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Working paper

Revisiting the causes of fertility decline in Bangladesh: Family planning program or female education?

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Abstract

Bangladesh, one of the world's poorest countries, has experienced a dramatic fertility decline since 1985 with the TFR declining from 5.5 to 2.1. The reasons for this rapid decline have been controversially discussed by international researchers with some studies attributing it primarily to family planning programs others point at the simultaneously expanding female education and other socio-economic factors. In this study we try to comprehensively review the empirical evidence by merging the data of seven rounds of Bangladesh Demographic and Health Surveys from 1993 to 2014 and reconstruct cohort and period fertility trends by single years of age and level of educational attainment. Multilevel regression analyses applied to over 75,000 individual women shows that education is highly significant and negatively associated at both community and individual level while the indicator of family planning efforts (visits by family planning workers) is not associated with lower family size, except in the earliest period at the community level. We conclude that for the bulk of the strong fertility decline in Bangladesh increasing female education was likely the main driver both at individual level and through diffusion processes also at the community level.

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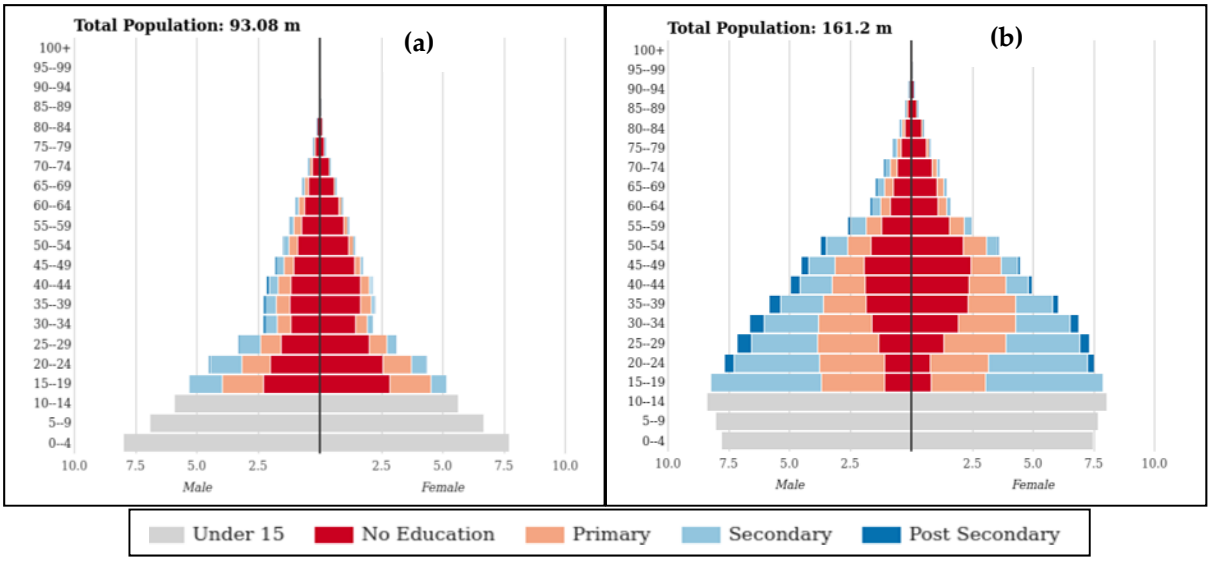
Introduction

Bangladesh is a prominent country for demographers wanting to demonstrate the effectiveness of family planning programs. While still being one of the world's poorest countries it still experienced a steep fertility decline from a TFR of 5.5 in 1985 to 3.7 in 1995 on to 2.1 in 2017 (The World Bank 2019). Given strong family planning efforts together with little economic development over these years it seemed like a sort of natural experiment which can help to isolate the effects of these two possible drivers of fertility decline which in many other countries tend to change together. A recent prominent paper on population growth and climate change (Bongaarts & O'Neill 2018) also singles out Bangladesh as the country that demonstrates that family planning programs work and are thus an effective way to curb population growth as part of climate change mitigation.

A closer look at available data and in-depth studies on the drivers of fertility decline in Bangladesh, however, reveals that the evidence for this strong claim is surprisingly fragmentary. In particular, it turns out that the educational attainment of women in reproductive age increased roughly in parallel with birth rates declining. Figure 1 illustrates this with age- and education pyramids for the years 1985 and 2015 which shows the change from a very large proportion of children together with a majority of women in reproductive age having no education at all (dark red) to a narrowing of the pyramid at the bottom and a majority of women having primary or higher education. For the youngest cohorts more than half have even secondary education. As will be discussed later in this section, also quite a number of studies on Bangladesh point at the important role of education in the fertility decline.

Figure 1. Population Pyramid (in millions) with Medium SSP2[#] Scenario by education in a) 1985 and b) 2015, Bangladesh



Source: Wittgenstein Centre (2018)

[#]Population Component of Medium (SSP2): This is the middle of the road scenario that can also be seen as the most likely path for each country. It combines for all countries medium fertility with medium mortality, medium migration, and the Global Education Trend (GET) education scenario.

In this context the present study tries to give a comprehensive assessment of fertility trends by merging the data from seven rounds of Bangladesh Fertility Surveys between 1992 and 2014 and constructing cohort histories as well as period rates by level of education. The specific focus of a multi-level statistical analysis is then on assessing the relative effects of education change and different indicators of family planning efforts and usage after controlling for other possible factors. The advantage of the multi-level approach is that it does not only consider the direct compositional effect of improving educational attainment but also addresses spill-over and diffusion effects at the local level.

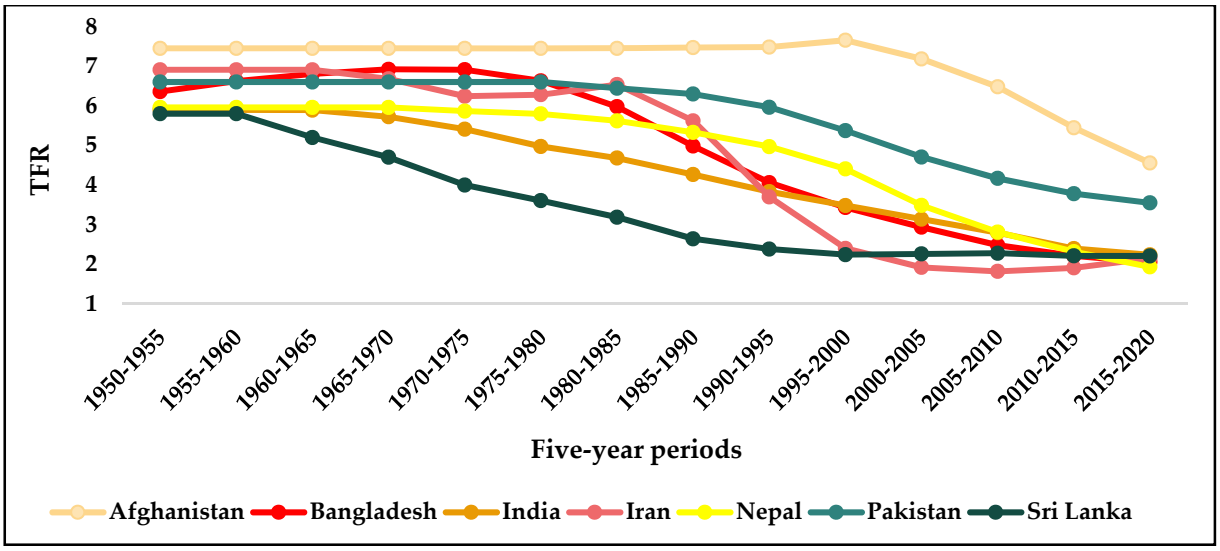
This study also contributes to a long-standing debate among demographers and health researchers as to whether female education or family planning programs are the main factors in bringing down fertility and that should receive priority when the goal is to curb rapid population growth. There has been a long tradition of studies highlighting the impact of female education on bringing fertility "within the calculus of conscious choice" (Coale 1973), enhancing the "numeracy in desired family size" (van de Walle 1992) as well as increasing the mean age at marriage, empowering the women to pursue their lower family size desires vis a vis their husbands and increasing the opportunity cost of children (Basu 2002; Cleland 2002; Martin & Juarez 1995; Jejeebhoy 1996; Kravdal 2002; Bongaarts 2010; Lutz & Skirbekk 2013). On the other hand, it has been argued that family planning programs have been highly effective through either providing easier access to contraception or propagating at advantages of smaller families and often a combination of both. These studies mostly pointed to Asian countries experiencing accelerated fertility declines in a short period, such as Bangladesh, Indonesia and Iran (Gertler & Molyneaux 1994; Carty et al. 1993; Cleland et al. 1994; Angeles et al. 2005; Erfani & McQuillan 2008). Of course, the two approaches of female education and family planning are not mutually exclusive and it has been argued that they actually reinforce each other (Bongaarts 2017; Lutz 2014).

In this paper we will first briefly discuss the fertility in Bangladesh in a regional perspective and summarize previous studies on the topic. Next, we will describe the data used and the methods for sequencing seven rounds of fertility surveys to come up with trends in age- and education- specific fertility in the form of both cohort and period trends. Then we discuss data and evidence on available family planning effort and outcome indicators over time. Finally, we define the multi-level statistical model and apply it to all individual rounds of BDHS as well as a merged data set. More detailed information on all models in specific results is given in an appendix. We conclude with a summary of our findings and some discussions.

Fertility trends in Bangladesh

The rapid fertility declines in Bangladesh since around 1980 caught the attention of international researchers and policymakers due to several reasons. First, Bangladesh happened to be one of the poorest countries of the world when it experienced a steep decline in TFR. While until 1980 Bangladesh had higher fertility than most other countries in South Asia (see Figure 2) it outperformed most of these countries with a more rapid decline thereafter. Secondly, in a rare exception in the history of fertility transitions around the world, fertility decline in Bangladesh began at a relatively high level of under-five mortality. It was still above 200 per 1000 births in 1975-80, implying that one out of five children died before reaching age five. Finally, Bangladesh has been undergoing a substantial socio-economic transformation over the same period when fertility started falling triggering efforts to disentangle the drivers and gain a better understanding of demographic transition which could also be used for other high fertility countries.

