed IMNCS unions (relative change: −4.8%, $\chi^2 = 1.5$, $p < .001$). Thus, the high-performed IMNCS over control unions had a net effect in reducing the occurrence of live births ≥3 by 11.7%.

Table 4 also showed the odds ratio estimates (including the 95% CI) by study areas and survey year. The likelihood of occurring live births ≥3 among the mothers in high-performed IMNCS unions decreased by 42% during 2008–2013 (OR 0.58, 95% CI 0.50–0.68). While in control unions the likelihood of occurring live births ≥3 among the mothers decreased by 26% from 2008 to 2013 (OR 0.74, 95% CI 0.64–0.86). Therefore, it is easy to conclude from the above results that the high-performed IMNCS intervention is more protective for having higher fertility compared to control.

Furthermore, an inference can also be drawn from the estimates of odds ratio by stratifying the mothers age groups into younger (<25 years) and adult (≥25 years), and therefore, the high-performed IMNCS intervention unions' adult mothers (≥25 years) (high-performed IMNCS: OR 0.54, 95% CI 0.44–0.67 vs. control: OR 0.72, 95% CI 0.58–0.89) are less likely to have live births ≥3 than that of younger mothers <25 years (high-performed IMNCS: OR 0.64, 95% CI

Table 3. Lifetime Fertility Rate, Relative Percentage Change, 95% CI by Area and Year 2008–2013.

	Survey Year		Difference		Statistical Test			
Lifetime Fertility Rate	2008	2013	Absolute Change	Relative Percentage Change	*t*-Statistic	*p*	95% CI	*N*
Low-performed intervention, *L*	2.35	2.27	−0.09	−3.61	1.31	ns	(−0.01 0.18)	3,600
High-performed intervention, *H*	2.63	2.15	−0.48	−18.36	8.58	ψ	(0.37 0.59)	3,600
Control, *C*	2.42	2.18	−0.24	−10.06	4.29	ψ	(0.13 0.35)	3,600
Total (*n*)	7,200	3,600						10,800

Source: The authors.

Notes: Minus (−) and plus (+) signs indicate the decrease and increase respectively.
Significant differences between the 2008 and 2013 are; ψ$p < .001$.
ns = Not significant at 10% level.

Table 4. Occurrence of Live Births ≥3 by Study Area and Survey Year 2008–2013.

	Survey Year		Difference		Statistical Test			
Number of Live Births ≥3 (%)	2008	2013	Absolute Change	Relative Change in Percentage	Statistic (χ^2)	*p*	OR (95% CI)	*n*
Low-performed IMNCS	36.67	34.92	−1.75	−4.77	1.52	ns	0.93 (0.80 1.07)	3,600
High-performed IMNCS	42.83	30.42	−12.41	−28.98	51.99	ψ	0.58 (0.50 0.68)	3,600
Control	34.88	28.42	−6.46	−18.52	15.16	ψ	0.74 (0.64 0.86)	3,600
Total (*n*)	7,200	3,600						10,800

Source: The authors.

Notes: Minus (−) and plus (+) signs indicate decrease and increase respectively.
Significant differences between the year 2008 and 2013 are; ψ$p < .001$.
ns = Not significant at 10% level.
$\chi^2 = 27.563$, $p < .001$ vs. $\chi^2 = 10.169$, $p < .001$.

0.44–0.92 vs. control: OR 0.65, 95% CI 0.44–0.94). In other words, the control unions' adult mothers are more likely to have live births ≥3 than younger mothers.

