Fertility Trends in Bangladesh Employing Parity Progression Ratios

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Abstract

Fertility trends in Bangladesh have long been a subject of study due to the country's significant demographic transitions over the past few decades. This study investigated cohort fertility rates and trends using information from the Bangladesh Demographic and Health Surveys (BDHSs) (BDHS 2011, BDHS 2014, and BDHS 2017-2018). The study utilizes parity progression ratios (PPRs) to examine the fertility distribution among all women and currently married women. Fertility patterns are investigated across various birth cohorts of women spanning seven age groups (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49), including the entirety of the reproductive age range (15-49 years). In the BDHS 2011, the cohort total fertility rate (TFR^c) was 2.62 for all women and 2.73 for currently married women. In the BDHS 2014, the TFR^c for all women decreased to 2.40, and for currently married women, it declined to 2.56. Finally, in the BDHS 2017-18, the TFR for all women decreased to 2.30, while for currently married women, it reached 2.45. Notably, TFR^c exhibited a declining trend over the three surveys, with the TFR remaining constant at 2.30 from BDHS 2011 to BDHS 2017-18. It is worth mentioning that while the TFR and TFR^c values are identical, the TFR^c for currently married women in BDHS-2017-18 is slightly higher by 0.15 compared to all women (BDHS 2014). This research highlights significant shifts in cohort fertility levels in Bangladesh over time, offering valuable insights into fertility patterns among women of varying age groups within the reproductive span. The observed declines in both TFR^c underscore Bangladesh's evolving fertility dynamics. Policymakers should sustain declining fertility rates while balancing population control with development and regularly monitor trends to adapt policies to changing reproductive patterns.

1. Introduction

A parity progression ratio (PPR) is commonly used in demography to study fertility. The PPR is simply the proportion of women with a certain number of children who go on to have another child. The PPR is an essential indicator of fertility dynamics and family growth. A practical method for assessing family planning (FP) programmers and analyzing fertility statistics is the

model of PPR [1, 2]. Timing fertility measurements may confront numerous difficulties in detecting actual changes in fertility in the short term since they are impacted by the timing of births 'i' sensory indices of birth spacing pattern of population and represents female fertility. Cohort total fertility rate (TFR^c) is one of the most prominent fertility indices that measure an indicator of fertility of women across their whole reproductive life. The TFR^c has a fundamental flaw for women. However, this is not yet calculated to account for individuals who decline to go to a subsequent birth that has a specific number of children. This indicator is the most essential key aspect in determining a demographic advantage's average fertility performance. This activity can address family constrains, such as evaluating the impact of an FP scheme on fertility rates in developing countries like Bangladesh. The PPR$_S$ are vital for understanding the cohort fertility distribution [3, 4]. Fertility, mortality, and migration are the key factors driving population change [5]. Analyzing these elements is essential to understanding past, present, and future trends in population size, composition, and growth. Fertility is essential for socioeconomic planning, management, and societal progress. As a result, cohort fertility analysis is critical for understanding a country's fertility level, trend, and pattern. The interval between two subsequent births and the progression from one birth to the next higher-order birth are two vital dimensions of women's fertility attitudes. The primary viewpoint is the whole-life birth interval, which is an outstanding fertility level and pattern [6]. The PPRs are the specific exponent that controls fertility in the second dimension. The chance that a woman of a particular birth order would always continue forward to the next birth has gained a prominent position in the fertility research from this variable. Over time, the PPR has emerged as an essential fertility determinant for researchers, particularly when comparing the reproductive effects of two or more populations with comparable birth interval patterns but different desirable family shapes. Parity progression studies about fertility, as a result, play a significant part in the technique of determining the effect of contraceptive usage in populations [7].

The PPR analysis reveals that the two populations with equal birth interval patterns might have different restriction patterns and parity progressions [8, 9]. The incidence of secondary infertility varies with age and influences the PPR [10]. Ryder and Henry made the first attempt to calculate PPR in the early 1950s [11-13]. For the same goal, some researchers employed complete birth records. In contrast, others used data from the most recent closed and open birth intervals, and they discovered the resulting limited data in 1975 [14-17]. Yadava and Bhattacharya [18] proposed an alternative approach for estimating PPRs that incorporates data on open and last closed birth intervals for women who are still in the reproductive phase [18]. In addition, Yadava et al. [19] offered several alternative approaches to calculate the PPR that took into account the open, most recently closed, and last closed birth periods. Brass and a few other scholars made the first attempt to estimate PPR using birth order statistics in 1975 [20, 21]. The PPR computations were made in 1997 using birth order statistics and vital statistics by Panday et al., [22]. Most foundational studies and methods mentioned, including those by Ryder, Henry, Yadava, and Brass, were developed decades ago (1950-1997). More recent analyses of PPRs using up-to-date demographic data that reflects current social, economic, and healthcare developments. Therefore, the main purpose of this study is to examine the trend in PPRs among Bangladeshi women using data from the BDHS in the years 2011, 2014, and 2017-18.

2. Data and Methods

The data for this study were drawn from the BDHSs, which collect nationally representative data through multiple sources. These include household surveys to assess living conditions and

services, individual interviews with women aged 15-49 to gather information on fertility, FP, maternal and child health, and men's surveys for reproductive health knowledge. The survey also includes health facility data and biomarker collection, such as height, weight, and anemia testing, to assess nutritional and health status. Population census data and geographical information were utilized to ensure sampling accuracy and regional representativeness. These comprehensive data sources provide robust insights into Bangladesh's demographic and health trends.