Figure 2. Trend in fertility estimates according to UN-WPP for South Asian countries



Source: United Nations (2019)

In Bangladesh, the family planning activities were carried out in three distinct phases: In phase I activities were mostly voluntary in the early 1950s. In phase II activities in 1960, the government took some broader steps to check population growth. "Population control" was officially adopted in the First Five Year Plan of Pakistan (1960-65). During these two phases, Bangladesh was a part of Pakistan. In Phase III, after the independence of Bangladesh in 1971, the first Five Year Plan of Bangladesh was launched with a clear priority on population control and food production. Phase III also marked the beginning of comprehensive multi-sectoral and broadly-based population control and family planning program in the country (Barkat-e-Khuda & Barkat 2010).

Several studies until the middle of the 1980s inferred that government family planning program had little success despite of the considerable efforts and expenses to reduce fertility through family planning programs. According to an analysis of the data from the Poverty and Fertility Survey conducted in 1977 in four rural areas of the country, a modest rise in contraceptive use in Bangladesh had no significant impact on fertility (Amin et al. 1985). This study found that child mortality experience and contraceptive use were positively related to the number of children ever born. The positive correlation of contraceptive use with the number of children ever born could be explained by the fact that such use was usually adopted late in a couple's reproductive life. It inferred that although contraceptive use plays some role in depressing fertility at higher parities, high child and infant mortality and secondary sterility (at higher ages) dominated the fertility pattern in Bangladesh in the study period. Many other studies in this period confirmed that at the family level, the benefits of practicing contraception were minimal (Demeny 1975; Barkat-e-Khuda 1978; Arthur & McNicoll 1978; Cain 1981; Cain 1983). Analysing the trends in contraceptive use between 1969 and 1983, Amin et al. (1987) found that there was a steady rise in the use of contraceptive methods and this increase occurred among all women of all subgroups, irrespective of place of residence, education, and parity of women. However, women of high parity, and with a higher level of education and those living in urban areas had a higher likelihood of using contraceptives (Amin et al. 1987).

The debate over Bangladesh fertility intensified with the publication of some studies (Carty et al. 1993; Cleland et al. 1994) which attributed the entire decline in fertility to "increased use of contraceptives."

Cleland et al. (1994) concluded that "We have found that it is unnecessary and indeed implausible to invoke economic change and shifts in the utility of the children as the central determinant." Carty et al. (1993) concluded that no change was needed in the levels of economic development, urbanization, employment of women, and education for a family planning method to succeed. They inferred that a key lesson was the critical importance of sustained political commitment to an effective family planning program which was adopted and pursued at the highest levels of government (as stated in Caldwell et al. 1999). Caldwell et al. (1999) concluded that Bangladesh had undergone a great transformation through urbanization (6 percent in 1965 to 20 percent in 1997), improvement in Human Development Index (HDI) (about 45.5 percent rise between 1960 and 1980), a massive increase in girls attending primary and high school (between 1973 and 1986, 70 and 60 percent, respectively) and improvement in many other indicators like the number of villages with electricity, the number of doctors and nurses etc. (Caldwell et al. 1999). This study strongly refuted the notion that the family planning program was alone responsible for fertility decline although it may have had some impact on the timing of the onset of fertility decline and in the pace of decline.

Some other studies too, since the late nineties claimed that the faster decline of fertility in Bangladesh is the result of a combination of socio-economic changes, with substantial input of family planning programs. A qualitative study by Caldwell and Barkat-e-Khuda (2000) suggested that not just family planning programs have played an essential role in reducing the family size, but the economic and social changes and growing aspirations have influenced the couples to be more receptive to the idea of family planning. More recent studies also documented that fertility reduction in Bangladesh was the result of women's education, employment status, mass media access, urbanization and program efforts on family planning (R. Amin et al. 1995; Amin et al. 1996; Barkat-e-Khuda & Hossain 1996; Barkat-e-Khuda et al. 2000; Barkat-e-Khuda et al. 2018; Hahn et al. 2018). Some studies found that schooling had a large and statistically significant effect on traditional and modern reversible contraceptive use (Cleland et al. 1996; Hoque & Murdock 1997). Participation in income-generating projects or access to credit programs by poor rural women had been associated with their increased level of contraceptive use, decreased level of fertility and an increasing desire for no more children (S. Amin et al. 1995; Schuler et al. 1997). Education of women is always found to be a significant determinant of contraceptive use: modern and traditional teenage girls who had no education were found to have 2.76 times higher odds of adolescent motherhood than their counterparts who had higher than secondary education (Islam et al. 2017). Women's education has been found as a significant predictor (positive) of using contraceptive among employed and unemployed women in Bangladesh (Islam et al. 2016). A specific feature of Bangladesh is also the long series of data for the in-depth studies in the Matlab project. Sinha (2005) found that women exposed to intensive family planning programs in the Matlab area have 14 percent lifetime fertility reduction. This study concludes that family planning programs were highly successful in reducing fertility. Using data from the 1991 Contraceptive Prevalence Survey of 11,065 women, a study found that the most significant determinant of use modern contraceptive methods in a rural area was a visit by a Family Welfare Assistant (FWA) within the past three months. After the FWA visit, odds of use for rural women increased eight times, and odds of use for urban women increased 2.6 times (Kamal & Sloggett 1996). A study based on 141 villages in Matlab, Bangladesh from 1974 to 1996, confirmed a decline in fertility of about 15 percent in the program villages (receiving door-to-door outreach family planning and maternal-child health program) compared with the control villages (Schultz 2009).

Some qualitative studies, however, concluded that family planning programs were not successful. An in-depth study with interviews 104 women and 92 men (including 85 couples) as part of an ethnographic study in rural Bangladesh suggested that this strategy, despite its success in increasing contraceptive prevalence, often failed to provide adequate information and support to contraceptive users (Schuler et al. 1995). Interestingly,

a more recent study assessing the achievements and gaps of the Bangladesh Family Planning Program concluded that the program in Bangladesh achieved commendable success until the mid-1990s and then it slowed down resulting in a stalling or near stagnation in fertility in recent years (Barkat-e-Khuda & Barkat 2010). It inferred that there had been an erosion in political will and commitment of governments after the mid-1990s leading stalling fertility together with a high level of adolescent fertility and sharp differentials in fertility by socio-economic characteristics of women.

For the most recent years some authors have claimed that Bangladesh experienced two episodes of fertility stall in 1996-2000 and in 2011-2014. While the first stall occurred at a level of 3.3 births per woman, the second stall occurred at 2.3 births per woman (Barkat-e-Khuda & Barkat 2010; Rahman 2018). Rahman argues that deteriorating family planning services were strongly associated with the stall of fertility in both periods. In addition, a decline in female labour force participation was closely associated with fertility stall in the first period whereas not having any education, living in a rural area and being Muslim were found to be factors in the second stall (Rahman 2018).

This review of the literature on the drivers of fertility trends in Bangladesh clearly shows that this has been a highly controversial issue for the past decades and no consensus seems to be on the horizon. In this paper we thus try to revisit the issues with the broadest possible set of data available for the country through merging seven rounds of the nationally representative Bangladesh Demographic Health Survey (BDHS) through pooling of birth histories.

Trends arising from pooled BDHS Data

We used seven rounds of BDHS data conducted in 1993-94, 1996-97, 1999-2000, 2004, 2007, 2011, and 2014. BDHS is a nationally representative survey conducted under the authority of the National Institute for Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare, Government of Bangladesh and implemented by Mitra and Associates of Dhaka. The BDHS is part of the worldwide Demographic and Health Surveys (DHS) program, which is designed to collect data on fertility, family planning, and maternal and child health. We present the sample coverage of different rounds of BDHS in Table 1.

The details of sample design and survey methodology can be found in the respective reports of BDHS and Individual-level data are available from the Demographic Health Survey (DHS) data repository and can be accessed upon request.

Table 1. Sample coverage of BDHS in 1993-2014, Bangladesh

Survey year	Ever married women	Currently married men	Coverage of sample cluster	Field work
1993-94	9,640 (age 10-49)	3,284	301	November 1993-March 1994
1996-97	9,127 (age 10-49)	3,346 (age 15-59)	313	November 1996-March 1997
1999-2000	10,544 (age 10-49)	2,556 (age 15-59)	341 (urban-99, rural-242)	November 1999-March 2000
2004	11,440 (age 10-49)	4,297 (age 15-54)	361 (urban-122, rural-239)	January-May 2004
2007	10,996 (age 15-49)	3,771 (age 15-54)	361 (urban-134, rural-227)	March-August 2007
2011	17,842 (age 12-49)	3,997 (age 15-54)	600 (urban-207, rural-393)	July-December 2011
2014	17,863 (age 15-49)	NA	600 (urban-169, rural-431)	June-November 2014

Fertility trends are reconstructed by pooling birth histories from the successive surveys. We distinguish between women with four levels of educational attainment: no education, primary, secondary and higher education as defined by BDHS. To deal with apparent inconsistencies between fertility rates for the same cohorts as derived from different rounds of BDHS we apply adjustment procedures as discussed by Schoumaker (2014). As DHSs are the representative sample surveys, the information collected at different points in time for the same cohorts of women is not necessarily exactly the same. Figure 3 shows the cohort fertility rates for Bangladesh for the example of women without any formal education as derived from different rounds of surveys. It shows that, particularly for the earlier cohorts, one gets different figures of cohort fertility rates for the same cohorts but interviewed at different time. This discrepancy is stronger for the low education groups, possibly because of the so-called 'recall-bias'. Thus, reconstructing fertility trends by merely pooling the birth histories from different surveys would be not meaningful.

We have estimated age-specific fertility rates (ASFR) for single year age of women for the same cohorts. For that, a weighted average of the different surveys was used. First, for each survey, birth events, and exposures were computed by single years of age, birth year, and education category of women. Second, the weighted average of events and exposures of different surveys were computed for each age, birth cohort, and education category of women. Third, the age and education specific averaged events and exposures were smoothed using *spline* functions across ages and birth cohorts. Finally, the age and education specific cohort age-specific fertility rates were computed from the smoothed weighted average of events and exposures.

