



# Contributions of Proximate Determinants to Fertility Transition in Bangladesh: An Analysis of Bongaarts' Fertility Model



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## Abstract

**Introduction:** Fertility transition is outright by prime four proximate determinants (marriage, contraception, postpartum infecundability, and abortion). The present study examines the contributions of proximate determinants on fertility decline and quantifies inhibiting the effect of major proximate determinants according to the socioeconomic characteristics in Bangladesh.

**Methods:** The current study was based mainly on the three Bangladesh Demographic and Health Surveys (BDHSs) carried out in 1993-1994, 2004, and 2014. Bongaarts' fertility framework was applied to analyze the proximate determinants of fertility in the socioeconomic status of women in Bangladesh.

**Results:** In 1993-1994, contraception was the greatest impediment to fertility followed by postpartum infecundability, marriage, and induced abortion, respectively. In 2014, contraception was the highest fertility obstructing effect followed by marriage, postpartum infecundability, and abortion, respectively, in both rural and urban areas of Bangladesh. Throughout the study period and even now, fertility is reversed in the Sylhet and Chittagong divisions of Bangladesh. The fertility-inhibiting effect of marriage, contraception, and abortion has an affirmative relationship with the educational status of women. Postpartum infecundability, however, displays an inverse relationship with the educational status of women.

**Conclusion:** The current study suggests that contraception plays a vital role in fertility reduction in Bangladesh. In particular, special attention should be placed on those regions (Chittagong and Sylhet divisions) that register low contraception prevalence rates. Special programs should focus on creating an awareness of the disadvantages of child marriage among women who reside in the division of Chittagong and Sylhet of Bangladesh.

**Keywords:** Fertility, Proximate Determinants, Postpartum Infecundability, Abortion

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## Introduction

The world's population had reached 7.6 billion as of mid-2017, and it is expected to rise by 1 billion people over the next 12 years.<sup>1</sup> According to the projections of the medium variant, the population of Bangladesh will increase 37 million, from 165 million people in 2017 to 202 million in 2050.<sup>1</sup> Bangladesh is the 8th most populous country in the world,<sup>1</sup> and the total fertility rate (TFR) is now 2.2 births per women. In 2014, the Bangladesh Demographic and Health Survey (BDHS) revealed that the TFR is 2.3 children per woman, which is equivalent to the 2011 BDHS.<sup>2</sup> In 6 out of 7 divisions in Bangladesh, fertility decreased or remained the same during the last two BDHS surveys (2011 and 2014).<sup>2</sup>

In last two surveys, TFR was slightly increased in Dhaka division.<sup>2</sup> Khulna and Rangpur had the same fertility rate in the last two BDHSs.<sup>2</sup> In 2014, the BDHS revealed that Khulna and Rangpur divisions had already crossed below the replacement fertility level (TFR = 1.9), while Rajshahi division and Barisal division are near replacement fertility (2.1 and 2.2 births per woman, respectively).<sup>2</sup> In 2014, the BDHS showed that women's education and the wealth status is negatively associated with fertility; i.e. as the education level increased, fertility declined, and the same was true for the wealth status.<sup>2</sup>

In Bangladesh, fertility declined predominantly because of the successful implementation of family planning.<sup>3-6</sup> Several studies conducted in Ethiopia and Zambia found

that natural fertility was predominantly obstructed through to the marriage and postpartum infecundability,<sup>7,8</sup> while contraceptive practice was a key factor in the decline in fertility in Bangladesh.<sup>9</sup> The use of effective contraceptive methods and economic status have played vital roles in fertility transition.<sup>10</sup> Age at marriage and abortion have also been crucial in reducing fertility among Asian women.<sup>11</sup> The cause of the decline in fertility was not related to level of prosperity, and that the way it will chase is not compulsorily measured by socioeconomic factors.<sup>12-14</sup>

Researchers have found that fertility declines sharply with socio-economic development.<sup>13,15</sup> Human reproduction is an intricate process, which is regulable by socioeconomic and demographic factors and related to a number of biological, behavioral, and cultural factors.<sup>16,17</sup> Conversely, proximate determinants applies outright impacts on fertility fluctuation.<sup>7,18,19</sup> If one proximate determinant changes, fertility is changed necessarily by the other proximate determinants remaining constant.<sup>16,17,20</sup> Several researchers have observed that background factors are likely to influence the proximate determinants of fertility.<sup>16,21</sup>

The prime goal of this study was to identify the contribution of proximate factors on fertility transition in Bangladesh. The relative effects of marriage patterns, contraceptive use, abortion practice, and postpartum infecundability on fertility were found to be associated with socioeconomic characteristics in Bangladesh using data from the three BDHSs conducted in 1993-1994, 2004, and 2014 and applying Bongaarts' Proximate Determinants model.