Table 5 shows the change in the occurrence of live births ≥3 by key demographic, socioeconomic and cultural variables from baseline 2008 to endline status of 2013. The occurrence of live births ≥3 in high-performed IMNCS is strongly associated with women's first pregnancy age ≤19 years ($p < .01$), no child deaths ($p < .001$), Muslim religion ($p < .001$), family types ($p < .001$), education of women or husbands ($p < .001$) and service occupations of husbands ($p < .001$). Moreover, both the high-performed intervention and control were significantly associated with the women age ($p < .001$ vs. $p < .01$), using any contraceptives ($\chi 2 = 22.79$, $p < .001$ vs. $\chi^2 = 13.737$, $p < .001$), households sanitation facilities ($p < .001$ vs. $p < .01$), agriculture occupation ($p < .01$ vs. $p < .05$), wage earners occupation ($p < .001$ vs. $p < .05$), landowner of 50 decimal or more.

Table 5. Occurrence of Livebirths ≥3 by Socio-demographic and Cultural Factors by Area and Year.

	Low-performed IMNCS		High-performed IMNCS		Control	
Characteristics	2008	2013	2008	2013	2008	2013
Age of women (year) (%)						
<25 years	11.2	9.3	11.0	7.3‡	10.2	6.9*
25+ years	66.3	64.3	71.3	57.4ψ	61.3	53.2‡
Marriage age ≤17 years (%)	40.6	38.6	47.0	33.2	38.4	31.3
First pregnancy age ≤19 years (%)	38.7	36.6	45.5	32.6‡	37.5	30.3
Use any contraceptives (%)	37.5	36.1	43.7	33.5ψ	34.1	26.6ψ
No child deaths (%)	28.5	27.8	33.4	23.1ψ	27.8	22.4‡
Muslim religion (%)	37.7	36.8	43.8	31.1ψ	36.0	29.5
Joint family (%)	26.4	20.3*	30.5	17.7ψ	23.4	21.7
Female household head (%)	38.5	44.4	37.1	27.3	36.1	29.4
Improved sanitation (%)	34.4	33.9	39.7	29.5ψ	31.2	24.7‡
Education of women: primary + (%)	24.2	27.6	30.1	23.7ψ	22.2	21.2
Education of husbands: primary + (%)	27.6	28.7	32.8	22.8ψ	23.8	20.9
Women earning (%)	13.9	8.6‡	26.6	6.6	14.6	10.0
Occupation of husbands (%)						
Service	21.5	18.0	28.5	14.9ψ	23.7	22.8
Agriculture	37.3	36.2	45.0	37.2‡	36.6	31.9*
Business	37.4	37.4	43.7	34.0*	31.9	22.0‡

(Table 5 continued)

(Table 5 continued)

	Low-performed IMNCS		High-performed IMNCS		Control	
Characteristics	2008	2013	2008	2013	2008	2013
Wage earner	40.0	38.6	44.1	29.0ψ	36.3	27.2*
Others¥	48.6	35.5	53.6	40.0	47.4	47.1
Land 50 + decimal (%)	33.9	29.5	42.0	25.0ψ	31.7	23.1ψ
Wealth index (%)						
Poorest	40.1	47.8	50.5	44.8	47.0	36.5‡
Richest	27.5	31.6	28.1	22.5	18.2	16.4
Overall	36.7	34.9	42.8	30.4ψ	34.9	28.4ψ
Total (*n*)	2,400	2,400	2,400	1,200	1,200	1,200

Source: The authors.

Notes: Significant differences between the year 2008 and 2013 are *$p < .05$; ‡$p < .01$; ψ$p < .001$; ¥unemployed, beggar, disabled, student, non-response, etc. ns = Not significant at 10% level.

These findings revealed that the magnitude of association is strongly effective for high-performed IMNCS intervention compared to control unions. However, only the control unions were significantly associated with the bottom quintile households ($p < .01$). All of the above findings in Table 6 indicate that the live births (3) patterns effectively dropped from 2008 to 2013 in the IMNCS intervention's high-performed unions.