Figure 3. Cumulative total fertility rates by survey year and five-year birth cohorts for women with no formal education

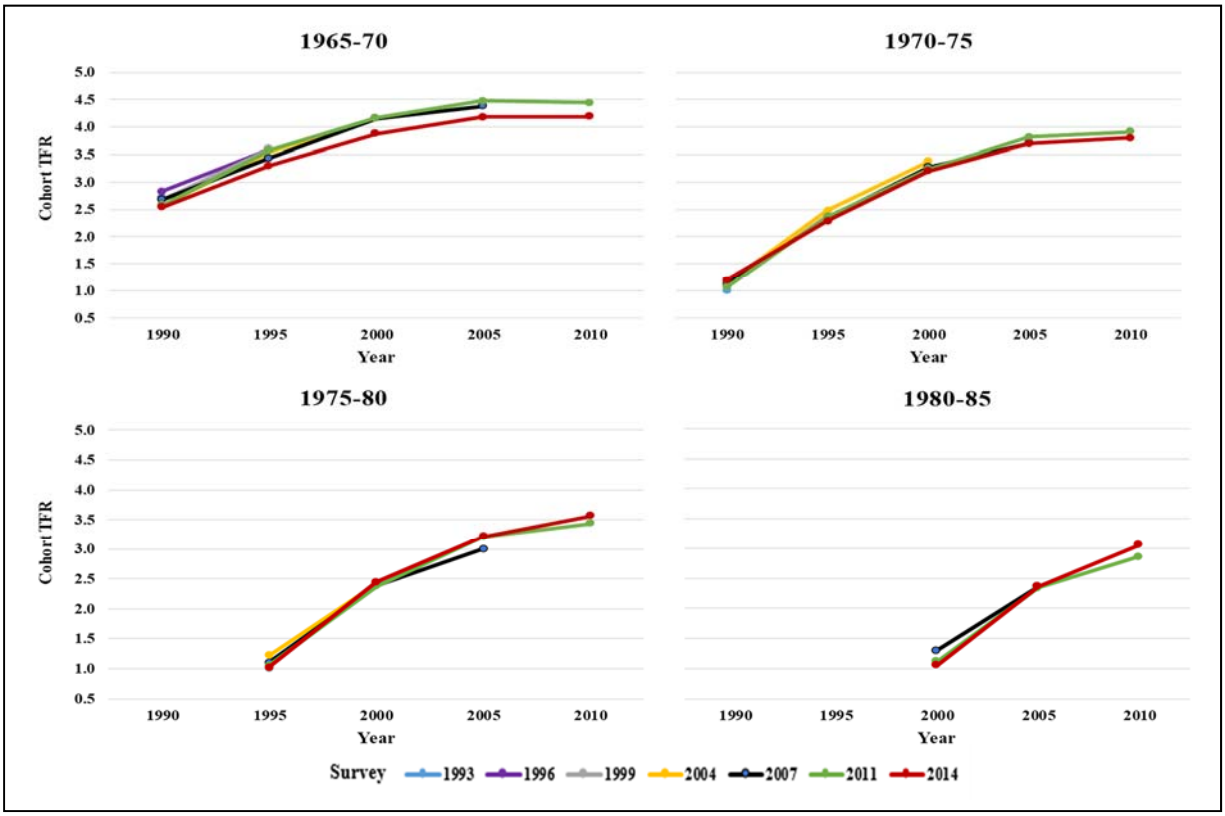
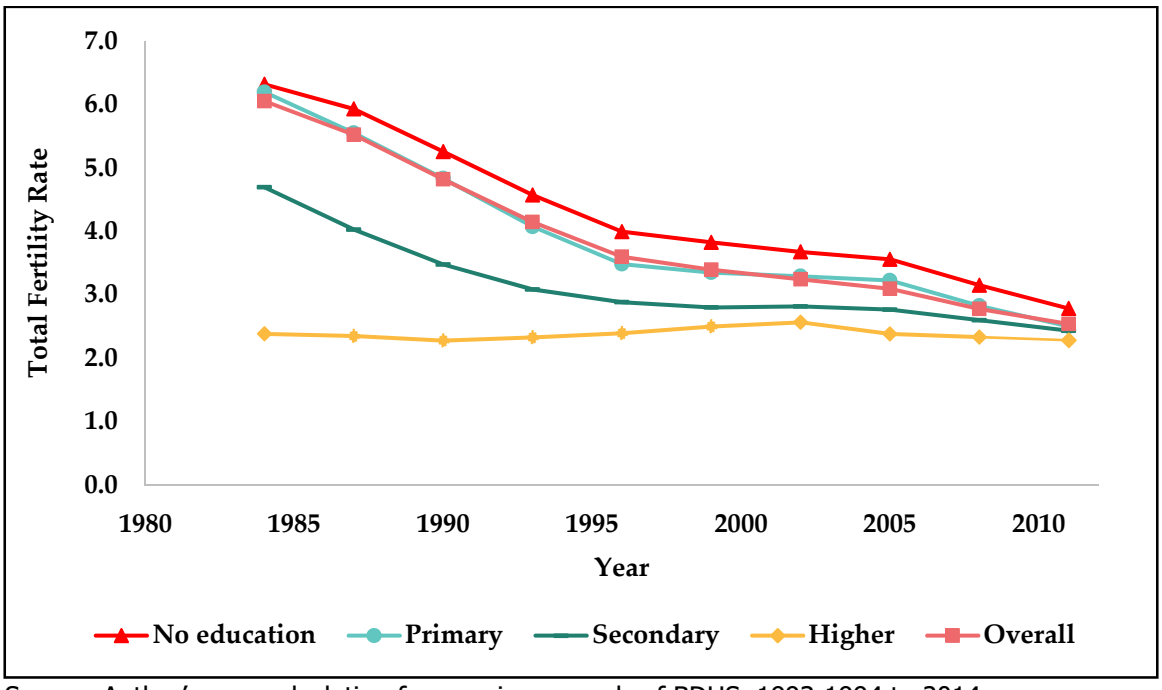


Figure 4 presents the reconstructed period-TFRs for Bangladesh for the period 1984-2011 based on successive DHSs. Figure 4 reveals that after an initial sharp decline in TFR from 1987 to the mid-1990s, Bangladesh experienced some stall in the TFR between 1996 to 2004. After that, fertility continued to decline up to 2011. The reconstructed TFR trend does not exhibit the above mentioned second fertility stall in 2011-2014.

The trends in TFR by educational attainment of women show a striking pattern (Figure 4). The TFRs for women with secondary and higher education are substantially lower than that of women with no or primary education with an indication of convergence in the most recent period. While women with no or primary education experienced a similar pattern of fertility decline or stalled to that of all women over time, women with secondary or higher education passed through a different trajectory. Women with secondary education experienced fertility decline from TFR 4.7 in 1984 to 3.1 in 1993 and then experienced a stall for an extended period in between 1996-2005. The TFR for women with higher education was almost constant from 2. 4 in 1984 to 2.3 in 2011.

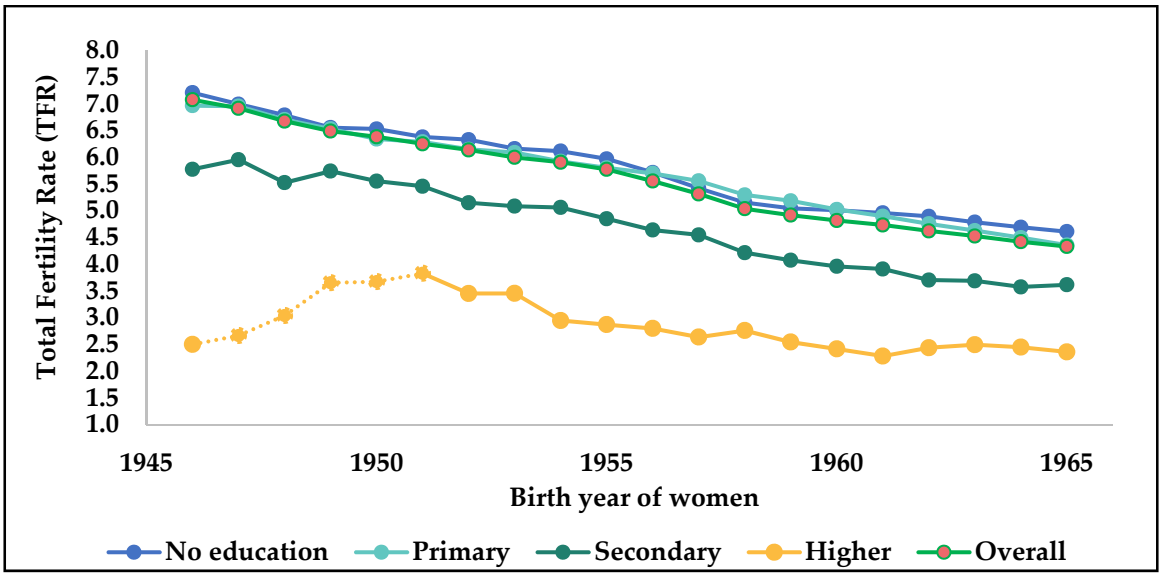
Figure 5 presents the TFR by birth cohorts and level of education of women. Aside from the very small group of women with higher education born before 1955, there is a continuous decline in the overall TFR for each consecutive birth cohort at each level of education. This is a remarkably consistent picture which also does not show stalls in TFRs. The figure also clearly shows the different levels of fertility by level of education. While the trends for women with no education and primary education as well as the national average are very similar, the difference to women with secondary education is roughly one child and is surprisingly constant over time. Women having higher levels of education have the lowest fertility rates, although the due to small numbers that trends have to be interpreted with caution.

Figure 4. Period total fertility rates (three years moving average) by women's level of education, Bangladesh, 1984-2011



Source: Author's own calculation from various rounds of BDHS, 1993-1994 to 2014

Figure 5. Total fertility rate by birth cohort (three years moving average) and women's level of education (aged 15-49), Bangladesh



Source: Author's own calculation from various rounds of Bangladesh Demographic and Health Surveys, 1993-1994 to 2014

Note: Dotted lines indicate small number of cases.

To put the above described trends in education-specific fertility into context, Figure 6 shows the trends in educational attainment for women by age 5-year age groups for the period 1993-2014. Figure 6 reveals that there was a sharp increase in the proportion of women with secondary education for the age groups 15-34 since the mid-1990s, whereas the percentage of women with primary education either remains stagnant or reduced. At the same time there is a sharp decline in the percentage of women with no education. The percent share of women with higher education increases from 0 to about 10 percent for women in the age groups 15-34.

Trends in indicators of family planning programs

Figure 7 shows the trends in percent of women using contraception aged 15-49 by level of education. As expected, the percentage of women using contraception is lower among women without any education than women with some education (women with no education: 44.8 percent vs. Women with higher education: 53.3 percent). Over time, all education groups show in increasing trend in the use of modern contraceptives with the most recent years showing a stagnation among uneducated women. The use of traditional methods is roughly constant over time with a temporary increase around 2000-05. It is interesting to note that women with the highest level of education also have the highest level of use of traditional methods, although declining over time. But they also have the highest use of modern contraception which implies that they generally have a higher desire to avoid pregnancies by using any method. As indicated by some analysis of DHS data for other countries on obstacles to meeting the unmet need for contraception, this could also be explained by a higher fear of side effects by more educated women who do want to contracept but have more access to information about possible side effects (Lutz 2014).