## Methods

The study was carried out on secondary data adopted from the first, fourth, and seventh programs of the BDHS (1993-1994, 2004, and 2014). All the surveys were administered by the Bangladesh Bureau of Statistics (BBS) and are nationally representative. All surveys except the 2014 BDHS comprised successful interviews with women aged 10-49 and were based on a two-stage stratified sample of households. In the first stage, 304 and 361 primary sampling units were selected in the 1993-1994 and 2004 BDHSs, respectively.<sup>22,23</sup> Six hundred enumeration areas (EAs) were selected with probability proportional to the EA size in the 2014 BDHS.<sup>2</sup> For the purpose of the study, data was collected on ever-married women aged 15-49 years. In the 1993-1994, 2004, and 2014 BDHSs, 9495, 11290, and 17863 ever-married women aged 15-49 were successfully interviewed.<sup>22,23</sup> To quantify the inhibition of fertility due to the major proximate determinants according to the socioeconomic characteristics in Bangladesh, Bongaarts' Proximate Determinants model was applied. The Statistical Package for Social Sciences (SPSS) version 23 software was used for data processing and analyses.

## Bongaarts' Proximate Determinants Model

Bongaarts' aggregate model examines the relationship between TFR and proximate determinants of fertility.<sup>16,17</sup> Bongaarts' model observed that four major proximate determinants had the highest variation of fertility: marriage, contraception, induced abortion, and postpartum infecundability, and those

indices are denoted by  $C_m$ ,  $C_c$ ,  $C_a$ , and  $C_i$ , respectively.

Bongaarts' model is as follows:

$$TFR = C_m \times C_c \times C_a \times C_i \times TF \quad (1)$$

where,  $C_m$ =index of marriage,

$C_c$ =index of contraception,

$C_a$ =index of abortion,

$C_i$ =index of postpartum infecundability,

$TF$ =Total Fecundity, and

$TFR$ =Total fertility rate.

The estimated value of each index ranged from 0 to 1, with 0 indicating a greater inhibition of fertility and 1 indicating a lower inhibiting effect. Bongaarts' model showed that the value of  $TF$  ranged between 13 and 17 births per women, but the average value of  $TF$  all over the world is 15.3.<sup>20</sup>

Bongaarts' aggregate fertility model from equation (1) becomes:

$$TFR = C_m \times C_c \times C_a \times C_i \times 15.3$$

## The Index of Marriage

The estimated value of the marriage variable ( $C_m$ ) is the ratio of TFR to total marital fertility rate (TMFR):

$$C_m = \frac{TFR}{TMFR}$$

## The Index of Contraception

The estimated value of contraception ( $C_c$ ) was calculated as:

$$C_c = 1 - 1.08 \times u \times e$$

where  $u$  is the prevalence of current contraceptive use among married women aged 15 to 49 years and  $e$  is the weighted average use - effectiveness of contraceptive with the constant 1.08 as an adjustment factor.

## The Index of Induced Abortion

The estimated value of induced abortion ( $C_a$ ) was obtained as:

$$C_a = TFR / (TFR + 0.4 \times (1+u) \times TA)$$

The abortion rate was calculated in a manner similar to that of age-specific fertility rate, but here, the denominator was the number of abortions in the last year among pregnant women rather than the number live births in the last year.

Therefore, the value of total abortion was calculated by:

$$TA = 5 * ASAR$$

## The Index of Postpartum Infecundability

The estimated value of postpartum infecundability ( $C_i$ ) was calculated as:

$$C_i = \frac{20}{(18.5 + i)}$$

where  $i$  = mean duration of postpartum infecundability through to the breastfeeding or postpartum abstinence.

$$\text{Mean duration } (i) = \sum p_i \times w_i$$

where  $p_i$  is the proportion insusceptible for the first group, and  $w_i$  is the time interval between midpoint value of the current group and the preceding group.

### Importance of the Fertility-Inhibiting Effect Being Accounted for Each Proximate Variables

The fertility-obstructing effect of each proximate determinate was calculated by the ratio of the differences between TF and estimated TFR, with the product of the logarithm of each index to the sum of the logarithm of all indices of proximate variables.<sup>24</sup>

$$\text{Effect of marriage} = \frac{[\text{TF}-\text{TFR}(\text{estimated})] \times \log_e C_m}{\log_e C_m + \log_e C_c + \log_e C_i + \log_e C_a}$$

$$\text{Effect of contraception} = \frac{[\text{TF}-\text{TFR}(\text{estimated})] \times \log_e C_c}{\log_e C_m + \log_e C_c + \log_e C_i + \log_e C_a}$$

$$\text{Effect of induced abortion} = \frac{[\text{TF}-\text{TFR}(\text{estimated})] \times \log_e C_a}{\log_e C_m + \log_e C_c + \log_e C_i + \log_e C_a}$$

$$\text{Effect of postpartum infecundability} = \frac{[\text{TF}-\text{TFR}(\text{estimated})] \times \log_e C_i}{\log_e C_m + \log_e C_c + \log_e C_i + \log_e C_a}$$

## Results

### Residence

Table 1 shows the changes in the indices of all proximate factors on fertility variations according to residence in Bangladesh from the 1993-1994 to 2014 BDHSs. As can be seen, marriage had the highest significant effect on fertility changes in rural areas as compared with urban areas. The average value of  $C_m$  was 0.729 (accounting for 27.1% of the fertility reduction) in the given study periods.

