Asian Journal of Population Sciences p-ISSN 2822-1613
(A Peer-Reviewed, Open Access Journal; Indexed in NepJOL) e-ISSN 2822-1621
Email: population@pncampus.edu.np
eJournal Site: http://ejournals.pncampus.edu.np/ejournals/ajps/

[ORIGINAL RESEARCH ARTICLE]

Estimation and Comparative Analysis of Cohort and Period Total Fertility Rates in Bangladesh

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Article History
Submitted 30 August 2025; Reviewed 25 November 2025; Accepted 22 December 2025
DOI: https://doi.org/10.3126/ajps.v5i1.89339

Published by
Department of Population Studies
Prithvi Narayan Campus
Tribhuvan University
Pokhara, Nepal

Scan to Access eJournal

ABSTRACT

Background: Fertility rates are one of the most important factors in understanding demographic change. Issues related to population planning strategy are generated in Bangladesh because of its high fertility rates, still just marginally above the replacement rates. There is very little literature available related to Bangladesh, because the decrease in cohort fertility rates in developed countries has been widely reported. Focusing on parity progression and the process of family formation, this analysis examines the magnitude of the cohort fertility rate (CFR) and the total cohort fertility rate (TFRc).

Methods: This research used BDHS 2017-18 as its data source. Fertility was analyzed with parity progression ratio (PPR). The length of time between births and the chance of upgrading with increasing birth order are

important factors that have been evaluated. In exploring these trends, PPR values are evaluated with three approaches: by the proportion of women with at least one child ever born (CEB), the calculated TFRc values, and direct PPR values. Several estimates have been created for women in general and the married ones.

Results: The results reveal that the total fertility rate of Bangladesh remains a slight above the replacement rate. The TFRc for all women was 2.30, whereas for married women, the TFRc was 2.45, which matches the generally given TFR of 2.3 in BDHS 2017-18. Notwithstanding the total fertility rate gradually dropping, women are still mostly moving up from lower orders to higher orders of fertility, indicated by PPR study research.

Conclusions: Parity-based approaches such as PPR are important in understanding fertility change, as underscored in this study. While fertility is lower, it is still above replacement levels, and hence FP programs need to be strengthened, RH services need to be expanded, and families need to aim for small family sizes through policies that incorporate the use of PPR in fertility estimation.

Keywords: Parity; Total fertility rate; Cohort total fertility rate; Parity progression ratio; Children ever born

INTRODUCTION

The total fertility rate (TFR) represents the average number of children a woman is anticipated to have during her lifetime, based on prevailing fertility trends. The cohort total fertility rate (TFR^c) assesses the average number of children a woman would bear if she were to experience the age-specific fertility rates of a specific cohort throughout her reproductive span (15-49 years). The TFR^c offers a more precise estimate of completed fertility in comparison to the period TFR, as it takes into account actual birth patterns over time. In contrast to the period TFR, which shows fertility at a particular moment, the TFR^c delivers a longitudinal view by monitoring a specific cohort of women as they age. This methodology aids in reducing the distortions caused by variations in birth timing and delivers a clearer understanding of fertility trends and behaviors. The parity progression ratio (PPR) signifies the proportion of women at a certain parity who go on to have another child. The PPR is defined as the conditional probability of the (i+1)-th birth given that a woman has already had the i-th birth, serving as a significant measure of fertility dynamics and family formation (Srinivasan, 1968; Srnvasan, 1967). The PPR model is an effective instrument for assessing family planning (FP) initiatives and examining the factors influencing fertility (Feeney, 1983). The three fundamental elements of population change are fertility, mortality, and migration (Pandey et al., 1997). Analyzing fertility is important for understanding population dynamics, as it offers insights into fertility levels, patterns, and temporal variations. A primary emphasis is placed on the interval between live births, which is a vital indicator of fertility levels and patterns (Singh & Shukla, 2018). This determinant indicates the probability that women of a specific birth order will advance to their subsequent birth, emphasizing the significance of PPR analysis in examining fertility and the effects of contraceptive use within populations (Bosson-Amedenu Senyefia, 2019). The PPR is affected by age-related secondary infertility, while Hajnal (1947) distinctly approved the limits of period measures in the analysis of fertility trends.