Figure 6. The trend in women's level of education by 5-year age group in 1993-2014, BDHS, Bangladesh

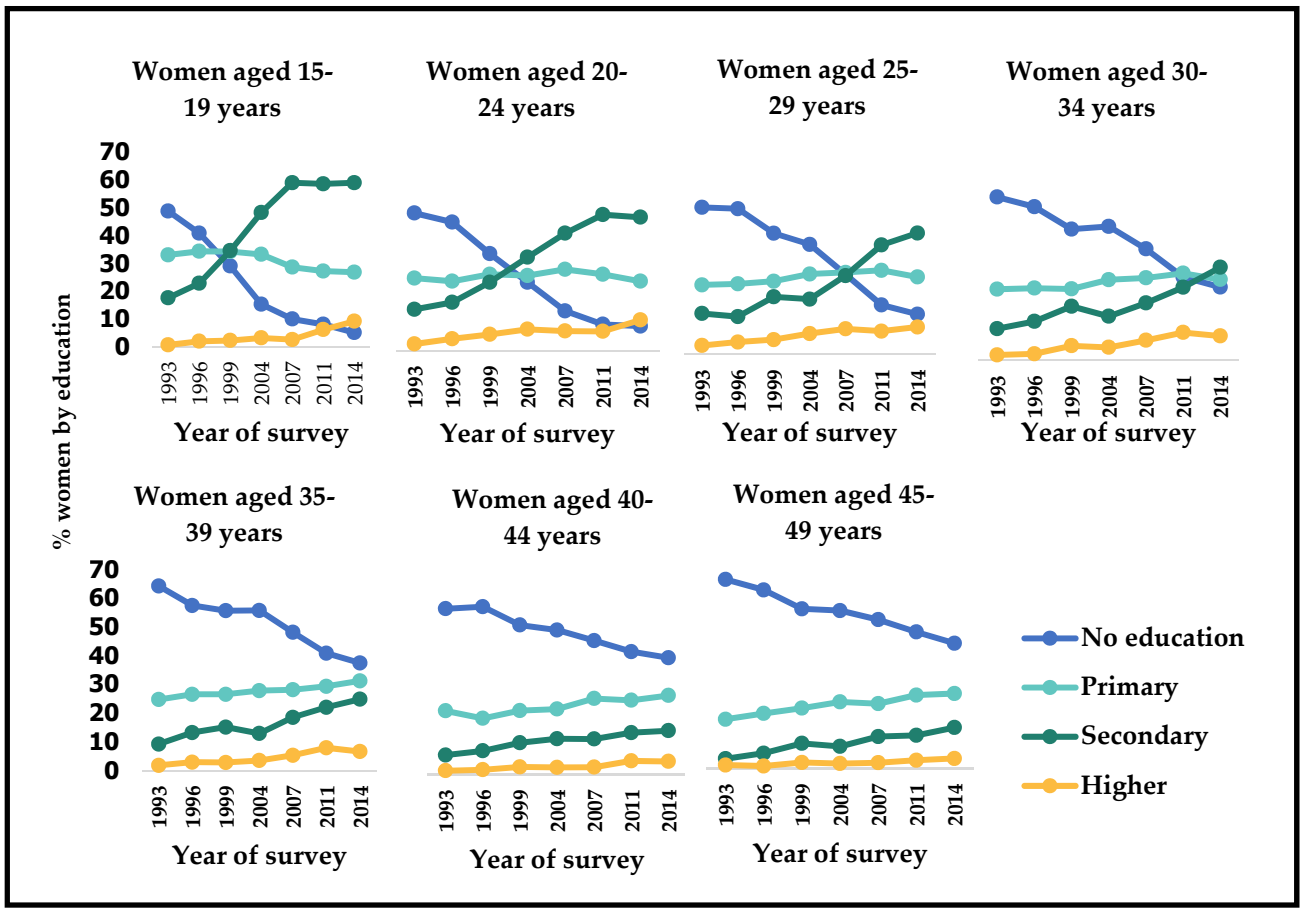
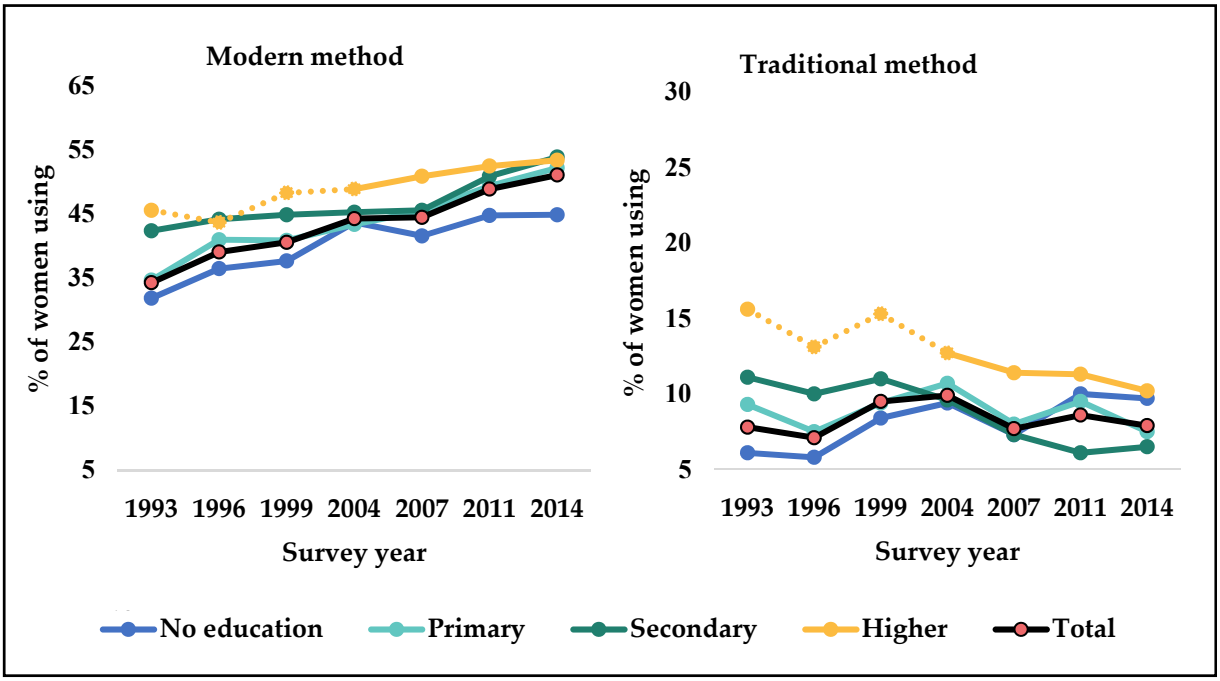


Figure 7. The trends in contraceptive use (modern and traditional method) by women's (aged 15-49) by the level of education, Bangladesh



Note: Dotted lines indicate small number of cases.

Figure 8 presents the trends in women visited by the FPFW in the last six months by women's level of education. In 1993, the FPFW visited 40.4 percent of the total women in the reproductive age. The percentage of women visited by FPFW is higher among secondary and above-educated women (47.9 percent) compared to the corresponding percentage among women without education (36.1 percent). Overall, the percentage of women visited by FPFWs has declined sharply from 40.4 percent in 1993 to 19.7 percent in 1999 and remained within a range of 19.6 percent to 13.7 percent in the following years. In all DHS rounds, women without education have lesser accessed to FPFWs than educated women, although the gap between these two groups is not substantial.

Figure 9 presents the trends in percent of women who received family planning support at a satellite clinic in the local area during the last three months before to the survey. Only a small percentage of women has received such services at satellite clinics according to DHS data.

Figure 8. Trends in women aged 15-49 visited by family planning field worker (FPFW) in last six months by women's level of education

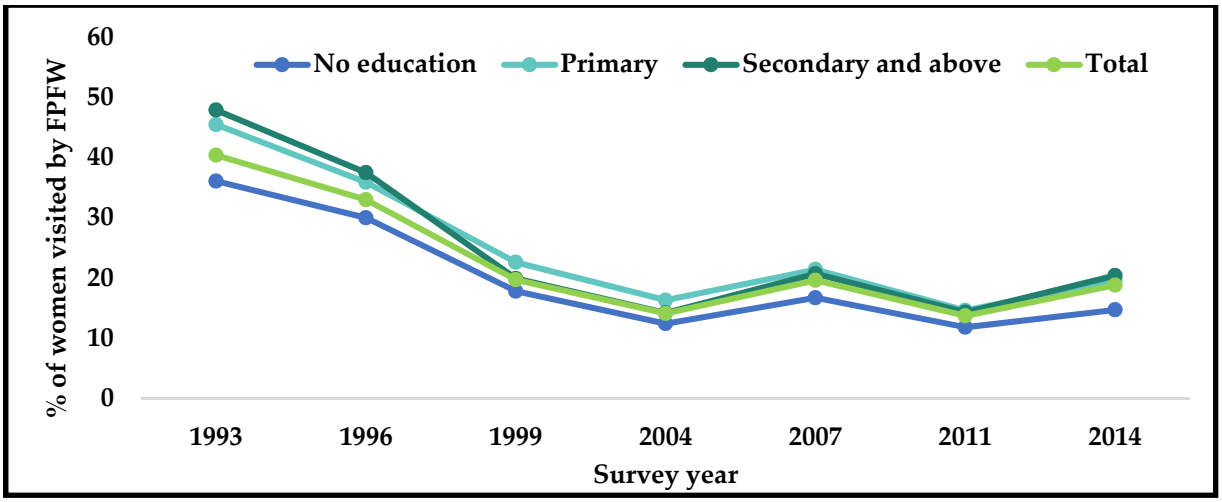


Figure 9. Percent of women aged 15-49 who received family planning support at satellite clinic in the local area during last 3 months prior to the survey, Bangladesh, 1993-2014