The PPRs were calculated using BDHS 2011 [23], BDHS 2014 [24], and BDHS 2017-18 [25] data sets. The data utilized for the cohort measures were based on past generative expertise of women ages 15 to 49 years. The approach used in this investigation is the PPR method, which is simple. The women were distributed according to their age and child birth order *i.e.*, children ever born (CEB) in a country. This study did not include the age-order-specific fertility rate and women's past pregnancies to estimate PPR. No additional model was used to calculate cohort fertility in this study; instead, PPRs were calculated separately. The study initially produced two types of tabulation: i) the distribution of women by parity, including their distribution over five years, and ii) the distribution of currently married women giving birth during their reproductive years. Separate calculations were conducted for both tabulation forms to ensure accuracy and clarity in the analysis.

The number of women was arranged in ascending order by parity, and the cumulative total from the bottom represented the number of women with at least the *i*-th number of CEB. To estimate the probability of the next birth, the adjacent figures were divided: the number of women with at least (*i*+1)-th number of CEB was divided by the number of women with at least *i*-th number of CEB. This calculation yields the probability of progressing from the *i*-th to the (i+1)-th parity, known as the PPR, which is formulated as follows:

$$PPR(i) = \frac{\text{Number of women who have born (i+1)th birth}}{\text{Number of women who have born (i)th birt}}. \tag{1}$$

Eq. (1) gives the information about the probability of having the birth for those who have already had birth among currently married women of age group. It is perfectly possible to calculate PPRs for younger women and compare them with PPRs of similarly aged women and currently married women in the same surveys to try and detect a change in fertility behavior. However, Moultrie and Zaba [26] stated that although more reliable conclusions can be drawn if PPRs for the same cohorts can be compared across more than one period, comparison of successive cohorts can also give information on trends of total fertility rate (TFR) in any country. This study used BDHS data to find out the PPRs of all women and currently married women compared with TFR of Bangladesh.

Using the PPRs, the ratio of women with at least a certain number of CEB can be calculated. For example, the PPR from zero to the first birth gives the proportion of women with at least one child. Similarly, multiplying the PPR from zero to the first birth by the PPR from the first to the second birth provides the ratio of women with at least two children. The process continues, with the PPR from the first to the second birth multiplied by the PPR from the second to the third birth, yielding the ratio of women with at least three children, and so forth.

Computational of cohort fertility rate: From the data on PPRs, the CFR can also be determined as a mathematical series of products of PPRs. This is formulated in an equation as:

$$CFR = a_0(1 + a_1 + a_1a_2 + a_1a_2a_3 + a_1a_2a_3a_4 + \ldots\ldots\ldots\ldots\ldots\ldots) \tag{2}$$

where, a_0: Parity progression ratio from 0 to 1 birth, a_1: PPR from 1 to 2 births, a_2: PPR from 2 to 3 births, a_3: PPR from 3 to 4 births, a_4: from 4 to 5 births and so on [27].

3. Pattern and level of parity progression ratio in Bangladesh

In Bangladesh, according to fertility measures, mortality, and other factors, women are thought to be most fertile between the ages of 15-19, 20-24, 25-29, 30-34, 35-39, and 40-45, respectively. As a result, all of these age groups were considered while calculating PPRs in this study. This study analyzed the fertility patterns in Bangladesh for all of these reproductive age groups (15-49), and to do so, PPRs were separately estimated for all women and women who are currently married by various birth age groups.

Table 1: Distribution of all women aged 15-49 years ranges by the number of children ever born by age groups based on BDHS 2011

Age	Number of children											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**>9**	**Total**
15-19	3255	896	142	13	-	-	-	-	-	-	-	4306
20-24	1015	1566	1108	300	57	12	-	-	-		-	4058
25-29	263	623	1400	805	294	84	25	7	-	-	-	3501
30-34	105	241	784	776	473	188	72	30	11	3	3	2686
35-39	77	132	460	618	462	254	161	53	37	10	-	2264
40-44	47	108	354	503	412	287	220	121	61	28	17	2158
45-49	40	87	217	330	316	288	208	168	86	46	38	1824

Source: Calculated by the author from the BDHS 2011.

Table 2: Distribution of all women aged 15-49 years by the number of children ever born by age groups based on BDHS 2014

Age	Number of children											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**>9**	Total
15-19	3382	991	103	9								4485
20-24	994	1479	918	188	33	4						3616
25-29	315	756	1467	691	230	53	18	4				3534
30-34	102	281	996	941	459	200	71	25	6	3		3084
35-39	47	163	604	652	413	231	145	47	18	9	5	2334
40-44	51	133	377	530	406	290	168	88	36	15	11	2105
45-49	28	73	234	371	359	326	189	104	41	25	19	1769

Source: Calculated by the author from the BDHS 2014

Table 3: Distribution of all women aged 15-49 years by the number of children ever born by age groups based on BDHS 2017-18.

Age	Number of children											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**>9**	**Total**
15-19	3744	918	115	4	-	-	-	-	-	-	-	4782
20-24	1163	1778	993	170	21	-	-	-	-	-	-	4155
25-29	333	882	1603	652	181	44	4	-	-	-	-	3704
30-34	105	351	1322	1042	452	171	49	14	-	-	-	3507
35-39	60	167	796	920	539	248	92	49	6	6	-	2885
40-44	60	102	476	628	448	319	152	83	30	9	2	2310
45-49	46	94	386	512	540	289	207	124	51	21	16	2299

Source**:** Calculated by the author from the BDHS 2017-18.