The birth interval, defined as the duration between the birth of one child and the subsequent child, is a crucial element in fertility research. The data available regarding birth intervals offers a considerable benefit for assessing fertility levels and elucidating

variations in fertility trends (Ní Bhrolcháin, 1987). The persistent decline in cohort fertility rate (CFR) has been extensively examined and recorded in developing nations (Billari & Kohler, 2004; Frejka, 2008; Frejka & Calot, 2001). In this regard, Ryder and Henry (1980) were among the first to calculate PPR with applying the life table technique for all PPR. Furthermore, Yadava and Bhattacharya (2021) introduced an alternative approach for determining PPRs, which utilized data on both open and last closed birth intervals for women who were still within their reproductive years. This method represented a decisive modification of Srinivasan's technique (Srinivasan, 1968) and did not necessitate information regarding the age at last birth for women who had concluded their reproductive phase. Following this, Yadava et al. (1992) created various another techniques for calculating PPR. Additionally, Brass (1975) was a trailblazer in the application of birth order statistics for estimating PPR, a technique that was subsequently embraced by numerous other scholars. Among these investigations, Pandey and Suchindran (1997) calculated PPR using vital statistics, while Pandey et al. (1997) utilized birth order data and examined both closed and open birth intervals to assess parity progression and instantaneous PPRs.

The TFR assesses overall fertility levels but fails to indicate the transition of women to subsequent births at each parity stage. In contrast, the PPR, which monitors the percentage of women advancing from the *i*-th to the (*i*+1)-th birth, is crucial for comprehending family formation trends, particularly in Bangladesh. The significance of tracking PPR trends through birth history surveys has increased (Pandey and Suchindran, 1989). Several studies have created models to estimate the PPR utilizing birth interval data (Feeney, 1983; Feeney and Ross, 1984; Islam and Yadava, 1997). Over the past few decades, fertility rates in Bangladesh have consistently decreased due to advancements in female education, FP, and socioeconomic progress; nevertheless, the TFR remains marginally above the replacement level, which raises concerns regarding population planning. Unlike developed nations, where cohort fertility has been thoroughly examined to gain insights into lifetime reproductive behaviors, data for Bangladesh is scarce. This deficiency obstructs a comprehensive understanding of long-term fertility trends, parity progression, and their consequences for policy and population management. Consequently, this research intends to estimate the Cohort Fertility Rate (CFR) and the Total Fertility Rate corrected (TFR^c) among Bangladeshi women by utilizing nationally representative data from the 2017-18 Bangladesh Demographic and Health Survey (BDHS). It investigates fertility trends and PPR across various cohorts to elucidate the family-building process. Additionally, the study contrasts cohort-based fertility metrics with period indicators to evaluate shifts in reproductive behavior over time.

DATA AND METHODS

This study utilized data from the BDHS 2017-18 and employed the basic PPR method to assess fertility trends (NIPORT, 2020). The analysis categorized women according to their age and birth order, illustrating the total number of children ever born (CEB) in Bangladesh. To compute the PPR, cohort fertility data obtained from that survey were utilized. Two key tabulations were utilized: the distribution of women by parity over five-year cohorts for all women and for currently married women. These distributions were essential for calculating PPRs. To calculate PPRs, women were first grouped in ascending order by parity. The cumulative number of women from the bottom was determined, providing the number of women with at least *i*-th CEB. The probability of having the next (*i*+1)-th birth was calculated by dividing the number of women with at

least (i+1)-th CEB by the number of women with at least i-th CEB. The CEB and average CEB were calculated using in the following ways: $CEB = \sum_{i=1}^{n} B_i$, where B_i, each live birth a woman has had and n, total number of live births over her lifetime. Again, for a group of women, Average $CEB = \frac{\sum_{j=1}^{N} CEB_i}{N}$, where CEB_j, CEB of woman j and N, number of women in the group. This ratio represents the PPR from i-th to (i+1)-th parity. The formula for calculating PPR is as follows:

$$PPR_{i-(i+1)} = \frac{\text{Number of women who have (i+1)−th birth}}{\text{Number of women who have i−th birth}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Equation (1) provides the probability of having the $(i + 1)$-th birth for women who have already had the iii-th birth, both among all women and among currently married women. Comparing these probabilities across women of similar ages can help detect changes in fertility behavior (Sloggett, 2015a, 2015b). However, as noted by Moultrie, *et. al.* (2013), while more reliable conclusions can be drawn by comparing PPRs for the same cohorts across multiple periods, examining successive cohorts also provides valuable information on trends in total fertility within a country.