The contraception index had the highest in rural areas (0.575 in 1993-1994, 0.443 in 2004, and 0.387 in 2014) compared with urban areas (0.473 in 1993-1994, 0.389 in 2004, and 0.354 in 2014). In rural areas,  $C_c$  decreased about 0.188 points from 1993-1994 to 2014, while it decreased 0.119 points in urban areas in the same period. The inhibition effect of abortion was greater in urban areas than among sexually active women in rural areas. The abortion index values for women residing in rural areas was 0.952 in 1993-1994, 0.917 in 2004, and 0.927 in 2014, whereas the same values in urban areas were 0.920 in 1993-1994, 0.874 in 2004, and 0.899 in 2014 (Table 1).

In terms of postpartum infecundability, the estimated values of the  $C_i$  index in rural areas were 0.646 in 1993-1994, 0.706 in 2004, and 0.750 in 2014, while in urban regions, these values were 0.677 in 1993-1994, 0.753 in 2004, and 0.772 in 2014 (Table 1). This implies that the controlling effect of postpartum infecundability was highest in rural areas (29.9%) compared with urban areas. During the study period, contraception had the most significant fertility-inhibiting effect among all proximate determinants in both urban and rural areas of Bangladesh.

### Division

Table 2 reveals the changes in the indices of all proximate factors on fertility variations according to the divisions of Bangladesh from the 1993-1994, 2004, and 2014 BDHSs. In the 1993-1994 BDHS, Bangladesh was partitioned into five major administrative divisions, but in the 2014 BDHS Bangladesh was partitioned into seven major administrative divisions. In 2014, marriage had the most important effect in Rangpur division with an index value of 0.651 (34.9% reduction in fertility). In the three studied survey periods, marriage had the highest controlling effect on fertility reduction in Rajshahi division compared to all other divisions, with a mean  $C_m$  index value of 0.744 (25.6% reduction in fertility). Following Rajshahi, the effect of marriage was significant in the Khulna divisions, with a mean  $C_m$  index value of 0.748 and, to some extent, in the Dhaka (mean value of  $C_m$  was 0.769) and Barisal (average index value was 0.773), Sylhet (mean  $C_m$  value was 0.784), and Chittagong divisions (mean  $C_m$  value was 0.788).

Contraception had the highest fertility-inhibiting effect of all proximate variables in Bangladesh. A similar picture emerged when regional variations in fertility in Bangladesh were considered. Table 2 shows that the continuous increasing trend of contraceptive use was a fertility inhibitor in almost all divisions in Bangladesh during the three studied surveys. In 2014, the fertility-inhibiting effect of contraception was highest (70.4% fertility reduction) in Rangpur division and lowest in Sylhet division. Contraception had the highest

Table 1. Variations of the Proximate Determinants on Fertility Changes According to Selected Residence of Bangladesh: 1993-1994 to 2014 BDHS

Residence and Survey Years	Proximate Determinants				TFR
	$C_m$ (Percentage of Fertility Reduction)	$C_c$ (Percentage of Fertility Reduction)	$C_a$ (Percentage of Fertility Reduction)	$C_i$ (Percentage of Fertility Reduction)	
Urban					
1993-1994	0.798 (20.2%)	0.473 (52.7%)	0.920 (8.0%)	0.677 (32.3%)	3.60
2004	0.719 (28.1%)	0.389 (61.1%)	0.874 (12.6%)	0.753 (24.7%)	2.82
2014	0.716 (28.4%)	0.354 (64.6%)	0.899 (10.1%)	0.772 (22.8%)	2.69
Rural					
1993-1994	0.752 (24.8%)	0.575 (42.5%)	0.952 (4.8%)	0.646 (34.5%)	4.07
2004	0.729 (27.1%)	0.443 (55.7%)	0.917 (8.3%)	0.706 (29.4%)	3.20
2014	0.705 (29.5%)	0.387 (61.3%)	0.927 (7.3%)	0.750 (25.0%)	2.90
Total					
1993-1994	0.756 (24.4%)	0.566 (43.4%)	0.942 (5.8%)	0.649 (35.1%)	4.00
2004	0.726 (27.4%)	0.433 (56.7%)	0.902 (9.8%)	0.715 (28.5%)	3.10
2014	0.708 (29.2%)	0.384 (61.6%)	0.900 (10.0%)	0.754 (24.6%)	2.82

Abbreviation: TFR, total fertility rate.

**Table 2.** Variations of the Proximate Determinants on Fertility Changes according to the Divisions of Bangladesh: 1993-1994 to 2014 BDHS