4. Results and discussion
5.1 Parity progression ratios of all women based on BDHS 2011

Among all women in aged 15-19, the probability of having one child for those with zero children is about 24% in BDHS 2011 (Table 4). For all women of age group, 15-19 years PPR from 1-2 and 2-3 birth are 14% and 8%, respectively and the CFR of this group is 0.28. The possibility of getting a second child for those who have in the meantime had one child of age group 20-24 years among all women is about 49% in DHS 2011. It signifies that about half of all women in that birth cohort are expecting their second birth shortly, and the CFR of this group is 1.22. The probability of getting a third child for those who have in the meantime had a second child in the age group 25-29 among all women is 46%. It signifies that over two-fifths of all women in that birth cohort are expecting their third birth shortly and the CFR of this group is 2.18. The possibility of having a fourth child for those who have already had three children of the age group 30-34 among all women is about 50%. It signifies that half of all women in that birth cohort are expecting their fourth birth shortly, and the CFR of this group is 2.88. The possibility of having a fifth child for those who have already had four children of age group 35-39 among all women is about 53%. It signifies that over half of all women in that birth cohort are expecting their fifth birth shortly, and the CFR of this group is 3.42. The possibility of having a sixth child for those who have in the meantime had five children of, the age group 40-44 among all women is about 52%. It signifies that over half of all women in that birth cohort are expecting their sixth birth shortly, and the CFR of this group is 3.92 and finally, the possibility of having a seventh child for those who have in the meantime had six children of the age group 45-49 among all women is about 61%. It signifies that over three-fifths of all women in that birth cohort are expecting their seventh birth shortly, and the CFR of this group is 4.45. Also, for all women of age group 45-49 years, PPR from 7-8, 8-9, and 9-10+ birth is 50%, 49% and 45%, respectively. From all the age groups it is observed that increasing the parity at the same time CFR is also increased. The estimation of PPR of all women calculated (Table 4) by the use of all women aged 15-49 years ranges by the number of CEB according to age group data of BDHS 2011 (Table 1).

Table 4: Parity progression ratios of all women different birth cohorts based on BDHS 2011

Parity progression	Age group						
	15-19	20-24	25-29	30-34	35-39	40-44	45-49
0-1	**0.244078**	0.749877	0.924879	0.960908	0.965989	0.975772	0.97807
1-2	0.147479	**0.485376**	0.807597	0.906238	0.940101	0.935248	0.951233
2-3	0.083871	0.249831	**0.464627**	0.664814	0.776265	0.803748	0.872127
3-4	-	0.186992	0.337449	**0.500965**	0.612782	0.656088	0.777027
4-5	-	0.173913	0.282927	0.392811	**0.527607**	0.601185	0.725217
5-6	-	-	0.275862	0.369281	0.503876	**0.522167**	0.654676
6-7	-	-	0.218750	0.362832	0.392308	0.471698	**0.619048**
7-8	-	-	-	0.268293	0.490196	0.413333	**0.502959**
8-9	-	-	-	-	0.280000	0.419355	**0.494118**
>9	-	-	-	-	0.357143	0.423077	**0.452381**
CFR	0.28	1.22	2.18	2.88	3.42	3.92	4.45

Source: Calculated by the author from Table 1

5.2 Parity progression ratios of all women based on BDHS 2014

Among all women of the age group 15-19 years, the probability of having the first child for those who have zero children is about 24% in Bangladesh DHS 2014 (Table 5), and it is indicating that about one-fourth of them are expecting their first birth shortly at the early age group of reproductive period and CFR of this group is 27%. Among all women of the age group 20-24 years, the possibility of getting a second child for those who already had one child is about 44%. It is indicated that over two-fifths of them are expecting their second birth shortly and the CFR of this group is 0.73. For all women of the age group 25-29 years, the possibility of getting a third child for those who have already had two children is about 41%, indicating that over two-fifths of them are expecting their third birth shortly and the CFR of this group is 2.0. Among all women of the age group 30-34 years, the possibility of getting a fourth child for those who have already had three children is about 45%, and it signifies that over two-fifths of them are expecting their fourth birth soon, and CFR of this group is 2.79. The possibility of getting a fifth child for those who have already had four children in the age group 35-39 is 52% and it signifies that over half of them are expecting their fifth birth soon and the CFR of this group is 3.26. For all women of the age group 40-44 years, the probability of getting a sixth child for those who have already had five children is 52%, indicating that over half of them are expecting their sixth birth soon and the CFR of this group is 3.66. For all women of the age group 45-49 years, the probability of having the seventh birth for those who have already had six children is 50%, and it signifies that about half of them are expecting their seventh birth soon, and the CFR of this group is 4.11. Also, for all women of age group 45-49 years the probability of PPR from 7-8, 8-9, and 9-10+ birth is 44%, 51% and 43%, respectively. From all the age groups it is observed that increasing the parity at the same time CFR also increases. The estimation of PPR of all women calculated (Table 5) by the use of all women aged 15-49 years ranges by the number of CEB according to age group of BDHS 2014 (Table 2).

Table 5: Parity progression ratios for all women by birth cohort by age groups based on BDHS 2014

Parity progression	Age group						
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**
0-1	**0.245931**	0.725111	0.911149	0.966926	0.979863	0.975772	0.984082
1-2	0.101541	**0.435927**	0.765217	0.905768	0.928728	0.935248	0.958406
2-3	0.080357	0.96850	**0.405032**	0.631248	0.715631	0.803748	0.860157
3-4	-	0.64444	0.307615	**0.448094**	0.571053	0.656088	0.741416
4-5	-	0.108108	0.250814	0.399215	**0.524194**	0.601185	0.662571
5-6	-	-	0.285714	0.344262	0.492308	**0.522167**	0.537803
6-7	-	-	0.181818	0.32381	0.352679	0.471698	**0.501326**
7-8	-	-	-	0.264706	0.405063	0.413333	**0.449735**
8-9	-	-	-	0.333333	0.4375	0.419355	**0.517647**
>9	-	-	-	-	0.357143	0.423077	**0.431818**
CFR	0.27	0.73	2.00	2.79	3.26	3.66	4.11