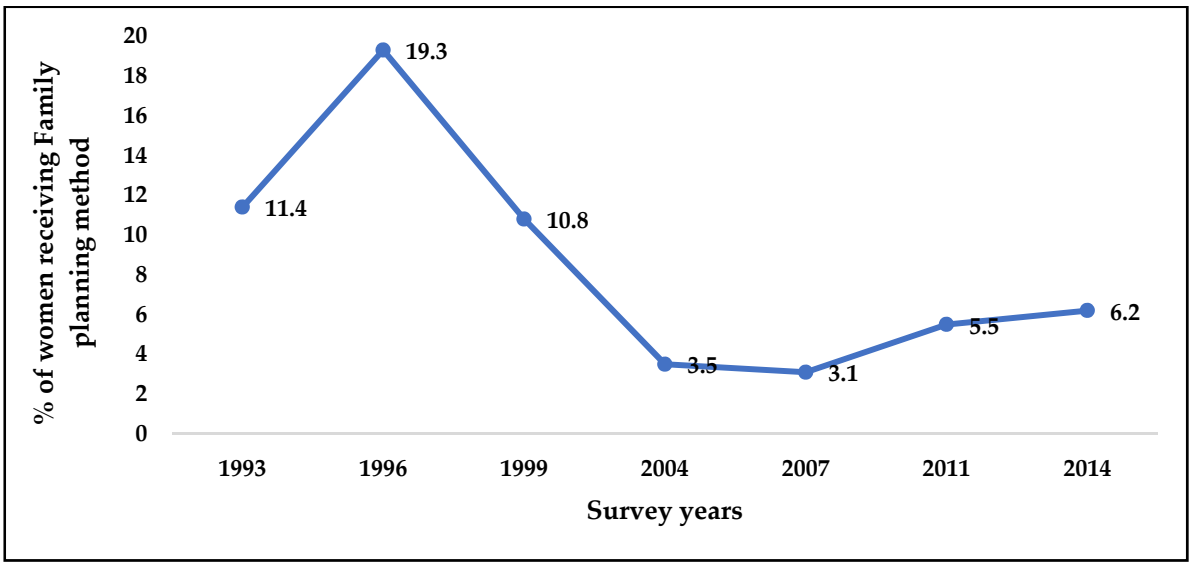
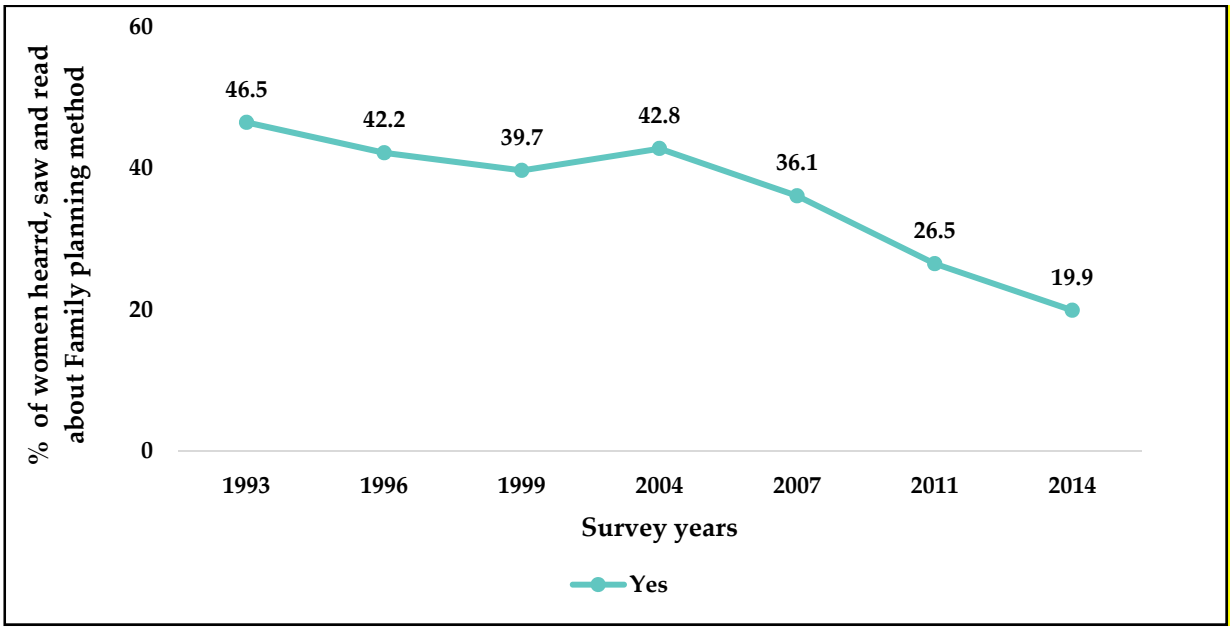


Figure 10. Percent of women aged 15-49 exposed to (heard, saw and read) family planning messages on mass media in one month before to the survey, Bangladesh, 1993-2014



We also investigated the possible role of media on the awareness of family planning programs among women in Bangladesh. Figure 10 presents the trends in the percent of women reporting to having seen a message on family planning programs in mass media. The exposure to media on family planning program was assessed by asking respondents in the last month have you heard about family planning: a) on the radio, b) on the television, c) in a newspaper or magazine, d) from a poster, billboard or leaflet. In our analysis media impact is considered if women heard, read or seen about family planning program message on radio, TV, newspapers/ magazine, poster, brochures or billboard in last month. During 1993-2004, more than 40 percent percent of women were exposed to family planning messages in mass media; it reduced to 19.9 percent by 2014.

Multi-level analysis

The above described trends of convergence in the fertility levels of different education groups – at least for the recent period TFRs – together with a general decline in the indicators of family planning efforts and utilization of services looks somewhat puzzling at first sight. What were the forces bringing down fertility and increasing contraceptive prevalence in the low education groups under weakening family planning efforts and services? The most plausible explanation of such a trend is the assumption of strong diffusion processes of the lower family size ideals and the use of contraception from more educated to less educated women. Since such diffusion processes tend to happen at the local and community levels a natural way of studying the process seems to be that application of statistical multi-level models that consider education and family planning indicators both at the individual and at the community level. In the following we will apply such models that also control for household wealth, religion, urban/rural place of residence and region to all the different DHS rounds as well as a merged data set of all seven rounds together.

Once the model and the independent variables have been determined, an open issue was the choice of the fertility indicators that should be used as dependent variable. There are two competing objectives. Since we

primarily want to understand the quantum of fertility and not capture the influence of changes in the timing of fertility this would suggest completed cohort fertility as the indicator of choice. On the other hand, if we look at children ever born to women above age 45 who are many years beyond the child bearing ages we would primarily capture the fertility behaviour of women many years before the time of the survey and because of the fact that DHS surveys only interview women up to age 50 this would have left us with a rather small number of cases in the age group 45-49. As a compromise between these two competing objectives we decide to focus on children ever born to women aged 35-49 as the dependent variable of this study. We also include the age group of the woman as a further control variable in the model in order to capture the additional birth after age 35 and possibly inter-cohort changes. As sensitivity analysis we also ran the model for all women aged 20-49.

Following the above literature review and reflecting the availability of information in our data, we selected the independent variables at two levels: the individual level and the community level. The individual level predictors are age of the women in years (20-24, 25-29, 30-34, 35-39, 40-44, 44-49), women's level of education (no, primary, secondary and higher education), religion (Islam, others), place of residence (urban, rural), wealth index (poorest, poorer, middle, richer, richest), family planning field worker (FPFW) visited respondent house in the last six months (no, yes) and division of residence (Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet). The community level predictors are the women's mean years of schooling in the community (sample cluster) and the proportion of women visited by health workers in each community. The community-level variables were generated by aggregating the individual women's responses within their clusters. The aggregates for clusters were computed using the mean of the proportions of women in each category of a given variable.

To measure the performance of family planning programs in the study period, we considered four possible indicators 1) Trends in the percentage of women using contraceptives (modern and traditional method) 2) Trends in the percentage of women visited by FPFW in last six months 3) Trends in the percentage of women receiving family planning support at satellite clinic in the local area during the last 3 months prior to the survey and 4) Trends in the percentage of women exposed to family planning methods through media. After sensitivity analysis with all four possible family planning indicators and because of theoretical considerations we chose the one measuring the visits by family planning workers over the last six months because it seemed to measure the family planning efforts most directly.

Bivariate and multilevel analyses were used in this study. At the bivariate level, cross-tabulation was done to see the percentage distribution of women characteristics by different rounds of BDHS survey. At the multilevel analysis, a three-level mixed-effects linear regression modelling was performed to examine the association between fertility outcome and selected predictors. Mixed-effects models are characterized as containing both fixed effects and random effects, which are essential in multilevel analyses, were employed to interpret the results.

DHS data are hierarchical, i.e., women are at the individual level (i), nested within clusters (j), nested within divisions (k) that allows doing the multilevel model. A three-level mixed-effects model can be written as:

$$y_{ijk} = \beta_0 + \sum_{p=1}^{p} \beta_p \, x_{pijk} + u_{0k} + v_{0jk} + e_{ijk}$$

where,

The outcome y_{ijk} is the number of children ever-born for ith women of jth community from kth division x_{pijk} is the pth independent variable at individual (level-1), community (level-2) and divisional (level-3) level and β_p is the corresponding regression coefficient

u_{0k} is the random divisional effect assumed to be normal distribution with N (0,σ_u^2)
v_{0jk} is the random community effect assumed to be normal distribution with N (0,σ_v^2)
e_{ijk} is the random errors assumed to be normal with N (0,σ_e^2) and independent of the random effects at both level 2 and 3.