Regression Estimates (Factors Predicting Three or More Live Births)

The model's pseudo-R^2 indicates all independent variables explained separately 43.2% for low-performed IMNCS, 45.3% for high-performed IMNCS and 38.0% for the control (Tables 6 and 7). Multi-collinearity arose among few explanatory variables for the model because of high correlation coefficients (r) of women age with husbands age, marriage age with first pregnancy age, women education with husbands' education, land ≥50 decimal with the richest quintile and the sanitation facilities with the poorest quintile, $r = 0.63$, $r = 0.49$, $r = 0.394$, $r = 0.35$, $r = -0.34$, respectively. At the second step, after excluding husbands age, marriage age, husbands' education, land ≥50 decimal, poorest quintile, the logistic regression model was run with 14 explanatory variables following the forward Wald method. The model screened out insignificant variables such as using contraceptives, women earning, agriculture work, religion, and sale of labour, and finally, the model considered 10 explanatory variables in predicting the live births ≥3. The results indicate an overall likelihood of increasing more children per woman was about 35% lower in the year 2013 compared to reference year 2008 in high-performed IMNCS unions, and the change is significantly highest in high-performed IMNCS (OR 0.66, 95% CI 0.535-0.818) compared to control (OR 0.86, 95% CI 0.706-1.052) and low-performed IMNCS unions (OR 1.03, 95% CI 0.841–1.274).

The estimates of odds ratios, except the overall results, were calculated by controlling for each category of background variables separately. Logistic regression analysis found that among area-specific outcome factors, live births ≥3 in high-performed IMNCS areas declined significantly in 2013 compared to 2008. However, when data for low-performed IMNCS or control unions were analysed independently, no significant difference in reducing the prevalence of live births ≥3 was observed in the survey year 2013.

Table 6. Multiple Logistic Regression Coefficients, ORs Against Year 2013 (2008 as Reference Year) in Predicting the Risk for Live Births ≥3 by Each Factors and Areas (n = 10,800).[å]

Factors	Model-I[ø] (n = 3,600)	Model-II[¢] (n = 3,600)	Model-III[§] (n = 3,600)
All	1.03	0.66[ψ]	0.86
Women age			
<25 years	1.03	0.74	0.70
25+ years	1.05	0.63[ψ]	0.94
First pregnancy age			
≤19 years	1.07	0.67[‡]	0.83
20+ years	0.92	0.66	1.01
Experience of child deaths			
No	1.20	0.66	1.45
Yes	1.01	0.66[ψ]	0.81
Education of women			
None	1.13	0.66*	0.75
Primary+	0.99	0.67[‡]	0.92
Occupation of husband			
Non-service	1.07	0.67[ψ]	0.85
Service	0.67	0.67	1.02
Wealth index			
Poorest/middle	0.997	0.66[‡]	0.84
Richest	1.35	0.68	0.90
Family type			
Nuclear	1.21	0.69[‡]	0.76*
Joint	0.66	0.60*	1.16
Sex of household head			
Male	1.04	0.66[ψ]	0.86
Female	2.08	0.69	0.34
Sanitation status			
Not improved	0.93	0.66*	0.87
Improved	1.09	0.66[‡]	0.85

Source: The authors.

Notes: Significant differences between the year 2008 and 2013 are *p < .05; [‡]p < .01; [ψ]p < .001.
[ø]Results for low-performed IMNCS area.
[¢]Results for high-performed IMNCS area.
[§]Results for control area.
[å]Number of live births ≥3 ever born per woman of the childbearing age and dichotomised as live births ≥3 (code 1) and live births ≤ 2 (code 0).

In comparison to the control, the high-performed intervention demonstrated a significantly declining trend for a variety of factors—particularly for adult women respondents, women with a first pregnancy age of 19 years or less, women with primary/higher education, husbands engaged in non-service occupations (i.e., agriculture, wage employment—agri or non-agri, large or small business), households with the poorest or moderate poor or middle-class socio-economic status (SES), and households with adequate sanitation. However, a substantial number of young mothers from control unions, who are from nuclear family demonstrated an impressive reduction in their risk of having the live births ≥3, but the magnitude of reduction is more precise in high-performed IMNCS unions (OR 0.69, 95% CI 0.54–0.88 vs. OR 0.76, 95% CI 0.60–0.97).