Source: Calculated by the author from the Table 2

5.3 Parity progression ratios of all women based on BDHS 2017-18

Among all women of the age group 15-19 years, the possibility of having the first child for those who have zero children is 22% in Bangladesh DHS 2017-18 (Table 6). It signifies that one-fifth of them are expecting their first birth soon at early age group of reproductive period and CFR of this group is 0.26. Among all women of the age group 20-24 years, the probability of getting a second child for those who have already had one child is about 44% indicating over two-fifths of them are expecting their second birth soon and the CFR of this group is 1.04. For all women of the age group 25-29 years, the possibility of getting a third child for those who have already had two children is about 36%. It signifies that over three-fifths of them are expecting their third birth soon and CFR of this group is 1.89. Among all women of the age group 30-34 years, the possibility of getting a fourth child for those who have already had three children is about 40% and it signifies that two-fifths of them are expecting their fourth birth soon and CFR of this group is 2.62. The possibility of having a fifth child for those who have already had four children in the age group 35-39 years is about 43%. It signifies that over two-fifths of them are expecting their fifth birth soon and the CFR of this group is 3.09. For all women of the age group 40-44 years, the probability of getting a sixth child for those who have already had five children is 46% and it is indicating that over two-fifths of them are expecting their sixth birth in near future and CFR of this group is 3.53 and finally all women of age group 45-49 years, probability of having the seventh child for those who have already had the six children is 50% and it signifies that about half of them are expecting their seventh birth in near future and CFR of this group is 3.88. Also for all women of the age group 45-49 years probability of PPR from 7-8, 8-9 and 9-10+ births are 41%, 42% and 43%, respectively. From all the age groups it is observed that increasing the parity at the same time CFR also increase. The estimation of PPR of all women calculated (Table 6) by the use of all women aged 15-49 years ranges by the number of CEB according to age group data of BDHS 2017-18 (Table 3).

Table 6: Parity progression ratios of different birth cohorts by age groups for all women based on BDHS 2017-18

Parity progression	Age group						
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**
0-1	**0.223398**	0.718061	0.909314	0.970051	0.979188	0.974026	0.979991
1-2	0.147632	**0.399730**	0.735849	0.896795	0.940843	0.954667	0.958278
2-3	0.025157	0.161318	**0.347578**	0.566557	0.700301	0.778399	0.821214
3-4	-	0.109948	0.268150	**0.396991**	0.505376	0.624402	0.71066
4-5	-	-	0.209607	0.341108	**0.426596**	0.570881	0.571429
5-6	-	-	0.083330	0.269231	0.381546	**0.464765**	0.584722
6-7	-	-	-	0.222222	0.398693	0.447653	**0.503563**
7-8	-	-	-	-	0.196721	0.330645	**0.415094**
8-9	-	-	-	-	0.500000	0.268293	**0.420455**
>10						0.181818	**0.432432**
CFR	0.26	1.07	1.89	2.62	3.09	3.53	3.88

Source: Calculated by the author from Table 3, Bangladesh Demographic and Health Survey 2017-18

Table 7: Cohort fertility rate of all women from based on BDHS 2011, BDHS 2014, and BDHS 2017-18

Age group	Surveys		
	BDHS 2011	**BDHS 2014**	**BDHS 2017-18**
15-19	0.28	0.27	0.26
20-24	1.22	0.73	1.07
25-29	2.18	2.00	1.89
30-34	2.88	2.79	2.62
35-39	3.42	3.26	3.09
40-44	3.93	3.66	3.53
45-49	4.45	4.11	3.88
TFR^c	2.6	2.4	2.3

Note: 'BDHS, Bangladesh Demographic and Health Survey', 'TFR^c, Cohort total fertility rate'

5.4 Trend of cohort total fertility rate of all women

The following figure (Figure 1) represents the TFR^c for all women was 2.6 in BDHS 2011, 2.4 in BDHS 2014, and 2.3 in BDHS 2017-18. The trend shows a decreasing path.
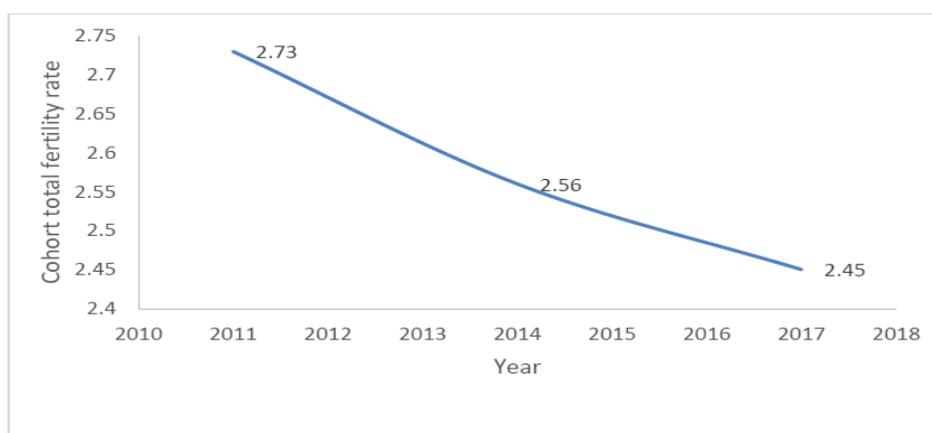
Figure 1: Trend of cohort total fertility rate for all women

Table 8: Distribution of currently married women of age group 15-49 years by number of children ever born by age groups based on BDHS 2011

Parity / Age	0	1	2	3	4	5	6	7	8	9	>9	Total
15-19	883	887	139	13	2	-	-	-	-	-	-	1925
20-24	431	1511	1083	296	61	14	-	-	-	-	-	3396
25-29	130	581	1376	783	287	75	23	7	-	-	-	3262
30-34	58	203	749	752	463	185	73	30	13	3	3	2532
35-39	40	102	427	581	447	241	150	46	33	10	4	2081
40-44	33	74	322	459	366	260	209	112	58	27	17	1937
45-49	24	51	162	266	263	251	181	147	78	45	33	1501