Cohort fertility rate

The CFR can be derived from PPR values as a mathematical series of their products, which is expressed in equation (Pandey et al., 1997):

$$CFR = a_0(1 + a_1 + a_1a_2 + a_1a_2a_3 + a_1a_2a_3a_4 + \ldots\ldots\ldots\ldots), \quad \ldots\ldots\ldots (2)$$

where, a_0 = PPR from 0 to 1 birth, a_1 = PPR from 1 to 2 births, a_2 = PPR 2 to 3 births, a_3 = PPR from 3 to 4 births, a_4 = PPR from 4 to 5 births and so on.

Levels and patterns of PPRs in BDHS 2017-18

For the PPR analysis, Bangladeshi women were divided into seven age groups (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49 years). These groups cover the entire reproductive age span of 15-49 years. The study examined PPRs for each group to understand fertility patterns in Bangladesh. Calculations were done separately for all women and for currently married women across different birth cohorts.

RESULTS

Distribution of all women by number of CEB across different age groups

Table 1 presents the distribution of women aged 15-49 years by the number of CEB, based on data from the BDHS 2017-18 (NIPORT, 2020). The table illustrates the variation in fertility among various age groups, emphasizing the percentage of women who are childless, those with one child, and those with multiple births. It depicts the evolution of childbearing throughout the reproductive lifespan, showing that younger women are predominantly found in the lower parity categories, while older women are more prevalent in the higher parity categories. This distribution offers a comprehensive overview of fertility trends among Bangladeshi women at different phases of their reproductive years.

Table 1

Distribution of all women cohort aged 15-49 by number of children ever born according to age group data of BDHS 2017-18

	Number of CEB											
Parity / Age	0	1	2	3	4	5	6	7	8	9	10+	Total
15-19	3744	918	115	5	-	-	-	-	-	-	-	4782
20-24	1193	1778	993	170	21	-	-	-	-	-	-	4155
25-29	333	882	1603	652	182	48	4	-	-	-	-	3704
30-34	105	351	1322	1042	452	172	49	14	-	-	-	3507
35-39	61	167	796	920	540	248	92	49	6	6	-	2885
40-44	60	102	476	628	448	319	153	83	30	9	2	2310
45-49	46	94	386	513	540	299	209	124	51	21	16	2299

Note: *CEB,* children ever born

The PPRs of all women aged 15-49 years in Bangladesh

The PPRs are shown in Table 2 for women of age 15-49 years and the likelihood of moving one parity to the next. This table illustrates the probabilities of births of further children at different reproductive ages and gives an indication about fertility patterns and family-building activities among women in Bangladesh.

Table 2

Parity progression ratios for all women aged 15-49 years

Age group (in year)	CEB	Women	Total	PPR	CFR
15-19	0	3744	4782		0.24320368
	1	918	1038	0.21706399	
	2	115	120	0.115606936	
	3	5	5	0.041666667	
20-24	0	1193	4155		1.048857
	1	1778	2962	0.712876053	
	2	993	1184	0.399729912	
	3	170	191	0.161317568	
	4	21	21	0.109947644	
25-29	0	1193	4155		1.899568
	1	1778	2962	0.712876053	
	2	993	1184	0.399729912	
	3	170	191	0.161317568	
	4	21	21	0.109947644	
30-34	0	105	3507		2.617907043
	1	351	3402	0.97005988	
	2	1322	3051	0.896825397	
	3	1042	1729	0.566699443	
	4	452	687	0.397339503	
	5	172	235	0.342066958	
	6	49	63	0.268085106	
	7	14	14	0.222222222	
35-39	0	61	2885		3.091223
	1	167	2824	0.978856	
	2	796	2657	0.940864	
	3	920	1861	0.700414	
	4	540	941	0.505642	
	5	248	401	0.426142	
	6	92	153	0.381546	
	7	49	61	0.398693	
	8	6	12	0.196721	
	9	6	6	0.5	
40-44	0	60	2310		3.534632
	1	102	2250	0.974026	
	2	476	2148	0.954667	
	3	628	1672	0.778399	
	4	448	1044	0.624402	
	5	319	596	0.570881	
	6	153	277	0.464765	
	7	83	124	0.447653	
	8	30	41	0.330645	
	9	9	11	0.268293	