Divisions and Survey Years	Proximate Determinants				TFR
	Cm (Percentage of Fertility Reduction)	Cc (Percentage of Fertility Reduction)	Ca (Percentage of Fertility Reduction)	Ci (Percentage of Fertility Reduction)	
Barisal					
1993-1994	0.798 (20.2%)	0.540 (46.0%)	0.936 (6.4%)	0.641 (35.9%)	3.96
2004	0.816 (18.4%)	0.467 (53.3%)	0.906 (9.4%)	0.730 (27.0%)	3.86
2014	0.706 (29.4%)	0.364(63.6%)	0.916 (8.4%)	0.791 (20.9%)	2.85
Chittagong					
1993-1994	0.825 (17.5%)	0.714 (28.6%)	0.938 (6.2%)	0.636 (36.4%)	5.38
2004	0.810 (19.0%)	0.543 (45.7%)	0.930 (7.0%)	0.662 (33.8%)	4.14
2014	0.731 (26.9%)	0.453 (54.7%)	0.935 (6.5%)	0.716 (28.4%)	3.39
Dhaka					
1993-1994	0.793 (20.7%)	0.565 (43.5%)	0.912 (8.8%)	0.653 (34.7%)	4.08
2004	0.799 (20.1%)	0.420 (58.0%)	0.908 (9.2%)	0.748 (25.2%)	3.49
2014	0.716 (28.4%)	0.378 (62.2%)	0.918 (8.2%)	0.726 (27.4%)	2.76
Khulna					
1993-1994	0.789 (21.1%)	0.462 (53.8%)	0.887 (11.3%)	0.685 (31.5%)	3.39
2004	0.794 (20.6%)	0.377 (62.3%)	0.901 (9.9%)	0.746 (25.4%)	3.08
2014	0.661 (33.9%)	0.336 (66.4%)	0.928 (7.2%)	0.797 (20.3%)	2.51
Rajshahi					
1993-1994	0.777 (22.3%)	0.461 (53.9%)	0.894 (10.6%)	0.647 (35.3%)	3.17
2004	0.785 (21.5%)	0.324 (67.6%)	0.893 (10.7%)	0.743 (25.7%)	2.58
2014	0.671 (32.9%)	0.306 (69.4%)	0.911 (8.9%)	0.832 (16.8%)	2.38
Rangpur					
1993-1994	NA	NA	NA	NA	NA
2004	NA	NA	NA	NA	NA
2014	0.651 (34.9%)	0.296 (70.4%)	0.908 (9.2%)	0.872 (12.8%)	2.33
Sylhet					
1993-1994	NA	NA	NA	NA	NA
2004	0.794 (20.6%)	0.689 (31.1%)	0.938 (6.2%)	0.643 (35.7%)	5.05
2014	0.775 (22.4%)	0.520 (48.0%)	0.919 (8.1%)	0.734 (26.6%)	4.16
Total					
1993-1994	0.756 (24.4%)	0.566 (43.4%)	0.942 (5.8%)	0.649 (35.1%)	4.00
2004	0.726 (27.4%)	0.433 (56.7%)	0.902 (9.8%)	0.715 (28.5%)	3.10
2014	0.708 (29.2%)	0.384 (61.6%)	0.900 (10.0%)	0.754 (24.6%)	2.82

Abbreviation: TFR, total fertility rate; NA, not applicable.

crucial effect in Rajshahi division compared with all other divisions, having a mean Cc value of 0.364 (63.6% of fertility reduction) during the studied survey periods (Table 2). Following Rajshahi division, the effect of contraception was significant in Khulna division, with an average index value of 0.392 (60.8% reduction in TN relative to TMFR) and partially in Dhaka (mean Cc value was 0.454) and Barisal (mean Cc value was 0.457) divisions. Its importance was less significant in the Sylhet and Chittagong divisions.

The inhibition effect of abortion was greatest in Rajshahi division (0.899), followed by Khulna (0.905), Rangpur (0.908), Dhaka (0.913), and Barisal (0.919) divisions, and its importance was less significant in Sylhet and Chittagong divisions (Table 2). The controlling effect of postpartum infecundability to fertility showed a continuously decreasing trend in almost all divisions in Bangladesh during the three studied surveys.

### Women's Education

Table 3 presents the changes in the indices of all proximate factors on fertility variations according to the educational status of women in Bangladesh in the 1993-1994, 2004, and 2014 BDHSs. Marriage was the most important proximate determinant of fertility change among women with a secondary or higher education. The Cm value was 0.719 in

1993-1994, 0.712 in 2004, and 0.701 in 2014. Marriage had the most important fertility-inhibiting effect among women with a secondary or higher education compared with their counterparts; the mean value of Cm during the three studied surveys was 0.711 (28.9% reduction in fertility).

Among women who had completed a primary education, the Cc value showed a falling trend in all survey periods (0.553 in 1993-1994, 0.410 in 2004, 0.364 in 2014). To be more precise, Cc declined about 34.2% between 1993-1994 and 2014. The Cc value also showed a decreasing tendency among women who were educated (secondary or higher education), with a value of 0.463 in 1993-1994, which fell by about 12.5% to 0.405 in 2004 and fell by a further 13.1% to 0.352 in 2014 (Table 3). Among all proximate determinants, contraception had the highest role in reducing fertility among women who had completed a secondary or higher education (mean index score was 0.407) compared with women with no education (mean Cc score was 0.471).