Source: Calculated by the author from the BDHS-2011

Table 9: Distribution of currently married women of age group 15-49 years by number of children ever born by age groups based on BDHS 2014

Parity Age	0	1	2	3	4	5	6	7	8	9	>9	Total
15-19	903	974	101	8								1984
20-24	437	1529	963	199	35	3						3166
25-29	149	725	1391	679	234	52	16	3				3249
30-34	58	239	963	914	444	199	67	23	9	3		2919
35-39	19	123	553	616	401	222	142	45	17	11	4	2153
40-44	30	96	330	484	373	266	158	86	28	15	9	1875
45-49	18	54	192	320	313	281	168	92	33	22	18	1512

Source: Calculated by the author from the BDHS 2014

Table 10: Distribution of currently married women of age group 15-49 years by number of children ever born by age groups based on BDHS 2017-18

Parity Age	0	1	2	3	4	5	6	7	8	9	>9	Total
15-19	995	893	116	4	-	-	-	-	-		-	2008
20-24	550	1718	976	168	14	-	-	-	-	-	-	3426
25-29	183	816	1581	637	179	45	3	-	-	-	-	3444
30-34	56	304	1260	1006	443	169	50	13	-	-	-	3301
35-39	43	135	748	510	240	89	46	5	-	-	-	1816
40-44	32	74	441	590	420	297	139	82	25	8	2	2110
45-49	24	69	329	454	474	266	178	115	43	17	15	1984

Source: Calculated by the author from BDHS 2017-18

5.5 Parity progression ratios of currently married women based on BDHS 2011

Among currently married women aged 15-19, the possibility of getting one child for those with zero children is about 54% in Bangladesh DBHS 2011(Table 11). For currently married women of age group 15-19 years, PPR from 1-2 and 2-3 birtsh are about 15% and 10%, respectively and the CFR of this group is 0.63. The possibility of getting a second child for those who have in the meantime, had one child of age group 20-24 years among currently married women is 49%. It indicates that about half of them are expecting their second child soon and CFR of this group is 1.43. The probability of getting a third child for those who have had two children of age group 25-29 years, among currently married women is 46%. It indicates that over two-fifths of them are expecting their third birth soon and the CFR of this group is 2.26. The possibility of currently married women who have four children in the age group 30-34 years, among currently married women, is about 44%. It indicates that over two-fifths of them are expecting their fourth birth soon and the CFR of this group is 2.70. The possibility of getting a fifth child for those who have four children of age group 35-39, among currently married women is about 52%. It indicates that over half of them are expecting their fifth birth shortly and CFR of this group is 3.51. The possibility of getting a sixth child for those who have already had five children of age group 40-44 years, among currently married women, is about 62%. It indicates that over three-fifths of them are expecting their sixth birth shortly and the CFR of this group is 4.01.The probability of getting a seventh child of currently married women who have already had six children in the age group 45-49 is 62%. This signifies that over three-fifths of them

expect their seventh birthday shortly, and the CFR of this group is 4.63. Also, for currently married women of the age group 45-49 years, the probability of PPR from 7-8, 8-9 and 9-10+ birth is 51%, 50% and 42%, respectively in Bangladesh. The PPRs of currently married women in different birth cohorts (Table 11) were calculated by the use of currently married women of age group 15-49 years by number of CEB according to age group data of BDHS 2011 (Table 8).

Table 11: Parity progression ratios of currently married women by birth cohorts based on BDHS 2011

Parity progression	Age group						
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**
0-1	**0.541299**	0.873086	0.960147	0.919826	0.980778	0.98296	0.984011
1-2	0.148752	**0.490388**	0.814496	0.678403	0.950024	0.96113	0.965471
2-3	0.096774	0.255158	**0.460212**	0.522152	0.779783	0.82404	0.886396
3-4	0.133333	0.202156	0.333049	**0.437576**	0.615741	0.69562	0.789557
4-5	-	0.186667	0.265985	0.487535	**0.519871**	0.6511	0.736473
5-6	-	-	0.278846	0.437576	0.502066	**0.61933**	0.658503
6-7	-	-	0.206897	0.487535	0.382716	0.50591	**0.621901**
7-8	-	-	-	0.585227	0.505376	0.47664	**0.511628**
8-9	-	-	-	0.737864	0.297872	0.43137	**0.506494**
>9	-	-	-	0.828947	0.285714	0.38636	**0.423077**
CFR	0.63	1.43	2.26	2.70	3.51	4.01	4.63

Source: Calculated by the author from the Table 8, BDHS 2011

5.6 Parity progression ratios of currently married women based on BDHS 2014

Among currently married women of age group 15-19 years, the possibility of having the first child for those who have zero children is 54% in BDHS 2014 (Table 12) and it signifies that over two-fifths of them are expecting their first birth soon at early ages group of reproductive period and CFR of this group is 0.60. Among currently married women of the age group 20-24 years, the probability of getting a second child for those who have already had one child is about 44% and it is indicating that over two-fifths of them are expecting their second birth shortly and the CFR of this group is 1.42. For currently married women of the age group 25-29 years, the possibility of getting their third child for those who have already had two children is 41% and it signifies that over two-fifths of them are expecting their third birth shortly and CFR of this group is 2.26. Among currently married women of the age group 30-34 years, the possibility of getting a fourth child for those who have already had three children is about 45%.It signifies that over two-fifths of them are expecting their fourth birth shortly and the CFR of this group is 2.70. The possibility of getting a fifth child for those who have already had four children of currently married women of age group 35-39 years is 52% and it signifies that over half of them are expecting their fifth birth shortly and the CFR of this group is 3.51. For currently married women of the age group 40-44 years, probability of getting a sixth child for those who have already had five children is 52% and it is indicating that over half of them are expecting their sixth birth shortly, and CFR of this group is 4.01 and finally currently married women of age group 45-49 years, probability of having the seventh child for those who have already had the six children is about 50%. It signifies that about half of them are expecting their seventh birth in near future and CFR of this group is 4.63. Also, for currently married women of age group 45-

49 years probability of PPR from 7-8, and 8-9 and9-10+ birth is 44%, 54% and 45%, respectively in Bangladesh. The PPRs of currently married women in different birth cohorts (Table 12) were calculated by the use of currently married women of age group 15-49 years by number of CEB according to age group data of BDHS 2011 (Table 9).