	10+	2	2	0.181817	
45-49	0	46	2299		3.888212
	1	94	2253	0.979991	
	2	386	2159	0.958278	
	3	513	1773	0.811214	
	4	540	1260	0.719660	
	5	299	6720	0.571429	
	6	209	421	0.584722	
	7	124	212	0.503563	
	8	51	88	0.415094	
	9	21	37	0.420455	
	10+	16	16	0.432432	

Notes: 'CEB, Children ever born', 'PPR, Parity progression ratio', 'CFR, Crude fertility rate'

The PPRs of Bangladeshi women show variation in fertility patterns across diverse age cohorts. Among women in the age group 15-19, they show a CFR of about 0.24 children per woman with a lifetime probability of 22% for giving birth to a first child, and about 12% and 4% for second and third births, respectively; demonstrating diminishing probabilities for higher-order births. The CFR for women aged 20-24 is around 1.04 children with the probabilities of having a first, second, third and fourth child at 71%, 40%, 16% and 11%, respectively.

Women in the 20-24 age group average 1.04 children per woman (CFR), with progression probabilities of 71% for a first birth, 40% for a second, 16% for a third, and 11% for a fourth. The CFR hikes to 1.89 among those aged 25-29, where the probabilities of reaching first through sixth births stand at 91%, 74%, 36%, 26%, 22%, and 8%, respectively. This trend continues for women aged 30-34, showing 91% likelihood for the first- to sixth-child, 74% 36%, 26%, 22%, and 8%, respectively. In the 35-39 cohort, the CFR reaches 3.09, with probabilities for first- to ninth-child births dropping from 98% down to 50%. For ages 40-44, CFR reaches 3.53, as PPR fall steadily from 98% for the first birth to just 18% for a tenth. Women aged 45-49 exhibit the highest CFR at 3.89, with first- to tenth-child probabilities declining from 98% to about 43%. These findings reveal a consistent drop in the chances of higher-order births as both age and family size advance.

Distribution of currently married women by number of CEB across age groups

Table 3 presents the distribution of currently married women aged 15-49 by their CEBs which is obtained from BDHS, 2017-18. The table highlights how fertility varies across different age groups, showing the proportion of women with no children, one child, and higher-order births. It highlights the patterns of child spacing among married women and indicates the family-size dynamics in reproductive age stages as it has evolved in Bangladesh.

Table 3

Distribution of currently married women aged 15-49 years by number of children ever born according to age group data of BDHS 2017-18.

Parity / Age	0	1	2	3	4	5	6	7	8	9	10+	Total
15-19	995	893	114	4								2006
20-24	550	1717	976	168	24							3435
25-29	183	817	1581	637	179	45	3					3445
30-34	56	304	1260	1006	443	169	45	3				3308
35-39	43	135	748	510	240	89	46	8	5			2699
40-44	32	74	441	420	297	297	139	80	25	8	2	2109
45-49	23	69	329	454	474	266	179	115	44	16	14	1983

The PPRs of currently married women aged 15-49 years in Bangladesh

The PPRs for ever-married women in their reproductive span (15-49 years) are presented in Table 4. The PPR estimates the chance that a woman with a specified number of children gives birth to her next child, thereby it offers information about fertility at consecutive births. PPR values higher than this are associated with a greater probability of advancing to the next parity, while values lower imply an inclination towards family size restriction. These rates are also helpful in understanding fertility behaviour, evaluating reproductive plans and predicting potential population growth.

Table 4

Parity progression ratio for currently married women of the age group of 15-49 years