Table 2 presents the sample description for the pooled BDHS by the socio-economic characteristics of the women. Over the study period, the mean number of children ever born by age 35 declined from 5.9 in 1993-1994 to 3.7 in 2014. The percentage of women without education declined by 23.8 percentage points (65.3 percent in 1993-1994 to 41.5 percent in 2014). The percentage of women with secondary education or above increased from 9.9 percent to 27.2 percent. In all rounds, more than 85 percent of women belong to Islam religion. The percentage of women living in an urban area increased substantially (16.0 percent to 35.3 percent). The mean years of schooling at the community level increased, whereas the proportion of women visited by FPFWs at community level either declined or remained stagnant.
Tables 3 and 4 present the multilevel regression output. We carried out four stepwise models for each Table 3 and Table 4. In model 1 we show the regression coefficients of all individual-level variables without controlling for the wealth index and the community level variables. Model 2 presents the regression coefficients of all individual-level characteristics, including the wealth index but without controlling the role of community-level variables. Model 3 presents the regression coefficients for the community-level variables without adjusting for the role of any of the individual level variables except age of the woman, model 4 presents regression coefficients for all the selected variables of individual and community level variables. In model 4, we replaced the individual level variable "women visited by FPFWs in the last six months" by the community level variable "proportion of women FPFWs visited in the community", to control for possible reverse causation between FPFWs visit and total number of children at individual level, accounting for the possibility that FPFWs visit women with more births for maternal health reasons.
Model 1 in Table 3 shows that the variation in children ever born at the women's level (variance= 3.797) is much higher than that at the community level (variance= 0.576) and the divisional level (variance=0.278). The intraclass correlation coefficient shows that about 18 percent of the variations in children ever born are due to the community level clustering of women, adjusted for individual-level characteristics except for wealth index. Compared to women with no education, women with secondary (β= -0.89, SE: 0.04, p<0.001) or higher (β= -1.72, SE: 0.06, p<0.001) education have a lower likelihood of higher children ever born. Women belonging to other religions have a lower likelihood of having more children (β= -0.73, SE: 0.04, p<0.001). Interestingly, women visited by FPFW have a higher likelihood of having more children ever born than women who have not visited by FPFW (β=0.50, SE: 0.03, p<0.001). This significant positive effect may be an indication that the visits of FPFWs indeed may be more associated with pregnancies and maternal health rather than with efforts to prevent births. As expected, rural women (β=0.52, SE: 0.04, p<0.001) have a higher likelihood of having more children than urban women, even after controlling for all the other variables. The same patterns hold after controlling the role of wealth index in model 2. Women belonging to richest wealth index household have a lower likelihood of having more children than the women belonging to the poorest wealth index household. In model 3 which only includes the community level determinants, mean years of schooling is also significantly inversely (β= -0.33, SE: 0.03, p<0.001) associated with children ever born while the proportion of women visited by FPFWs is not statistically significant.
In the final model 4, which includes all individual level and community level variables, education comes out with a consistent negatively significant effect whereas the family planning indicator at the community level is insignificant, even though we had deleted this variable from list if individual level characteristics to possibly

strengthen its estimated effect at the community level. But, no matter how we modified the model in terms of including and excluding different variables the education variables always turned out significantly negative at both individual and community level whereas indicators of family planning efforts remained statistically insignificant. Given the very large number of cases (about 29000 observations) this is a rather robust finding.

Table 2. Sample description of women aged 35 years or more for the regression analysis of BDHS 1993-94, 2004, 2014, and pooled data for 1993-2014, Bangladesh

Indicators	BDHS round						Pooled from 1993-2014 (all seven BDHS rounds)	
	1993-94		2004		2014			
	N	%	N	%	N	%	N	%
Individual level characteristics								
Mean (SD) child ever born	5.9 (2.6)		4.7 (2.3)		3.7 (1.8)		4.4 (2.3)	
Age of the women (in years)								
35-39	1,197	44.2	1,480	39.6	2,340	37.0	11,394	39.4
40-44	870	32.1	1,185	31.7	2,170	34.3	9,610	33.2
45-49	644	23.7	1,075	27.7	1,814	28.7	7,939	27.4
Women's level of education								
No education	1,770	65.3	2,022	54.1	2,625	41.5	14,610	50.5
Primary	673	24.8	1,036	27.7	1,983	31.4	8,196	28.3
Secondary	222	8.2	543	14.5	1,314	20.8	4,760	16.4
Higher	46	1.7	139	3.7	402	6.4	1,376	4.8
Religion								
Islam	2,329	85.9	3,260	87.2	5,636	89.1	25,304	87.4
Others	382	14.1	480	12.8	688	10.9	3,639	12.6
Place of residence								
Urban	434	16.0	1,304	34.9	2,233	35.3	9,169	31.7
Rural	2,277	84.0	2,436	65.1	4,091	64.7	19,774	68.3
Women visited by family planning worker (FPFW) in past 6 months								
Not visited by FPFW	1,815	67.2	3,345	89.4	5,409	85.5	24,332	84.2
Visited by FPFW in last 6 months	885	32.8	395	10.6	915	14.5	4,582	15.8
Wealth index								
Poorest	514	19.0	609	16.3	1,046	16.5	4,769	16.5
Poorer	516	19.0	647	17.3	1,253	19.8	5,387	18.6
Middle	549	20.3	701	18.7	1,287	20.4	5,641	19.5
Richer	564	20.8	774	20.7	1,270	20.1	5,885	20.3
Richest	568	21.0	1,009	27.0	1,468	23.2	7,261	25.1
Community level characteristics								
Mean years of schooling at community level	3.7		4.3		4.2		4.1	
Proportion of women visited by the FPFWs in the community	0.24		0.20		0.20		0.21	
Total	**2,711**	**100.0**	**3,740**	**100.0**	**6,324**	**100.0**	**28,943**	**100.0**

Table 3. Multilevel regression output of children ever born (women age 35 years or more) with associated predictors from pooled data, all rounds of BDHS, 1993-2014, Bangladesh

Indicators	Pooled data			
	Model1	Model2	Model3	Model4
Fixed effect parameters				
Individual level characteristics				
Age of the women (in years)				
35-39 ®				
40-44	0.59***(0.03)	0.60***(0.03)	0.62***(0.03)	0.57***(0.03)
45-49	1.16***(0.03)	1.17***(0.03)	1.21***(0.03)	1.12***(0.03)
Women's level of education				
No education ®				
Primary	-0.17***(0.03)	-0.13***(0.03)		-0.11***(0.03)
Secondary	-0.89***(0.04)	-0.79***(0.04)		-0.75***(0.04)
Higher	-1.72***(0.06)	-1.58***(0.06)		-1.54***(0.06)
Religion				
Islam ®				
Others	-0.73***(0.04)	-0.74***(0.04)		-0.74***(0.04)
Place of residence				
Urban ®				
Rural	0.52***(0.04)	0.43***(0.04)		0.42***(0.04)
Women visited by family planning worker (FPFW) in past 6 months				
Not visited FPFW ®				
Visited FPFW in last 6 months	0.50***(0.03)	0.50***(0.03)		
Wealth index				
Poorest ®				
Poorer		0.07*(0.04)		0.08**(0.04)
Middle		0.03(0.04)		0.05(0.04)
Richer		-0.04(0.04)		-0.01(0.04)
Richest		-0.23***(0.05)		-0.21***(0.05)
Community level characteristics				
Mean years of schooling at community level			-0.33***(0.03)	-0.17***(0.02)
Proportion of FPFW visited in the community			0.18(0.33)	0.31(0.30)
Intercept	3.88***(0.20)	3.95***(0.21)	5.24***(0.24)	4.67***(0.23)
Random effect parameters				
Divisional level variance	0.278(0.151)	0.289(0.157)	0.256(0.141)	0.265(0.144)
Community level variance	0.576(0.029)	0.581(0.029)	0.796(0.372)	0.580(0.029)
Variance of residual	3.797(0.032)	3.789(0.032)	4.037(0.034)	3.811(0.032)
Residual intra-class correlation coefficient at divisional level	0.059(0.030)	0.062(0.031)	0.050(0.026)	0.056(0.029)
Residual intra-class correlation coefficient at community level	0.183(0.027)	0.186(0.028)	0.206(0.022)	0.181(0.025)
Observations	28,943	28,943	28,943	28,943
Number of divisional groups	7	7	7	7
Number of community groups	1692	1692	1692	1692
Log likelihood	-61359.94	-61334.59	-62465.73	-61476.53
Model fit statistics AIC	122743.9	122701.2	124947.5	122987.1

Note: a) Standard errors in parentheses b) *** p<0.01, ** p<0.05, * p<0.1 c) ® reference category d) AIC-Akaike's information criterion

Table 4. Multilevel regression output of children ever born (women age 20-49 years) with associated predictors from pooled data, all rounds of BDHS, 1993-2014, Bangladesh

Indicators	Pooled data			
	Model1	Model2	Model3	Model4
Fixed effect parameters				
Individual level characteristics				
Age of the women (in years)				
20-24 ®				
25-29	0.88***(0.02)	0.89***(0.02)	0.94***(0.02)	0.90***(0.02)
30-34	1.67***(0.02)	1.69***(0.02)	1.79***(0.02)	1.70***(0.02)
35-39	2.29***(0.02)	2.32***(0.02)	2.46***(0.02)	2.32***(0.02)
40-44	2.87***(0.02)	2.91***(0.02)	3.07***(0.02)	2.89***(0.02)
45-49	3.42***(0.02)	3.47***(0.02)	3.65***(0.02)	3.44***(0.02)
Women's level of education				
No education ®				
Primary	-0.20***(0.01)	-0.15***(0.02)		-0.13***(0.02)
Secondary	-0.70***(0.02)	-0.58***(0.02)		-0.56***(0.02)
Higher	-1.38***(0.03)	-1.20***(0.03)		-1.19***(0.03)
Religion				
Islam ®				
Others	-0.48***(0.02)	-0.49***(0.02)		-0.48***(0.02)
Place of residence				
Urban ®				
Rural	0.36***(0.02)	0.25***(0.02)		0.25***(0.02)
Women visited by family planning worker (FPFW) in past 6 months				
Not visited FPFW ®				
Visited FPFW in last 6 months	0.34***(0.01)	0.34***(0.01)		
Wealth index				
Poorest ®				
Poorer		-0.02(0.02)		-0.01(0.02)
Middle		-0.08***(0.02)		-0.07***(0.02)
Richer		-0.17***(0.02)		-0.16***(0.02)
Richest		-0.35***(0.02)		-0.35***(0.02)
Community level characteristics				
Mean years of schooling at community level			-0.23***(0.02)	-0.10***(0.01)
Proportion of FPFW visited in the community			0.01(0.21)	0.14(0.17)
Intercept	1.68***(0.13)	1.81***(0.13)	2.43***(0.15)	2.24***(0.14)
Random effect parameters				
Divisional level variance	0.107(0.058)	0.118(0.064)	0.105(0.057)	0.107(0.058)
Community level variance	0.196(0.009)	0.198(0.009)	0.344(0.014)	0.202(0.009)
Variance of residual	2.455(0.012)	2.445(0.012)	2.612(0.013)	2.460(0.012)
Residual intra-class correlation coefficient at divisional level	0.039(0.020)	0.042(0.022)	0.034(0.018)	0.038(0.020)
Residual intra-class correlation coefficient at community level	0.110(0.019)	0.114(0.020)	0.146(0.016)	0.111(0.018)
Observation	75,916	75,916	75,916	75,916
Number of divisional groups	7	7	7	7
Number of community groups	1693	1693	1693	1693
Log likelihood	-142894.4	-142752.7	-145773	-143162.4
Model fit statistics AIC	285818.9	285543.5	291568.1	286364.8

Note: a) Standard errors in parentheses b) *** p<0.01, ** p<0.05, * p<0.1 c) ® reference category d) AIC-Akaike's information criterion

A very similar pattern of results was observed in the case of applying the models to all women aged 20-49 for the pooled data present in Table 4. The effects of age on children ever born is – as it should be – very regular and highly significant with children ever born increasing with age. Education, again, is highly significant and equally regular at the individual level with a more modest change in effect from no to primary education and stronger negative effects on fertility for secondary and higher education. The effect of mean years of schooling of women at the community level is also significantly negative on top of the individual level effects. This points at a significant role of diffusion effects that further depress fertility even of women with low education in an environment of better educated women. The effects of the family planning indicators remain strangely positive at the individual level (Model 1 and 2) and insignificant at the community level (Models 3 and 4).