Abortion had the greatest fertility-inhibiting effect for women who had completed a secondary or higher education, with an average index value of 0.895 (10.5% fertility reduction) during the studied periods. The inhibition effect of postpartum infecundability decreased with increases in educational attainment. The inhibiting effect of postpartum infecundability among women with no education showed

**Table 3.** Variations in Proximate Determinants on Fertility Changes according to Women's Education in Bangladesh: 1993-1994 to 2014 BDHS

Women's Education and Survey Years	Proximate Determinants				TFR
	Cm (Percentage of Fertility Reduction)	Cc (Percentage of Fertility Reduction)	Ca (Percentage of Fertility Reduction)	Ci (Percentage of Fertility Reduction)	
<b>No Education</b>					
1993-1994	0.790 (21.0%)	0.595 (40.5%)	0.922 (7.8%)	0.625 (37.5%)	4.14
2004	0.792 (20.8%)	0.436 (56.4%)	0.929 (7.1%)	0.670 (33.0%)	3.29
2014	0.749 (25.1%)	0.381 (61.9%)	0.931 (6.9%)	0.742 (25.8%)	3.03
<b>Primary</b>					
1993-1994	0.799 (20.1%)	0.553 (44.7%)	0.906 (9.4%)	0.674 (32.6%)	4.12
2004	0.765 (23.5%)	0.410 (59.0%)	0.911 (8.9%)	0.720 (28.0%)	3.15
2014	0.735 (26.5%)	0.364 (63.6%)	0.922 (7.8%)	0.750 (25.0%)	2.98
<b>Secondary</b>					
1993-1994	0.719 (28.1%)	0.463 (53.7%)	0.880 (12.0%)	0.702 (29.8%)	3.15
2004	0.712 (28.8%)	0.405 (59.5%)	0.889 (11.1%)	0.728 (27.2%)	2.86
2014	0.701 (29.9%)	0.352 (64.8%)	0.915 (8.5%)	0.761 (23.9%)	2.63
<b>Total</b>					
1993-1994	0.756 (24.4%)	0.566 (43.4%)	0.942 (5.8%)	0.649 (35.1%)	4.00
2004	0.726 (27.4%)	0.433 (56.7%)	0.902 (9.8%)	0.715 (28.5%)	3.10
2014	0.708 (29.2%)	0.384 (61.6%)	0.900 (10.0%)	0.754 (24.6%)	2.82

a declining trend (0.625 in 1993-1994, 0.670 in 2004, and 0.742 in 2014) compared to that of women with a primary level education (0.674 in 1993-1994, 0.720 in 2004, and 0.750 in 2014) and women with a secondary or higher education (0.702 in 1993-1994, 0.728 in 2004, and 0.761 in 2014). On women who had completed a secondary or higher education, contraception and marriage had the greatest fertility-inhibiting effects between 1993-1994 and 2014. The TFR declined from 3.15 children per woman

#### Women's Economic Status

[Table 4](#) presents variations in the proximate determinants on

fertility changes according to the economic status of women in Bangladesh. The fertility-inhibiting effect of marriage was observed among women from the poorest households (0.809 in 1993-1994, 0.779 in 2004, and 0.805 in 2014) and those from the richest households in Bangladesh (0.720 in 1993-1994, 0.716 in 2004, and 0.710 in 2014) ([Table 4](#)). Among all proximate determinants, contraception had the highest fertility-reducing effect among the richest women in Bangladesh (0.491 in 1993-1994 to 0.396 in 2014) compared with the poorest women (0.592 in 1993-1994 to 0.396 in 2014). More precisely, the reduction in fertility through contraception was highest among the richest women (almost

**Table 4.** Variations in the Proximate Determinants on Fertility Changes according to the Wealth Status of Women in Bangladesh: 1993-1994 to 2014 BDHS

Women's Wealth Status and Survey Years	Proximate Determinants				TFR
	Cm (Percentage of Fertility Reduction)	Cc (Percentage of Fertility Reduction)	Ca (Percentage of Fertility Reduction)	Ci (Percentage of Fertility Reduction)	
<b>Poorest</b>					
1993-1994	0.809 (19.1%)	0.592 (40.8%)	0.933 (6.7%)	0.625 (37.5%)	4.27
2004	0.779 (22.1%)	0.470 (53.0%)	0.937 (6.3%)	0.679 (32.1%)	3.56
2014	0.805 (19.5%)	0.396 (60.4%)	0.942 (5.8%)	0.753 (24.7%)	3.44
<b>Poorer</b>					
1993-1994	0.804 (19.6%)	0.587 (41.3%)	0.928 (7.2%)	0.622 (37.8%)	4.16
2004	0.792 (20.8%)	0.428 (57.2%)	0.928 (7.2%)	0.704 (29.6%)	3.39
2014	0.800 (20.0%)	0.394 (60.6%)	0.921 (7.9%)	0.736 (26.4%)	3.26
<b>Middle</b>					
1993-1994	0.794 (20.6%)	0.582 (41.8%)	0.913 (8.7%)	0.637 (36.3%)	4.10
2004	0.782 (21.8%)	0.433 (56.7%)	0.921 (7.9%)	0.703 (29.7%)	3.34
2014	0.790 (21.0%)	0.374 (62.6%)	0.918 (8.2%)	0.757 (24.3%)	3.14
<b>Richer</b>					
1993-1994	0.770 (23.0%)	0.561 (43.9%)	0.917 (8.3%)	0.666 (33.4%)	4.04
2004	0.761 (23.9%)	0.425 (57.5%)	0.904 (9.6%)	0.723 (27.7%)	3.24
2014	0.750 (25.0%)	0.356 (64.4%)	0.916 (8.4%)	0.773 (22.7%)	2.89
<b>Richest</b>					
1993-1994	0.720 (28.0%)	0.491 (50.9%)	0.876 (12.4%)	0.703 (29.7%)	3.33
2004	0.716 (28.4%)	0.400 (60.0%)	0.871 (12.9%)	0.757 (24.3%)	2.89
2014	0.710 (29.0%)	0.345 (65.5%)	0.865 (13.5%)	0.783 (21.7%)	2.54
<b>Total</b>					
1993-1994	0.756 (24.4%)	0.566 (43.4%)	0.942 (5.8%)	0.649 (35.1%)	4.00
2004	0.726 (27.4%)	0.433 (56.7%)	0.902 (9.8%)	0.715 (28.5%)	3.10
2014	0.708 (29.2%)	0.384 (61.6%)	0.900 (10.0%)	0.754 (24.6%)	2.82

59% reduction in fertility) compared with the poorest women (51.4% reduction in fertility) in Bangladesh.