Table 12: Parity progression ratios of different birth cohorts for currently married women based on BDHS 2014

Parity progression	Age group						
	15-19	20-24	25-29	30-34	35-39	40-44	45-49
0-1	**0.544859**	0.861971	.95414	0.980130	0.991175	0.984000	0.988095
1-2	0.098982	**0.439722**	.766129	0.916463	0.942362	0.947967	0.963855
2-3	0.056075	0.19750	**.414316**	0.632723	0.725012	0.811321	0.866667
3-4	-	0.160338	.309959	**0.449668**	0.577503	0.658915	0.74359
4-5	-	0.078947	.232787	0.404826	**0.523753**	0.60107	0.662716
5-6	-	-	.267606	0.344371	0.496599	**0.52669**	0.541463
6-7	-	-	.157895	0.355769	0.351598	0.466216	**0.495495**
7-8	-	-		0.297297	0.415584	0.376812	**0.442424**
8-9	-	-		0.272727	0.46875	0.461538	**0.547945**
>9					0.266667	0.375000	**0.450000**
CFR	0.60	1.42	2.26	2.70	3.51	4.01	4.63

Source: Calculated by the author from Table 9

5.7 Parity progression ratios of currently married women based on BDHS 2017-18

Among currently married women of the age group 15-19 years, the probability of having the first birth for those who have zero children is about 50% in BDHS 2017-18 (Table 13) and it is indicating that half of them are expecting their first birth shortly, at the early age group of reproductive period and CFR of this group is 0.56. For the birth of currently married women of the age group 20-24 years, the probability of having a second child for those who have already had one child is 40%, It indicates that two-fifth of currently married women are expecting their second birth shortly and the CFR of this group is 1.24. For currently married women of the age group 25-29 years, the probability of getting a third child for those who have already had two children is about 35% and it is indicating that over one-three of them are expecting their third birth shortly and the CFR of this group is 1.98. For currently married women of the age group 30-34 years, the probability of having a fourth child for those who have already had three children is 46% and it is indicating that over two-fifths of them are expecting their third birth shortly and CFR of this group is 2.69. For currently married women of the age group 35-39 years, the probability of having a fifth child for those who have already had four children is about 37% and it is indicating that over two-fifths of them are expecting their fourth birth shortly and the CFR of this group is 3.13. For currently married women of age group 40-44 years, the probability of having a sixth child for those who have already had five children is about 46% and it is indicating that over two-fifths of them are expecting their fifth birth shortly and the CFR of this group is 3.59 and finally currently married women of age group 45-49 years, probability of having the seventh child for those who have already had the six children is about 51%. It indicates that over half of them are expecting their seventh child shortly and the CFR of this group is 3.95. Also, for currently married women of age group 45-49 years, the probability of PPR from 7-8, and 8-9 and9-10+ birth is 39%, 42% and 46% respectively in Bangladesh. The PPRs of currently married women in different birth cohorts (Table 13) were calculated by the use of currently married women of age group 15-49 years by number of the CEB according to age group data of BDHS 2011 (Table 10).

Table 13: Parity progression ratios different birth cohorts for currently married women based on BDHS 2017-18

Parity progression	Age group						
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**
0-1	**0.504482**	0.839463	0.946864	0.983035	0.976322	0.985301	0.988401
1-2	0.11846	**0.402643**	0.749770	0.906317	0.923858	0.964389	0.964286
2-3	0.033333	0.157168	**0.353374**	0.571574	0.543345	0.77994	0.825926
3-4	-	0.076923	0.262700	**0.401547**	0.42696	0.622521	0.709161
4-5	-	-	0.211454	0.343704	**0.368421**	0.568345	0.571816
5-6	-	-	0.62500	0.271552	0.364286	**0.462929**	0.581359
6-7	-	-	-	0.206349	0.098030	0.457031	**0.516304**
7-8	-	-	-	-	-	0.299145	**0.394737**
8-9	-	-	-	-	-	0.285714	**0.426667**
>9	-	-	-	-	-	0.200000	**0.468750**
CFR	0.56	1.24	1.98	2.69	3.13	3.59	3.95

Source: Calculated by the author from Table 10

Table1 14: Cohort fertility rate of currently married women based on BDHS 2011, BDHS 2014, and BDHS 2017-18

Age groups	Surveys		
	BDHS 2011	**BDHS 2014**	**BDHS 2017-18**
15-19	0.63	0.60	0.56
20-24	1.43	1.31	1.24
25-29	2.26	2.11	1.98
30-34	2.70	2.66	2.69
35-39	3.51	3.35	3.13
40-44	4.01	3.75	3.59
45-49	4.63	4.17	3.98
TFR^C	2.73	2.56	2.45

Note: 'BDHS, Bangladesh Demographic and Health Survey', 'TFR^c, Cohort total fertility rate'