Age group (in years)	CEB	Women	Total	PPR	CFR
15-19	0	995	2006		0.564806
	1	893	1011	0.503988036	
	2	114	118	0.116716123	
	3	4	4	0.033898305	
20-24	0	550	3435		1.24279476
	1	1717	2885	0.839883552	
	2	976	1168	0.404852686	
	3	168	192	0.164383562	
	4	24	24	0.125	
25-29	0	183	3445		1.988099
	1	817	3261	0.94688	
	2	1581	2445	0.74954	
	3	637	864	0.353374	
	4	179	227	0.262731	
	5	45	48	0.211454	
	6	3	3	0.0625	
30-34	0	56	3308		2.691051995
	1	304	3252	0.983071342	
	2	1260	294	0.906519065	
	3	1006	168	0.572591588	
	4	443	682	0.404028436	
	5	169	239	0.350439883	
	6	50	70	0.292887029	
	7	17	20	0.285714286	
	8	3	3	0.15	
35-39	0	43	2699		3.134864765
	1	135	2656	0.984068173	
	2	748	2521	0.949171687	
	3	875	1773	0.703292344	
	4	510	898	0.506486182	
	5	240	388	0.432071269	
	6	89	148	0.381443299	
	7	46	59	0.398648649	
	8	8	13	0.220338983	
40-44	0	32	2109		3.59412
	1	74	2077	0.984827	
	2	441	2003	0.964372	
	3	591	1562	0.77983	
	4	420	971	0.621639	
	5	297	551	0.567456	
	6	139	254	0.460980	
	7	80	115	0.452756	
	8	25	35	0.304348	
	9	8	10	0.285714	
	10+	2	2	0.200000	
45-49	0	23	1983		3.948563
	1	69	1960	0.988401	
	2	329	1891	0.964796	
	3	454	1562	0.826018	
	4	474	1108	0.709347	
	5	266	634	0.572202	
	6	179	368	0.580442	
	7	115	189	0.513587	
	8	44	74	.391534	
	9	16	30	0.405405	
	10+	14	14	0.466667	

Note: 'CEB, Children ever born', 'PPR, Parity progression ratio', 'CFR, Crude fertility rate'

Analysis of PPRs among currently married women in Bangladesh exposes clear age-specific patterns in fertility. Women aged 15-19 show a strong chance of first births, yet the chances of additional children drop off rapidly as parity rises. This same downward pattern holds for ages 20-24 and 25-29, where first births remain common but subsequent ones become progressively less likely. In the 30-34 and 35-39 age groups, probabilities for more children keep falling with larger family sizes, despite some small ups and downs at higher parities. For older women (40-44 and 45-49), higher average family sizes appear, but the prospect of extra births still wanes steadily with parity, with minor deviations at the highest orders. Therefore, while starting families is almost universal regardless of age, the chances of advancing to more children reliably diminish as both parity and age increase, shedding light on Bangladesh's family formation trends.

PPR of all women aged 15-49 years

The PPRs of the women in their reproductive span (15-49 years) are presented in Table 5, revealing the chance of continuing from one birth order to the next across diverse age groups. The patterns of PPR for all women in Bangladesh reveal the likelihood of having additional children across different age groups. Among 15-19-year-old women, around 22% have the chance of a first birth, meaning more than one in five are on the cusp of their initial childbirth. For those aged 20-24 who already have one child, the chance of a second rise to 40%, implying that about two out of every five will soon welcome another. For women aged 25-29, the probability of having a third child for those with two children is about 36%, signaling that over one-third are expecting a third child soon. In the 30-34 age groups, 40% of women with three children are likely to have a fourth child in the near future. For the 35-39 age groups, the probability of having a fifth child for those with four children is 43%, indicating that over two-fifths are expecting their fifth birth shortly. Similarly, for women aged 40-44, the probability of having a sixth child for those with five children is 46%, suggesting that over two-fifths are expecting their sixth birth soon. For women aged 45-49, the probability of having a seventh child for those with six children is about 50%, indicating that half are expecting their seventh child soon. The probability of having an eighth, ninth, or tenth child for women in this age group, with seven, eight, and nine children respectively, is around 41%, 42%, and 43%, suggesting that over two-fifths of these women are expecting each of these additional births shortly.

Table 5

Parity progression ratios different birth cohorts' age groups for all women, BDHS 2017-18

Parity progression ratios of age groups							
Parity progression	15-19	20-24	25-29	30-34	35-39	40-44	45-49
0-1	**0.21706399**	0.712876053	0.91009719	0.97005988	0.978856153	0.974025974	0.979991301
1-2	0.115606936	**0.39972991**	0.73835657	0.896825397	0.940864023	0.954666667	0.958277852
2-3	0.041666667	0.16131756	**0.35596625**	0.566699443	0.700414001	0.77839851	0.821213525
3-4	-	0.10994764	0.26410835	**0.397339503**	0.505642128	0.624401914	0.710659898
4-5	-	-	0.22222222	0.342066958	**0.426142402**	0.570881226	0.571428571
5-6	-	-	0.07692307	0.268085106	0.381546135	**0.464765101**	0.584722222
6-7	-	-	-	0.222222222	0.39869281	0.44765343	**0.503562945**
7-8	-	-	-	-	0.196721311	0.330645161	**0.41509434**
8-9	-	-	-	-	0.5	0.268292683	**0.420454545**
9-10+						0.181818182	**0.432432432**