Table 7. Multiple Logistic Regression: Predictors of Risk for Live Births ≥3 Among 15–49-Years-old Women (*n* = 10,800).[å]

Factors	Model-I[¤] (*n* = 3,600)	Model-II[¢] (*n* = 3,600)	Model-III[§] (*n* = 3,600)
Survey year			
2008	1	1	1
2013	1.03 (0.841 1.274)	0.66 (0.535 0.818)[ψ]	0.862 (0.706 1.052)
Women age			
<25 years	1	1	1
25+ years	26.47 (21.074 33.245)[ψ]	29.26 (23.151 36.982)[ψ]	16.97 (13.684 21.055)[ψ]
First pregnancy age			
≤19 years	1	1	1
20+ years	0.18 (0.139 0.234)[ψ]	0.21 (0.163 0.270)[ψ]	0.25 (0.198 0.325)[ψ]
Experience of child deaths			
Yes	1	1	1
No	0.09 (0.071 0.121)[ψ]	0.08 (0.063 0.114)[ψ]	0.14 (0.109 0.190)[ψ]
Women education			
None	1	1	1
Primary+	0.34 (0.277 0.428)[ψ]	0.44 (0.352 0.543)[ψ]	0.35 (0.284 0.425)[ψ]
Occupation of husband			
Non-service	1	1	1
Service	0.55 (0.386 0.787)[‡]	0.63 (0.459 0.877)[‡]	1.01 (0.705 1.436)
Wealth index			
Poorest/middle	1	1	1
Richest	1.04 (0.770 1.410)	0.77 (0.584 1.021)	0.53 (0.400 0.705)[ψ]
Family type			
Nuclear	1	1	1
Joint	0.67 (0.536 0.833)[ψ]	0.59 (0.469 0.738)[ψ]	0.84 (0.682 1.023)

(Table 7 continued)

(Table 7 continued)

Factors	Model-I[¤] (*n* = 3,600)	Model-II[¢] (*n* = 3,600)	Model-III[§] (*n* = 3,600)
Sex of household head			
Male	1	1	1
Female	0.61 (0.303 1.210)	0.64 (0.343 1.179)	1.38 (0.717 2.667)
Sanitation status			
Not improved	1	1	1
Improved	0.93 (0.751 1.150)	0.99 (0.796 1.233)	0.96 (0.792 1.171)
Constant	0.807	0.790	0.410
−2 Log likelihood	2671.696	2634.028	2828.721
Pseudo R^2 (Cox and Snell R^2)	0.432	0.453	0.380
Nagelkerke R^2	0.592	0.615	0.530

Source: The authors.

Notes: Significant differences between the year 2008 and 2013; ‡$p < .01$; ᴪ$p < .001$.
[¤]Results for low-performed IMNCS.
[¢]Results for high-performed IMNCS.
[§]Results for control.
[â] Number of live births ≥3 ever born per woman of the childbearing age and dichotomised as live births ≥3 (code 1) and live births ≤ 2 (code 0).

Discussion of Findings

The BRAC's IMNCS intervention covers four Northern rural districts of Bangladesh with a certain implementation procedure. However, regardless of the implementation strategy, the IMNCS intervention had a diverse impact after five years. This study has been a testament for an evaluation of health interventions and BRAC's response to the IEG of the World Bank (2013) in improving a high-quality impact evaluation with the focus on demographic indicators (IEG, 2013a). The lifetime fertility rate was used in estimating the effectiveness of IMNCS intervention over the said period in contrast to control areas (Barclay, 1958; Kpedekpo, 1982).