5.8 Trend of cohort total fertility rate of currently married women
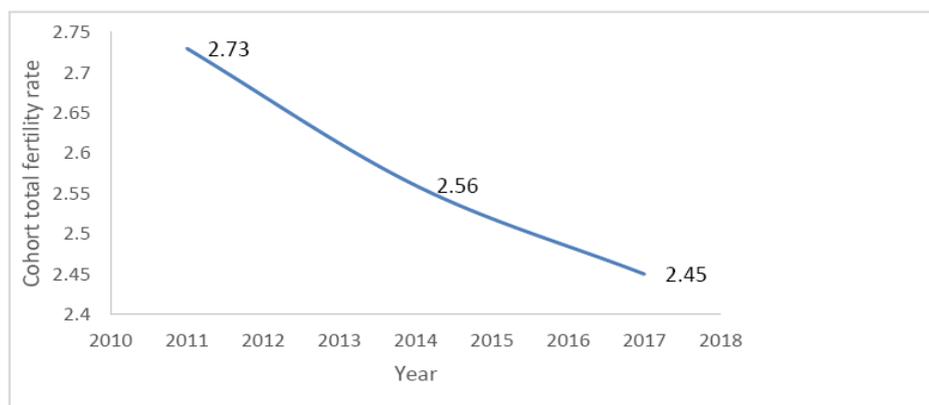
Figure 2: Trend of cohort total fertility rate of currently married women

The following figure (Figure 2) represents the TFR^c for of currently married women was 2.73 in BDHS 2011, 2.56 in BDHS 2014, and 2.45 in BDHS 2017-18. The trend shows a decreasing path.

Table 15: Cohort fertility raets of all women and currently married women based on BDHS 2011

All women		Currently married women	
Age group	**CFR**	**Age group**	**CFR**
15-19	0.28	15-19	0.63
20-24	1.22	20-24	1.43
25-29	2.18	25-29	2.26
30-34	2.88	30-34	2.70
35-39	3.42	35-39	3.51
40-44	3.92	40-44	4.01
45-49	4.45	45-49	4.63
TFR^c	2.62		2.73

Source: Calculated by the author from Table 4 and Table 11.

5.9 Trend of all women and currently married women of CFR of the different age groups of BDHS 2011
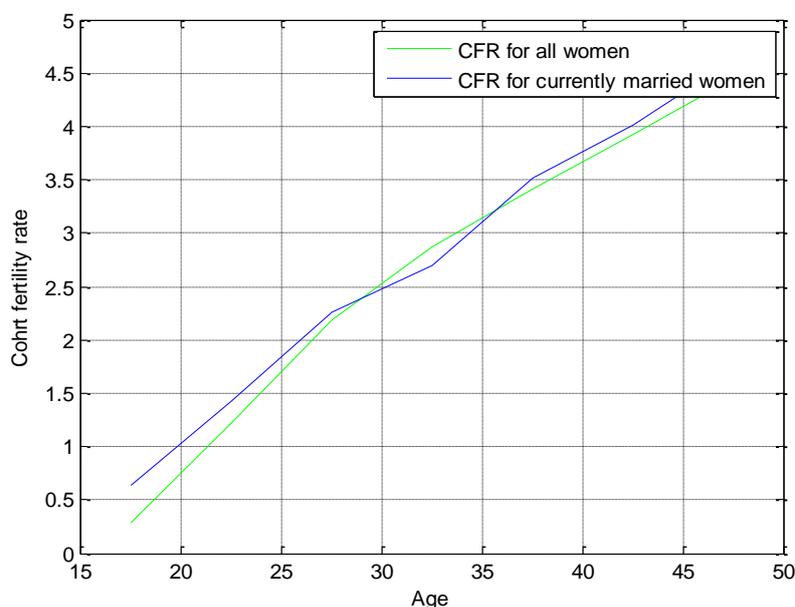
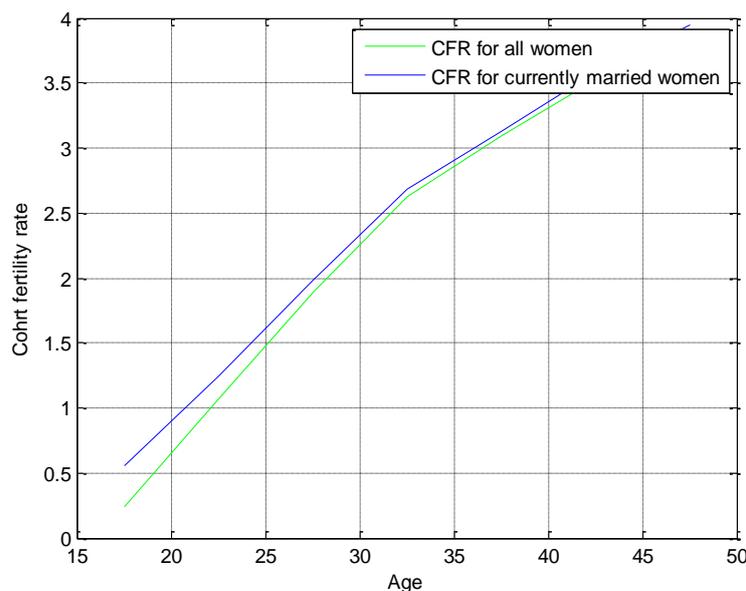**Figure 3:** Trend of cohort fertility rates for all women and currently married women of BDHS 2011

Fertility rates by the method PPR shows that currently married women higher CFR compared to all women (TFR^c 2.73>2.62). Figure 3 shows that CFR were generally greater currently married women than all women except for the age group 30-34 of CFR. The pattern for both all women

and currently married women shows a linear increased trend of CFR because CFR are increased with increases in the order of parity.