Conversely, the effect of postpartum infecundability showed a decreasing trend over the studied time frame. The results revealed that women's wealth index had a positive effect on marriage, contraception, and induced abortion, but a negative effect on postpartum infecundability. For women in rich households, the fertility-reducing effects of marriage, contraception, and abortion were maximal, but the effect of postpartum infecundability was weakest.

#### Fertility Regulating Effects of Each Proximate Determinant of Fertility by Selected Socioeconomic Characteristics

Table 5 shows the magnitude of the fertility-regulating effects

of the proximate determinants of fertility according to the socioeconomic characteristics for the period 1993-1994 to 2014 at two different time points (1993-1994 and 2014). The fertility controlling effects of the four proximate determinants varied with the residence of the respondents (Table 5). The fertility-regulating effects of marriage and postpartum infecundability were higher in rural areas, while the effects of contraception and abortion were higher in the urban areas of Bangladesh. Simply, the results indicate that out of the 11.70 births in 1993-1994 that were inhibited in urban areas of Bangladesh, 1.82 births (or 15.56% total inhibiting effects) were due to the effect of marriage, 6.05 births (51.71%) were because of contraception, 0.67 births (5.73%) were because of induced abortion, and 3.15 births (26.92%) were due to

**Table 5.** Fertility Regulating Effects of Proximate Determinants of Fertility According to the Socioeconomic Characteristics in Bangladesh: 1993-1994 to 2014 BDHS

Variables	Effect of Marriage		Effect of Contraception		Effect of Abortion		Effect of Postpartum Infecundability		Total effect	
	No. of Births	%	No. of Births	%	No. of Births	%	No. of Births	%	No. of Births	%
<b>1993-1994 BDHS</b>										
<b>Residence</b>										
Urban	1.82	15.56	6.05	51.71	0.67	5.73	3.15	26.92	11.70	100.0
Rural	2.42	21.55	4.69	41.76	0.42	3.74	3.70	32.95	11.23	100.0
<b>Division</b>										
Barisal	1.89	16.67	5.17	45.59	0.55	4.85	3.73	32.89	11.34	100.0
Chittagong	1.83	18.45	3.20	32.26	0.61	6.15	4.29	43.25	9.92	100.0
Dhaka	1.97	17.56	4.85	43.23	0.78	6.95	3.62	32.26	11.22	100.0
Khulna	1.87	15.70	6.10	51.22	0.95	7.98	2.99	25.10	11.91	100.0
Rajshahi	1.94	15.99	5.97	49.22	0.86	7.09	3.36	27.70	12.13	100.0
Rangpur	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sylhet	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
<b>Education</b>										
No education	2.01	18.01	4.43	39.70	0.69	6.18	4.01	35.93	11.16	100.0
Primary	1.91	17.10	5.05	45.21	0.84	7.52	3.36	30.08	11.17	100.0
Secondary	2.54	20.91	5.92	48.72	0.98	8.07	2.72	22.39	12.15	100.0
<b>Wealth Status</b>										
Poorest	1.83	16.59	4.53	41.07	0.60	5.44	4.06	36.81	11.03	100.0
Poorer	1.87	16.79	4.56	40.93	0.64	5.75	4.07	36.54	11.14	100.0
Middle	1.97	17.59	4.61	41.16	0.78	6.96	3.84	34.29	11.20	100.0
Richer	2.21	19.63	4.88	43.34	0.73	6.48	3.43	30.46	11.26	100.0
Richest	2.49	21.52	5.40	46.67	1.00	8.64	2.67	23.08	11.57	100.0
<b>2014 BDHS</b>										
<b>Residence</b>										
Urban	2.42	19.19	7.54	59.79	0.77	6.11	1.88	14.91	12.61	100.0
Rural	2.61	21.05	7.08	57.10	0.57	4.60	2.34	18.87	12.40	100.0
<b>Division</b>										
Barisal	2.58	20.72	7.70	61.85	0.65	5.22	1.74	13.98	12.45	100.0
Chittagong	2.48	20.82	6.26	52.56	0.53	4.45	2.64	22.17	11.91	100.0
Dhaka	2.45	19.54	7.12	56.78	0.63	5.02	2.34	18.66	12.54	100.0
Khulna	2.93	22.91	7.72	60.36	0.53	4.14	1.61	12.59	12.79	100.0
Rajshahi	2.77	21.44	8.22	63.62	0.65	5.03	1.28	9.91	12.92	100.0
Rangpur	2.96	22.82	8.40	64.76	0.67	5.17	0.94	7.25	12.97	100.0
Sylhet	2.18	19.57	5.59	50.18	0.72	6.46	2.65	23.79	11.14	100.0
<b>Education</b>										
No education	2.19	17.85	7.31	59.58	0.50	4.07	2.26	18.42	12.27	100.0
Primary	2.28	18.30	7.47	59.95	0.60	4.82	2.13	17.09	12.46	100.0
Secondary	2.56	20.19	7.51	59.23	0.64	5.05	1.96	15.46	12.68	100.0
<b>Wealth status</b>										
Poorest	1.73	14.59	7.36	62.06	0.48	4.05	2.26	19.06	11.86	100.0
Poorer	1.74	14.45	7.27	60.38	0.64	5.32	2.39	19.85	12.04	100.0
Middle	1.81	14.88	7.55	62.09	0.66	5.43	2.14	17.60	12.16	100.0
Richer	2.14	17.24	7.69	61.97	0.65	5.24	1.92	15.47	12.41	100.0
Richest	2.43	19.04	7.56	59.30	1.03	8.07	1.74	13.64	12.76	100.0