To further examine the sensitivity of these findings to changes over time, we carried out the entire regression analysis described above to all individual rounds of BDHS. We found that results are very similar with only some minor changes between the different survey rounds. In all cases individual level education turned out to be highly significant in the expected directions. Individual level FPFW visits also all have positive coefficients. The only interesting changes between the different rounds can be seen for the community level results. Here in the very first survey 1993/4 for women above age 35 the community level average education is not significant – presumably because at this time almost all women had very low education and there were not so marked differences between clusters – and the proportion of women in the cluster that received FPFW visits is significantly negative. This could point at the possibility that in this early phase of fertility decline, when the average TFR was still around five and a rather high proportion of women (over 30 percent) reported FPFW visits the different level of attention in terms of FPFW visits that different clusters received was indeed associated with lower fertility. But for later rounds of BDHS as well as for the models applied to all women aged 20-49 in 1993/4 this special pattern disappears, and the results are essentially in line with the pooled results reported here.

Discussion and conclusion

As seen from the review of the literature on fertility trends in Bangladesh, the debate about the relative roles of education and family planning programs driving the fertility decline has been inconclusive so far. In this paper we tried to address the questions with the broadest possible set of available individual level data. We merged the individual data of seven rounds of Bangladesh Demographic and Health Survey data between 1993 and 2014 including more than 75000 observations for almost 1700 community groups and 7 regional divisions.

In addition to merging the individual level data of all surveys, this study also made considerable efforts to reconstruct consistent trends over time in both period and cohort fertility by level of education thus avoiding inconsistencies and adjusting for some of the known data problems in DHS birth history data. These problems include misreporting of date of birth (age heaping, displacement of recent births, Potter effect), under-reporting of birth (omission of distant or recent births), sample implementation (oversampling/undersampling), and misreporting of women's age (Schoumaker 2014). To address these issues in the data from BDHS, we reconstructed the trend in TFR using pooled birth histories from various rounds of BDHS. We followed the method proposed by Schoumaker (2014). The new TFR estimates are partly higher than those in published reports of BDHS. The reconstructed trend in TFR in this study is consistent with the trend presented by Schoumaker (2014). The reconstructed trend in TFR also shows that Bangladesh experienced a fast decline in fertility, although at varying pace. Bangladesh experienced a steep

decline in TFR between 1980 and the early 1990s, followed by a fertility stall between 1996 and 2000. The TFR again declines continuously since 2000 without any evidence of a further stall in fertility. Thus, our findings contradict some previous studies (Barkat-e-Khuda & Barkat 2010; Rahman 2018) showing a different trend in TFR estimates directly from BDHS reports of individual rounds without adjusting data across rounds. Importantly, our reconstructed and consistent cohort data show and even smoother almost linear decline in fertility from the cohorts born around 1945 to those born around 1965. Even the education-specific cohort trends are almost linear, although at different levels. There also is no sign of stalls in the cohort fertility trends.

When relating fertility to its possible determinants, the simple trend analysis on fertility, women's educational attainment, contraceptive use, and family planning indicators (women visited by FPFWs, family planning method at satellite clinics, family planning messages in mass media) shows a puzzling picture. Despite the fact that uneducated women experienced the sharpest fall in fertility, the family planning program indicators over the same period either declined or remained at an already low level. Viewed from the other side, a reduction in family planning program indicators also does not seem to lead to a corresponding stall in the fertility decline. For instance, the percentage of women visited by FPFWs was rather high (33-40 percent) in the period 1993-1996 which experienced the described stall in period fertility whereas it was much lower (13-20 percent) after 2000 when there was continued fertility decline. Similarly, a decline in media exposure on family planning since 2007 did not lead to a corresponding stagnation in fertility declines. On the other hand, there was a massive improvement in educational attainment levels of reproductive age women between 1994 and 2014. This simple descriptive analysis of temporal changes in the aggregate level of fertility and different available family planning indicators already suggests that there is no obvious association that would imply that family planning efforts could be considered a major driver of the fertility decline. In contrast, a comparison of the aggregate level trend in the educational attainment of reproductive age women and fertility suggests a strong association.

The results of the multi-level regression analysis based on over 75000 individual observations provides a much stronger and more weighty confirmation of the finding that female education is the most significant driver of fertility decline at both individual and community level and that the indicator of family planning is consistently insignificant. This finding holds across all age groups and for both the merged data set of BDHS rounds as well as individual rounds. The fact that in model 4, the mean years of schooling of women in the community has a significant additional negative effect on top of the significant negative effect of individual level education points at an important role of diffusion effects in the fertility decline. This means that women with lower education living in communities with higher average education "learn" from the more educated women in the same community or are influenced by the local environment and cultural atmosphere in that community. This effect cannot be a function of differential availability of family planning efforts in the different communities because this factor is explicitly controlled for. Over time, this diffusion effect can also contribute for the decline trend in education-specific fertility of the less educated women.

Among the other explanatory variables considered in the model, religion and urban/rural place of residence also show very consistent patterns in the sense that following non-Islam faiths and living in an urban area are both associated with significantly lower fertility. With respect to the wealth index this study can also make a relevant contribute to another ongoing debate over the drivers of fertility decline, namely whether income or education is more relevant (Colleran & Snopkowski 2018).

For the model applied to women of all ages (20-49) the wealth index is statistically relevant for the most important variables, but the sizes of the effect are much weaker than those of different education groups.

Applied to women above age 35, the wealth effect is mostly insignificant, except for a mildly negative effect of the highest wealth quintile.

One advantage of our study as compared to others on specific regions of Bangladesh is that we addressed the role of education in fertility reduction in all rounds of BDHSs. Since BDHS is a nationally representative survey, our findings represent the entire country. But even though we reconstructed birth histories for different cohorts, this it is still a series of cross-sectional studies that cannot directly establish causality. For this a true longitudinal survey with an application of case-control study design would have been more appropriate for evaluating the relative role of education and family planning programs. This kind of study setting could help to separate the role of education and family planning on the use of contraception or age at marriage, affecting the fertility outcome. However, such study design requires great efforts and resources and could be on the research agenda for the future.

In conclusion, the findings of this comprehensive study clearly indicate that female education seems to have been the driving force behind the significant fertility decline in Bangladesh form the 1980s (TFR above 6.0) to 2014 (TFR around 2.2). Urbanisation and higher household wealth also were factors associated with lower number of children ever born. As to the family planning indicators for which data were available and that were considered in this study neither the descriptive analysis of comparing trends not the multi-level statistical analysis found any clear effect. This does not necessarily imply that earlier studies focussing on specific regions or on the very early phases of the fertility decline and published in the early 1990s such a Carty et al. (1993) and Cleland et al. (1994) who found strong effects of family planning were wrong. The significantly negative community level effect that appeared when applying the model only to older women in the very first round of BDHS (1993/4) may point to the fact that indeed in this early phase family planning may have played some important role. But for the main part of the remarkable fertility decline in Bangladesh from above five children per women in 1990 to close to replacement level currently there is no indication of a significant role of government family planning efforts in contrast to the expansion of female education which seems to have played a key role.

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Appendix 1

Multilevel regression output of children ever born (women age 35 years or more) with associated predictors BDHS 1993-94, 2004 and 2014, Bangladesh