Table 16: Cohort fertility rats of all women and currently married women based on BDHS DHS 2014

All women		Currently married women	
Age group	CFR	Age group	CFR
15-19	0.27	15-19	0.60
20-24	0.73	20-24	1.42
25-29	2.00	25-29	2.26
30-34	2.79	30-34	2.70
35-39	3.26	35-29	3.51
40-44	3.66	40-44	4.01
44-49	4.11	44-49	4.63
TFR^c	2.39	TFR^c	2.56

Source: Calculated by the author from the Table 5 and Table 12.

5.10 Trends of all women and currently married women of CFR of different age groups based on BDHS 2014
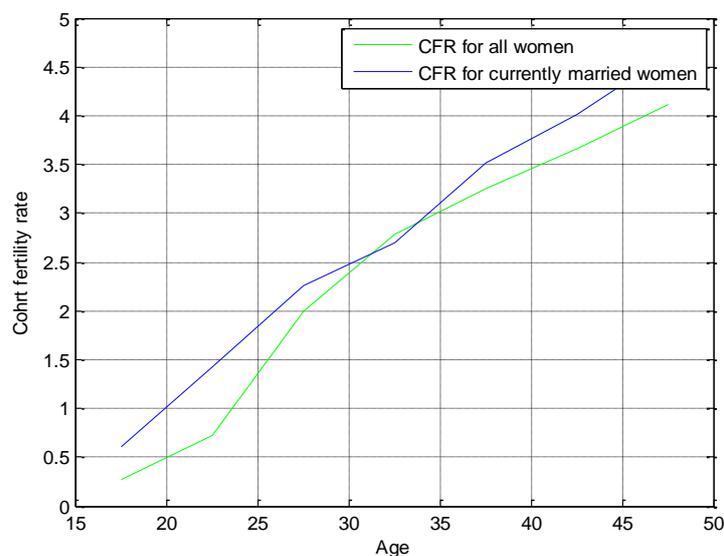
Figure 4: Trend of cohort fertility rates for all women and currently married women of BDHS 2014

Fertility rates by the method PPR shows that currently married women higher CFR compared to all women (TFR^c: 2.56>2.39). Figure 4 shows that CFR were generally greater currently married women than all women except for the age group 30-34 of CFR. The pattern for both all women and currently married women shows a linear increased trend of CFR because CFR are increased with increases in the order parity.

Table 17: Cohort fertility rates of all women and currently married women based on BDHS 2017-18

All women		Currently married women	
Age group	**CFR**	**Age group**	**CFR**
15-19	0.26	15-19	0.56
20-24	1.07	20-24	1.24
25-29	1.89	25-29	1.98
30-34	2.62	30-34	2.69
35-29	3.09	35-29	3.13
40-44	3.53	40-44	3.59
44-49	3.88	44-49	3.95
TFR^c(esti)	2.32	TFR^c(esti)	2.45

Source: Calculated by the author from Table 6 and Table13

5.11 Trends of all women and currently married women of CFR of the different age groups of women based on BDHS 2017-18

Figure 5: Trend of cohort fertility rates for all women and currently married women of BDHS 2017-18

Fertility rates determined by the method PPR show that currently married women have always higher CFR compared to all women (TFR^c: 2.45>2.3). Figure 5 shows that CFR there were greater currently married women than all women. The pattern for both all women and currently married women shows a linearly increased trend of CFR because CFR are increased with increases in the order of parity. Figure 5 shows that the all-women cohort total fertility, TFR^c and total fertility of BDHS are the same, which is 2.3.

6. Conclusions

This study aimed to highlight the trends in TFR across the three successive BDHS surveys of 2011, 2014, and 2017-18. As reproductive patterns have evolved, understanding TFR through the family-building process tracking how women progress from lower to higher parities and the time required for this progression using PPRs has become increasingly important. The TFR estimates based on PPRs for different birth cohorts revealed a higher likelihood of women opting for more children as their age increases, particularly among currently married women. The data shows that women in younger age groups, such as 15 to 19, have a lower TFR than older, currently married women. This declining pattern is consistent across age groups. The results demonstrate that the TFR^c for currently married women (2.7) is higher than for all women (2.6), a trend reflected in subsequent tables. Again, the TFR^c for currently married women (2.56) is higher than for all women (2.39), and currently married women have a higher TFR^c (2.45) than all women (2.32). The consistency of this trend across the 2017-18 BDHS is evident, and despite a slight increase in specific BDHS indicators, overall fertility rates continue to decline. Further, the study shows that TFR^c for all women is consistently lower than for currently married women, likely due to the inclusion of widows and divorced women in the former group. Overall, the TFR^c and TFR from the BDHSs are gradually converging, reflecting an ongoing decline in fertility over time.

The study's findings highlight several important policy implications. Targeted FP programs should focus on younger women, providing education and resources to help them make informed reproductive choices. Older, currently married women, who trend to have more children, may benefit from specialized reproductive healthcare. Additionally, policies must address the needs of divorced and widowed women, who trend to have lower fertility rates, by ensuring access to FP services. As fertility rates continue to decline, policymakers should aim to sustain this trend while balancing population control with socioeconomic development. Regularly monitoring fertility trends will also be essential to adapt policies to the evolving reproductive patterns in Bangladesh.

List of abbreviations: CEB: Children ever born, TFR: Total fertility rate, TFR^c: Cohort total fertility rate, BDHS: Bangladesh Demographic and Health Survey, PPR: Parity progression ration, FP: Family planning.

Author contributions: MMH, MNI, and MAS contributed to the study's conceptualization, developed the methodology, conducted data management, performed formal analysis, and interpreted the results. Additionally, MMH, MGH, and MNIM wrote the article's first draft and reviewed and edited it. MNI, MAS, and ASMA reviewed the article, provided supervision, and validated the research. All authors have read and agreed to the final version of the manuscript.

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