postpartum infecundability. However, in the 2014 BDHS, out of the 12.61 births that were inhibited in urban areas of Bangladesh, 2.42 births (19.19% total fertility-inhibiting effects) were because of marriage, 7.54 births (59.79%) were due to the use of contraception, 0.77 births (6.11%) were due to induced abortion, and 1.88 births (14.91%) were due to postpartum infecundability.

A similar picture emerged when the effects of divisional variations on fertility (Table 5) were considered. In 1993-1994, the fertility-inhibiting effect of contraception was highest in Khulna division (51.22%) followed by Rajshahi (49.22%) and Barisal (45.59%), whereas in the 2014 BDHS, the fertility-inhibiting effect of contraception was highest in Rangpur division (8.40 births or 64.76%) followed by Rajshahi (63.62%) and Khulna divisions (7.72 births or 60.36%). In the 2014 BDHS, the effect of postpartum infecundability was highest in Sylhet division (2.65 births or 23.79%) followed by Chittagong division (22.17%) and Dhaka division (18.66% percent), while in 1993-1994, the decline in fertility due to postpartum infecundability was highest in Chittagong division (4.29 births or 43.25%) followed by Barisal division (32.89%) and Dhaka division (32.26%). From Table 5, it can be seen that over the study period, the divisional effects of marriage, contraception, and abortion had an increasing trend, while the effect of postpartum infecundability decreased.

Marriage and contraception showed the highest fertility-inhibiting effects (decline of more than two births) among women with a secondary or higher education. Over the studied period, fertility decline due to the effects of proximate factors (marriage, contraception, and abortion) showed a rising trend, while the effect of postpartum infecundability showed a decreasing trend among women with a secondary or higher education during the studied period. The fertility-inhibiting effect of contraception was highest among women with a secondary or higher education (48.72% in 1993-1994, 59.23% in 2014) followed by those with a primary education. Thus, the lowest level of fertility among women who had completed a secondary or higher education occurred mainly because of the increased use of contraceptives.

In 1993-1994 the fertility-controlling effect of contraception was higher among women from the richest households (5.40 births or 46.67%) compared with women from the poorest households (4.53 births or 41.07 %). The fertility-regulating effects of marriage and contraception were higher in women from the richer and richest households (Table 5). However, the fertility-inhibiting effect of postpartum infecundability was higher in poor women. The effect of infecundability decreased with increases in women's economic status.

## Discussion

Fertility transition is indisputably ongoing in Bangladesh. Though Bangladesh has been encountering significant decreases in fertility rates over the last two decades, this change in fertility is not equal across the country or across parts of the society.

The index of contraception had the highest fertility-inhibition effect in 1993-1994, 2004, and 2014 for both rural and urban areas of Bangladesh. In 1993-1994, the effect of

contraception played a very important role in urban areas, followed by postpartum infecundability and marriage. This result is similar to that of an earlier study conducted in Bangladesh.<sup>4</sup> In Uganda, urban living arrangements were reliably correlated with lower fertility rates compared to rural residence.<sup>21, 25</sup> Fertility levels were also higher among rural residents compared with those in urban areas.<sup>26</sup> This consequence is identical with that shown in an earlier study conducted in Uganda, Sub-Saharan Africa, and Ethiopia, where the fertility rate was lower in urban areas.<sup>18, 27,28</sup>

In rural territories, despite the fact that contraception is picking up impact over time, postpartum infecundability is still the most crucial regulator of fertility. In 2014, however, contraception was the most significant fertility-inhibiting impact, trailed by marriage, postpartum infecundability, and abortion. This study also showed that contraception had the highest fertility-regulating effect than other proximate variables in Bangladesh. Contraception rose as the most noteworthy fertility diminishing factor in Bangladesh.<sup>5,29-31</sup> These findings are not consistent with those in Ethiopia,<sup>32-34</sup> Oman,<sup>35</sup> Malawi,<sup>36</sup> Zambia,<sup>7</sup> or Uganda,<sup>25</sup> where contraception had the lowest fertility-inhibiting effects. Postpartum infecundity, on the other hand, had a predominant hindering impact on fertility.