***Source**:* Calculated by the author's Table 2**.**

PPR of currently married women aged 15-49 years

Table 6 presents the PPRs for currently married women aged 15-49 years, indicating the likelihood of progressing from one parity to the next across different age groups. The patterns of PPR for currently married women in Bangladesh show similar trends to those of all women. For the age group 15-19 years, the probability of having a first child for women with no children is about 50%, indicating that half of them is likely to have their first birth soon. In the 20-24 age groups, the probability of having a second child for those with one child is about 40%, suggesting that two-fifths are expecting their second child in the near future. For women aged 25-29, the probability of having a third child for those with two children is about 35%, showing that about one-third are likely to have a third child soon. In the 30-34 age groups, 40% of women with three children are expected to have a fourth child shortly. For women aged 35-39, the probability of having a fifth child for those with four children is 43%, indicating that over two-fifths are expecting their fifth birth in the near future. For the 40-44 age group, the probability of having a sixth child for those with five children is 46%, suggesting that over two-fifths are expecting a sixth birth soon. In the 45-49 age group, the probability of having a seventh child for those with six children is about 51%, indicating that more than half are expecting their seventh birth soon. The probability of having an eighth, ninth, or tenth child for women in this age group, with seven, eight, or nine children, is around 39%, and 40% and 47%, showing that over two-fifths of these women are likely to have each of these additional births shortly.

Table 6

Parity progression ratios of different birth cohort age groups for currently married women, BDHS 2017-18

	Parity progression ratios of age groups						
Parity progression	15-19	20-24	25-29	30-34	35-39	40-44	45-49
0-1	**.503988036**	0.83988355	0.94687953	0.98307134	0.98406817	0.98482693	0.988401
1-2	.116716123	**0.40485268**	0.74954015	0.90651906	0.94917168	0.96437169	0.964796
2-3	0.03389830	0.16438356	**0.35337423**	0.57259158	0.70329234	0.77983025	0.826018
3-4	-	0.125	0.2627314	**0.40402843**	0.50648618	0.62163892	0.709347
4-5	-	-	0.21145374	0.35043988	**0.43207126**	0.56745623	0.572202
5-6	-	-	0.06250000	0.29288702	0.38144329	**0.46098003**	0.580442
6-7	-	-	-	0.28571428	0.39864864	0.45275590	**0.513587**
7-8	-	-	-	0.15	0.22033898	0.30434782	**0.391534**
8-9+	-	-	-	-	0.38461538	0.28571428	**0.405405**
9-10+						0.2	**0.466667**

Source: Calculated from Table 4

Table 7 shows that the noticeable slowdown in fertility is mainly due to higher PPRs for second and subsequent births among all women. Among currently married women, however, the PPR shows a declining trend for second and higher parities. While PPR is decreasing at higher parities, the proportion of all women in the 6-7 children birth group has increased, recording the highest ratio. For currently married women, the proportions generally decrease, except for the 6-7 children birth group, where an increase is observed. Again, Figures 1 and 2 show the age-specific CFR for all women and currently married women, respectively, illustrating how fertility changes across different age groups.

Table 7

Comparison parity progression ratios of all women and currently married women's aged 15 to 49 years

Parity progression	Age group (in years)	All women (%)	Currently married women (%)
0-1	15-19	22	50
1-2	20-24	40	40
2-3	25-29	36	35
3-4	30-34	40	40
4-5	35-39	43	43
5-6	40-44	46	46
6-7	45-49	51	51
7-8	45-49	42	39
8-9	45-49	42	40
9-10+	45-49	43	46

Cohort fertility rates

Based on the BDHS 2017-18 data (Table 8), the CFR for all women in the 15-19 age groups is 0.24. The CFR increases with age, peaking at 3.88 for women aged 45-49. The total fertility rate for all women is 2.3, matching the BDHS 2017-18. For currently married women, the CFR for the 15-19 age group is 0.56, also increasing with age and reaching 3.94 in the 45-49 age group. The cohort total fertility rate for currently married women is 2.45, higher than the BDHS 2017-18 TFR.