Indicators	BDHS round 1993-94				BDHS round 2004				BDHS round 2014			
	Model1	Model2	Model3	Model4	Model1	Model2	Model3	Model4	Model1	Model2	Model3	Model4
Fixed effect parameters												
Individual level characteristics												
Age of the women (in years)												
35-39 ®												
40-44	1.30***(0.10)	1.30***(0.10)	1.24***(0.11)	1.24***(0.10)	0.53***(0.08)	0.53***(0.08)	0.54***(0.08)	0.52***(0.08)	0.43***(0.05)	0.44***(0.05)	0.50***(0.05)	0.44***(0.05)
45-49	1.85***(0.12)	1.84***(0.12)	1.77***(0.12)	1.69***(0.12)	1.38***(0.08)	1.38***(0.08)	1.44***(0.09)	1.35***(0.08)	0.79***(0.05)	0.81***(0.05)	0.87***(0.05)	0.80***(0.05)
Women's level of education												
No education ®												
Primary	-0.03(0.11)	-0.05(0.11)		0.02(0.12)	-0.06(0.08)	0.02(0.08)		0.04(0.08)	-0.15***(0.05)	-0.08(0.05)		-0.07(0.05)
Secondary	-0.98***(0.18)	-0.97***(0.19)		-0.88***(0.19)	-0.70***(0.11)	-0.51***(0.12)		-0.49***(0.12)	-0.70***(0.06)	-0.50***(0.06)		-0.49***(0.06)
Higher	-2.16***(0.37)	-2.11***(0.38)		-1.99***(0.38)	-1.88***(0.20)	-1.66***(0.20)		-1.64***(0.21)	-1.34***(0.09)	-1.06***(0.10)		-1.05***(0.10)
Religion												
Islam ®												
Others	-0.91***(0.14)	-0.91***(0.14)		-0.94***(0.14)	-0.83***(0.12)	-0.85***(0.12)		-0.85***(0.12)	-0.48***(0.08)	-0.52***(0.07)		-0.52***(0.07)
Place of residence												
Urban ®												
Rural	0.61***(0.16)	0.60***(0.16)		0.61***(0.17)	0.51***(0.10)	0.38***(0.10)		0.42***(0.11)	0.48***(0.06)	0.30***(0.07)		0.30***(0.07)
Women visited by family planning worker (FPW) in past 6 months												
Not visited FPW ®												
Visited FPW in last 6 months	0.74***(0.10)	0.72***(0.10)			0.39***(0.11)	0.39***(0.11)			0.17***(0.06)	0.15**(0.06)		
Wealth index												
Poorest ®												
Poorer		0.22(0.15)		0.26*(0.15)		0.19(0.12)		0.20*(0.12)		-0.13*(0.07)		-0.12*(0.07)
Middle		0.35**(0.15)		0.40***(0.15)		-0.01(0.12)		0.01(0.12)		-0.17**(0.07)		-0.17**(0.07)
Richer		0.32**(0.15)		0.41***(0.15)		-0.21*(0.12)		-0.19(0.12)		-0.37***(0.07)		-0.37***(0.07)
Richest		0.14(0.18)		0.18(0.18)		-0.41***(0.13)		-0.39***(0.13)		-0.64***(0.09)		-0.64***(0.09)
Community level characteristics												
Mean years of schooling at community level			-0.32***(0.07)	-0.08(0.07)			-0.12**(0.06)	-0.07(0.05)			-0.15***(0.04)	-0.04(0.03)
Proportion of FPW visited in the community			-0.92(0.89)	-1.73**(0.83)			-1.77**(0.75)	-0.03(0.66)			0.13(0.48)	-0.07(0.39)
Intercept	4.56***(0.20)	4.37***(0.22)	6.52***(0.37)	5.31***(0.41)	4.10***(0.21)	4.26***(0.23)	5.06***(0.38)	4.56***(0.35)	3.34***(0.20)	3.65***(0.21)	3.94***(0.28)	3.85***(0.26)
Random effect parameters												
Divisional level variance	0.053(0.045)	0.049(0.043)	0.039(0.039)	0.022(0.026)	0.207(0.128)	0.219(0.135)	0.184(0.118)	0.211(0.130)	0.260(0.142)	0.267(0.146)	0.271(0.150)	0.260(0.142)
Community level variance	0.360(0.079)	0.366(0.080)	0.503(0.093)	0.359(0.079)	0.329(0.057)	0.300(0.055)	0.593(0.077)	0.297(0.055)	0.300(0.032)	0.261(0.030)	0.512(0.044)	0.259(0.030)
Variance of residual	5.118(0.147)	5.100(0.146)	5.402(0.155)	5.212(0.149)	4.161(0.101)	4.149(0.101)	4.302(0.104)	4.163(0.101)	2.375(0.044)	2.369(0.044)	2.464(0.046)	2.372(0.044)
Residual intra-class correlation coefficient at divisional level	0.009(0.008)	0.009(0.007)	0.006(0.006)	0.003(0.004)	0.044(0.026)	0.047(0.027)	0.036(0.022)	0.045(0.026)	0.088(0.044)	0.092(0.045)	0.083(0.042)	0.090(0.044)
Residual intra-class correlation coefficient at community level	0.074(0.015)	0.075 (0.015)	0.091(0.015)	0.068(0.014)	0.114(0.026)	0.111(0.027)	0.153(0.023)	0.109(0.027)	0.190(0.040)	0.182(0.042)	0.241(0.036)	0.179(0.041)
Observation	2,711	2,711	2,711	2,711	3,740	3,740	3,740	3,740	6,324	6,324	6,324	6,324
Number of divisional groups	5	5	5	5	6	6	6	6	7	7	7	7
Number of community groups	301	301	301	301	361	361	361	361	600	600	600	600
Log likelihood	-6111.158	-6107.343	-6225.554	-6158.043	-8088.629	-8076.469	-8200.616	-8081.347	-11971.75	-11941.33	-12178.14	-11943.76
Model fit statistics AIC	12246.32	12246.69	12467.11	12350.09	16201.26	16184.94	16417.23	16196.69	23967.5	23914.67	24372.28	23921.52

*Note: a) Standard errors in parentheses b) *** p<0.01, ** p<0.05, * p<0.1 c) ® reference category d) AIC- Akaike's information criterion*

Appendix 2

Multilevel regression output of children ever born (women age 20-49 years) with associated predictors BDHS 1993-94, 2004 and 2014, Bangladesh

Indicators	BDHS round 1993-94				BDHS round 2004				BDHS round 2014			
	Model1	Model2	Model3	Model4	Model1	Model2	Model3	Model4	Model1	Model2	Model3	Model4
Fixed effect parameters												
Individual level characteristics												
Age of the women (in years)												
20-24 ®												
25-29	1.09***(0.06)	1.10***(0.06)	1.13***(0.06)	1.12***(0.06)	0.89***(0.05)	0.90***(0.05)	1.00***(0.05)	0.90***(0.05)	0.75***(0.03)	0.76***(0.03)	0.80***(0.03)	0.76***(0.03)
30-34	2.20***(0.06)	2.20***(0.06)	2.23***(0.06)	2.19***(0.06)	1.63***(0.05)	1.65***(0.05)	1.81***(0.05)	1.66***(0.05)	1.40***(0.03)	1.43***(0.03)	1.54***(0.03)	1.44***(0.03)
35-39	3.26***(0.07)	3.26***(0.07)	3.30***(0.07)	3.23***(0.07)	2.27***(0.06)	2.31***(0.06)	2.49***(0.06)	2.31***(0.06)	1.82***(0.04)	1.87***(0.04)	2.04***(0.04)	1.87***(0.04)
40-44	4.55***(0.07)	4.55***(0.07)	4.55***(0.07)	4.48***(0.07)	2.79***(0.06)	2.83***(0.06)	3.02***(0.06)	2.83***(0.06)	2.25***(0.04)	2.31***(0.04)	2.52***(0.04)	2.31***(0.04)
45-49	5.06***(0.08)	5.07***(0.08)	5.05***(0.08)	4.93***(0.08)	3.65***(0.06)	3.70***(0.06)	3.92***(0.06)	3.68***(0.06)	2.61***(0.04)	2.68***(0.04)	2.90***(0.04)	2.67***(0.04)
Women's level of education												
No education ®												
Primary	-0.09*(0.05)	-0.07(0.05)		-0.02(0.05)	-0.19***(0.04)	-0.13***(0.04)		-0.12***(0.04)	-0.20***(0.03)	-0.16***(0.03)		-0.15***(0.03)
Secondary	-0.74***(0.06)	-0.66***(0.07)		-0.60***(0.07)	-0.75***(0.05)	-0.60***(0.05)		-0.59***(0.05)	-0.58***(0.03)	-0.45***(0.03)		-0.43***(0.03)
Higher	-1.64***(0.14)	-1.54***(0.14)		-1.48***(0.14)	-1.50***(0.07)	-1.31***(0.08)		-1.30***(0.08)	-1.16***(0.04)	-0.94***(0.05)		-0.93***(0.05)
Religion												
Islam ®												
Others	-0.51***(0.06)	-0.51***(0.06)		-0.53***(0.06)	-0.56***(0.06)	-0.56***(0.06)		-0.56***(0.06)	-0.35***(0.04)	-0.37***(0.04)		-0.37***(0.04)
Place of residence												
Urban ®												
Rural	0.32***(0.08)	0.27***(0.08)		0.25***(0.08)	0.35***(0.06)	0.24***(0.06)		0.29***(0.06)	0.34***(0.04)	0.20***(0.04)		0.20***(0.04)
Women visited by family planning worker (FPW) in past 6 months												
Not visited FPW ®												
Visited FPW in last 6 months	0.55***(0.04)	0.54***(0.04)			0.29***(0.05)	0.28***(0.05)			0.16***(0.03)	0.15***(0.03)		
Wealth index												
Poorest ®												
Poorer		0.17***(0.06)		0.21***(0.06)		0.00(0.06)		0.01(0.06)		-0.12***(0.03)		-0.12***(0.03)
Middle		0.15**(0.07)		0.19***(0.07)		-0.13**(0.06)		-0.12**(0.06)		-0.21***(0.04)		-0.20***(0.04)
Richer		0.06(0.07)		0.11*(0.07)		-0.26***(0.06)		-0.26***(0.06)		-0.34***(0.04)		-0.34***(0.04)
Richest		-0.07(0.08)		-0.04(0.08)		-0.40***(0.07)		-0.40***(0.07)		-0.53***(0.04)		-0.53***(0.04)
Community level characteristics												
Mean years of schooling at community level			-0.23***(0.04)	-0.05(0.03)			-0.11***(0.04)	-0.06*(0.03)			-0.14***(0.02)	-0.04**(0.02)
Proportion of FPW visited in the community			-0.51(0.47)	-0.81*(0.42)			-1.20**(0.48)	0.17(0.38)			0.15(0.30)	0.07(0.22)
Intercept	1.56***(0.13)	1.52***(0.14)	2.79***(0.21)	2.13***(0.22)	1.93***(0.14)	2.10***(0.14)	2.37***(0.24)	2.30***(0.21)	1.56***(0.13)	1.79***(0.13)	1.83***(0.18)	1.98***(0.16)
Random effect parameters												
Divisional level variance	0.049(0.034)	0.049(0.034)	0.037(0.027)	0.031(0.022)	0.087(0.053)	0.092(0.056)	0.080(0.051)	0.089(0.054)	0.094(0.052)	0.101(0.055)	0.103(0.057)	0.098(0.053)
Community level variance	0.127(0.020)	0.127(0.020)	0.185(0.025)	0.117(0.019)	0.163(0.019)	0.145(0.018)	0.318(0.031)	0.140(0.018)	0.130(0.011)	0.106(0.010)	0.242(0.017)	0.103(0.009)
Variance of residual	3.148(0.050)	3.142(0.050)	3.312(0.052)	3.208(0.050)	2.590(0.037)	2.583(0.037)	2.734(0.039)	2.592(0.054)	1.581(0.018)	1.574(0.018)	1.660(0.019)	1.578(0.018)
Residual intra-class correlation coefficient at divisional level	0.014(0.010)	0.015(0.010)	0.010(0.007)	0.009(0.006)	0.030(0.018)	0.032(0.019)	0.025(0.015)	0.031(0.0186)	0.052(0.027)	0.057(0.029)	0.051(0.027)	0.055(0.028)
Residual intra-class correlation coefficient at community level	0.053(0.011)	0.053(0.011)	0.062(0.010)	0.044(0.008)	0.088(0.018)	0.084(0.019)	0.127(0.016)	0.081(0.018)	0.124(0.025)	0.117(0.027)	0.172(0.024)	0.113(0.027)
Observation	8,225	8,225	8,225	8,225	9,737	9,737	9,737	9,737	15,840	15,840	15,840	15,840
Number of divisional groups	5	5	5	5	6	6	6	6	7	7	7	7
Number of community groups	302	302	302	302	361	361	361	361	600	600	600	600
Log likelihood	-16402.93	-16394.48	-16739.82	-16573.91	-18637.94	-18612.12	-18977.28	-18625.95	-26466.64	-26393.01	-26973.9	-26404.44
Model fit statistics AIC	32835.86	32826.96	33501.64	33187.82	37305.89	37262.23	37976.57	37291.9	52963.28	52824.02	53969.79	52848.89

*Note: a) Standard errors in parentheses b) *** p<0.01, ** p<0.05, * p<0.1 c) ® reference category d) AIC- Akaike's information criterion*