The index of contraception is an increasingly more important determinant when considering regional variations of fertility in Bangladesh during the study period. It demonstrates a persistent expanding pattern as an inhibitor of fertility in the majority of areas in Bangladesh during the studied time. Contraception is the most fertility reducing factor in all regions of Bangladesh.<sup>37</sup> The low fertility levels in Khulna and Rajshahi divisions are due mainly to higher rates of contraceptive use.<sup>38</sup> Contraception has had the most significant impact in Rajshahi division compared with all other divisions. The postpartum infecundability index became an inexorably increasingly significant determinant between 1993-1994 and 2014, demonstrating a consistent pattern of fertility inhibition in the majority of divisions in Bangladesh.

The findings of the current study are in agreement with those of numerous other investigations.<sup>39,40</sup> The effect of postpartum infecundability is highest in Chittagong division, followed by Sylhet and Dhaka divisions. From the findings of the current study, it can be observed that the divisional effect of marriage, contraception, and abortion all have increasing trends, while the effect of postpartum infecundability has decreased in all surveys in the studied period. This result is similar to that of many other studies conducted in Bangladesh.<sup>29,30</sup>

Marriage and contraception displayed the most noteworthy fertility-restraining impact (more than two births) among women who had completed at least a secondary education. Over the studied period, the effects of education level on marriage, contraception, and abortion showed an increasing trend, while the effect of postpartum infecundability showed a decreasing trend. An analysis of the proximate determinants indicated that advanced education levels are concordantly connected with lower fertility rate.<sup>41</sup> Women's literacy has a significant negative impact on fertility transition.<sup>42</sup> Results

of some previous studies are in agreement with the present results,<sup>29,30,39,43,44</sup> indicating that fertility is inversely associated with education status.<sup>26,30,43,45-49</sup> A few other investigations, however, discovered no noteworthy effect of education on fertility.<sup>50</sup>

Marriage and contraception have better fertility-restraining impacts on women from richer and richest households. The lowest degree of fertility in the richest women is due particularly to the accelerated use of powerful contraceptive methods. The modern-day contraceptive rate for the richest women is double that of the poorest women.<sup>51,52</sup> Younger women inside the richer wealth index are much more likely to apply modern contraceptive methods than the poorest class countries.<sup>42, 53,54</sup> However, postpartum infecundability has a higher fertility-restraining effect on poor women. The effect of infecundability is decreased as the economic status of women increases. This result is in agreement with the findings of several other studies conducted in Bangladesh.<sup>29,30, 39,43,44</sup> An analysis in Zambia determined that fertility was higher among women from the poorest households compared with those from the richest households.<sup>49</sup> Women from the poorest families have nearly two times as many children as those who reside within the richest quintile.<sup>10</sup>

## Conclusion

Fertility is a key component in population change. Place of residence, divisional variation, women's education, and wealth status are circuitously associated with fertility. This study determined that contraception had the greatest fertility-inhibition effect in rural and urban areas in 1993-1994, trailed by postpartum infecundability, marriage, and induced abortion. In 2014, contraception again had the highest fertility-regulating effect in urban and rural areas followed by marriage, postpartum infecundability, and abortion. Across all three studied periods, fertility continued to be high in Sylhet and Chittagong divisions. The fertility-restraining effects of marriage, contraception, and abortion showed positive associations with education level. However, postpartum infecundability displayed a negative correlation with education level. Economic status positively affects marriage, contraception, and induced abortion, while postpartum infecundability was negatively associated with economic status. In 1993-1994 and 2014, among all aspects of fertility, contraception had the highest variation on fertility-inhibiting effects of all proximate determinants in Bangladesh. However, the fertility-inhibiting effect of postpartum infecundability decreased between the period 1993-1994 and 2014. Therefore, programs need to concentrate on engendering and raising public awareness on the disadvantages of child marriage as well as on the use of effective contraceptive methods. Moreover, Chittagong division and Sylhet division require more and intensive programs on this agenda.

## Authors' Contributions

IH had the original idea for this study. IH and MA contributed all the experimental work and manuscript writing. IH contributed extensively to statistical analysis. MA and IHM helped in the interpretation of data and critical revision. All

## Research Highlights

### What Is Already Known?

Prior to this, the main impact of the predictor determinants at the national level of Bangladesh was identified mainly in the study by applied Bongaarts' fertility model. Most studies have shown that due to the total proximity factors in Bangladesh, fertility has changed and it has not been identified any section was more attentive and reduced fertility in order to achieve transplant levels.

### What This Study Adds?

This paper is mainly focuses on quantify of prime four proximate determinants according to the selected socioeconomic characteristics. The present study indicates that, the Chittagong division and the Sylhet division fertility level are higher compared to the opponent. The three principal determinants of fertility (marriage contraception and abortion) have a positive relationship with the education and socioeconomic status of women, respectively. In addition, postpartum insusceptibility indicates inverse relationship between education level and the financial status of women respectively. The present study reveals that, not only the abortion effect is not negligible, but also it has played a crucial role to reduce fertility in all selected socioeconomic status and increases trend in the case of fertility reduction.

authors read and approved the final manuscript.

## Conflict of Interest Disclosures

The authors declare that they have no conflicts of interest.

## Ethical Approval

This study did not require ethics committee authorization.

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