However, socioeconomic characteristics of female respondents living in intervention or control areas were not completely controlled during the control area selection process. The final results revealed this fact. Due to the close proximity of the controls to intervention unions, it is likely that an underestimate of the true effect of intervention unions occurred. With an aim to surmount this issue, we applied the stratification theory of epidemiology in our analysis in controlling the potential confounders' effect, which is associated with outcome and exposure variables (Rothman, 2002). Macinko et al. (2007) conducted an impact study assuming the quasi-experimental design and rated the healthcare programme with scoring, and we pursued a similar approach in stratifying the IMNCS intervention unions. We though ranked the high- or low-performed intervention unions in such a way that each union-specific mean difference of live

births ever born per woman during 2008–2013 could be compared between the intervention and control unions. Even though the overall effects of IMNCS in declining lifetime fertility rates were higher, but variations in lifetime fertility rates within IMNCS unions were remarkable. However, the stratification analysis indicated that the process of care should be prioritised, indicating the possibility of quality improvement initiatives to ascertain how the best performed IMNCS unions achieved a greater reduction in lifetime fertility and to communicate lessons learned to low-performed IMNCS unions (Macinko et al., 2007).

Areas were classified as low- and high-performers based on high intensity and low intensity. We understand the fact it may not be reasonable to predict that high-performed areas would have a greater impact. If, on the other hand, high-performers are chosen based on their performance in family planning indicators prior to the baseline, then their strong impact in that area may even be more promising (assuming that cutting fertility is a desirable thing—which may not be the case though).

Our analyses suggested that the overall lifetime fertility rate was about 2.2 per woman. This, in fact, reflected the results of the Bangladesh Health and Demographic Survey (NIPORT et al., 2016). The lifetime fertility rates were 2.5 in 1999–2000, 2.3 in 2007 and 2.2 in 2011 (NIPORT et al., 2009, 2013). The basic analysis confirmed that overall lifetime fertility rates declined most effectively in high-performed IMNCS unions in contrast to control unions. Therefore, the high-performed IMNCS had a net effect in declining lifetime fertility rate by 8.3%.

In general, the age-specific lifetime fertility patterns assess the shape, structure and age patterns of fertility by areas (Barclay, 1958). As expected, the area-specific curves tend to increase steadily and gradually spread with respect to mean ages at childbearing. Thus, low age-specific lifetime fertility rates are frequently associated with high levels of intervention, and it is easy to deduce that fertility declines as the degree of intervention increases (Barclay, 1958; Kpedekpo, 1982). Our findings indicate that lifetime fertility rates declined significantly in the age group of 35 years or older women living in high-performed IMNCS unions between 2008 and 2013, and as a result, this age group was recognised as the most influential factor in reducing fertility. Abbasi-Shavazi et al. (2013) and Jones and Gubhaju's (2009) study endorse the findings. More than half of the selected respondents were younger and they represent the high-performed IMNCS unions. This implies that the improvements in maternal and neonatal health services, particularly those directed at young women (25 years), have the potential to reverse this trend. Jones and Gubhaju (2009) argued that this pattern is obviously related to the delay in age at marriage, and consequently a higher proportion of women remain single in Eastern Asia (Jones & Gubhaju, 2009).

During 2008–2013, the occurrence of live births ≥3 was analysed, and high-performed IMNCS intervention appeared as the most effective in declining the occurrence of live births (OR 0.58, 95% CI 0.50–0.68 vs. OR 0.74, 95% CI 0.64–0.86). Odds ratio analyses suggest the probability of lowering the live births ≥3 among mothers in high-performed IMNCS unions than that of the control unions, to be highest. In other words, the above data indicate that the

high-performed IMNCS intervention is more protective against having a high fertility rate than the control unions.

Overall, the findings confirmed that between 2008 and 2013, the occurrence of live births decreased dramatically across a range of socio-demographic factors such as first pregnancy age of 19 years, child deaths, women or husbands education, employment and a few cultural factors such as religion and joint family formation—but the degree of decline is much greater for high-performed IMNCS intervention compared to control. Numerous studies had already highlighted our study findings with the exception of contraceptive uses (Aarssen, 2005; Abbasi-Shavazi & Gubhaju, 2014; El-Ghannam, 2005; Khan & Raeside, 1997; Sobotka & Beaujoun 2014; Weeks, 1994). Several other studies confirmed the fact that usually increasing contraceptive uses is attributed to declining of fertility (Casterline & Sinding 2000; Cleland et al., 2006), but surprisingly our study is inconclusive about this issue. Because this was only supported by cross-tabulation analyses, not revealed through multivariate analyses. This study flagged the similar question, can fertility preferences be influenced on contraceptive use, if so how, as for some other studies (Bongaarts, 2011; Robinson & Cleland, 1992) including a few studies conducted at Matlab of Bangladesh (Freedman, 1997). Unlikely that the IMNCS intervention had no significant effect on the poorest or richest households, but a significant reduction of more live births is evident only in control area for the poorest households ($p < .01$). However, the multicollinearity problem precludes drawing causal conclusions about some of these findings, which are frequently observed in other studies as well (Bongaarts, 2011).

After area stratification, we employed regression modelling to thoroughly control the impacts of confounders in order to illustrate the intervention's effects (Rothman, 2002). The logistic regression analyses suggested the risk of occurring live births ≥3 in high-performed IMNCS unions declined significantly in the year of 2013 as compared to 2008. While data were analysed specifically for low-performed IMNCS and control unions, no significant reduction in the chance of having live births ≥3 was observed in 2013.

In contrast to the control area, the high-performed IMNCS intervention demonstrated a significant decline in number of factors, including adult mothers, first pregnancy at the age of 19 years or younger without child death, women with primary or higher education, husbands engaged in non-service occupations, such as agriculture, wage employment—agri or non-agri, large or small business, socioeconomic status, sanitation facilities and household head. However, a substantial number of younger mothers of control unions living with a nuclear family had shown an impressive nature in reducing the risk for having live births ≥3, but the strength of reduction is more precise for the high-performed IMNCS unions' mother.

Finally, the overall effectiveness of high-performed IMNCS intervention had the highest magnitude in reducing lifetime fertility rate as compared to control and/or low-performed IMNCS. The IMNCS intervention, including control is strongly correlated with the lifetime fertility rates, and the low levels of fertility rates, are found to be mostly associated with high-performed IMNCS intervention. Thus, the reasoning is straightforward lifetime fertility becomes lower as the degree of IMNCS intervention becomes higher.

Conclusion

In general, high-performed IMNCS interventions were more effective at lowering lifetime fertility rates than controls or low-performed IMNCS interventions. The IMNCS intervention, including control, has a strong correlation with lifetime fertility rates, and low fertility levels are generally connected with high-performed IMNCS interventions. Thus, the reasoning is straightforward: as the degree of intervention increases, lifetime fertility decreases.

In Bangladesh, socio-demographic and cultural differentials do explain a little about fertility reduction in recent decades—but not all of it. A substantial residual exists, which is most likely explained by the existence of an effective family planning programme. Given that the drop in fertility has slowed, it is reasonable to wonder how the pace can be sustained. Women with higher fertility are less likely to utilise the health services so that the case for home visits should be reconsidered as a part of the wider strategy for fertility reduction. To reduce total fertility, it is necessary to target younger women, including spouses, by encouraging the use of contraceptives, increasing community understanding about the optimal maternal age for conception and increasing knowledge about pregnancy-related issues through health education.

The policy implication is that a target-oriented quality programme on MNCH has been a significant contributor to improving the fertility rates in Bangladesh, as it remains unchanged. Hence, this is relevant to the current context in Bangladesh. Finally, multilevel modelling can be applied suitably on the same topic and could be replicated and justified for other demographic parameters like neonatal or infant mortality coupled with epidemiologic concepts, in determining the impact of IMNCS intervention more precisely to inform the health, population and development practitioners, stakeholders and the policymakers.

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