Table 8

Cohort Fertility Rate of All Women and Currently Married Women Aged 15-49 Years

All women		Currently married women	
Age group	**CFR**	**Age group**	**CFR**
15-19	0.243204	15-19	0.564806
20-24	1.048857	20-24	1.242795
25-29	1.899568	25-29	1.988099
30-34	2.617907	30-34	2.681006
35-29	3.090468	35-29	3.134864
40-44	3.534632	40-44	3.594120
45-49	3.888212	45-49	3.948562
TFR^c estimated	2.331835≈ 2.3	TFR^c estimated	2.450607≈ 2.45
TFR (Observed) = 2.3			

Note: 'TFR^c, Cohort total fertility rate', 'CFR, Cohort fertility rate'

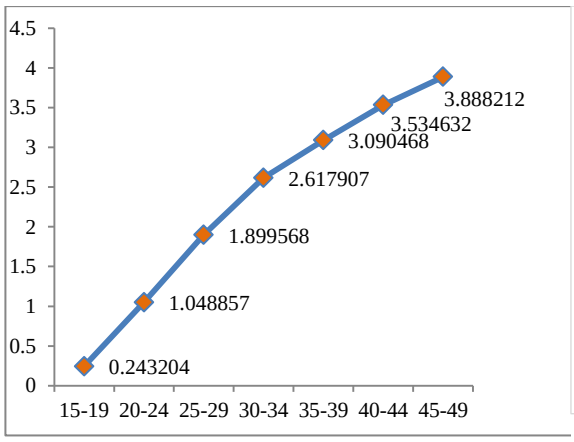

Figure 1. Age-specific cohort fertility rate of all women

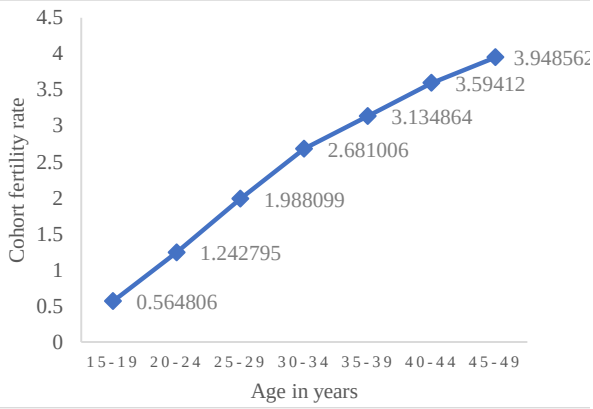

Figure 2. Age-specific cohort fertility rate of currently married women

Compare cohort total fertility rate with total fertility rate

The cohort total fertility rate for all women in the Bangladesh BDHS 2017-18 matches the total fertility rate which is 2.3 (Table 9). For currently married women, cohort total fertility rare is the 2.45. The cohort total fertility rate for currently married women is 0.15 higher than the BDHS 2017-18. A previous study showed that the patterns of PPRs were similar for both currently married and all women across reproductive ages (15-49). The total number of women in the all-women group was 23,642, and for currently married women, it was 18,984. The all-women group includes divorced and widowed women, but the currently married group does not. Because divorced and widowed women usually have fewer children, the TFR^c for currently married women is higher than the TFR reported in BDHS 2017-18.

Table 9

Compare the Cohort's Total Fertility Rates of All Women and Currently Married Women with TFR of BDHS 2017-18.

Obtained from	TFR^c *or* TFR	Comments
Bangladesh Health and Demography Survey TFR	2.3	TFR=2.3
TFR^c of all women	2.3	TFR^c =TFR=2.3
TFR^c of currently married women	2.45	TFR^c >TFR and differs 0.15

Note. 'TFR^c, Cohort fertility rate', 'TFR, Total fertility rate

DISCUSSION

The results of this study provided significant perceptions into the fertility patterns and transitions in Bangladesh through TFR^c and PPRs. These results identified that fertility in Bangladesh remains a little bit higher the replacement level, with a TFR^c of 2.30 among all women and 2.45 among currently married women. These estimates are consistent with the BDHS 2017-18 TFR of 2.3 (NIPORT, 2020), indicating that parity-based methods reliably capture fertility patterns.

The results of PPR analysis show a clear age-related shape in fertility dynamics. Among younger women (15-19 years), a few women (about 12%) with one child were expected to have a second birth, representing delayed family building and lower fertility expectations at the younger ages. This result aligns with Bangladesh's demographic transition, where early marriage is still common but childbearing is increasingly delayed due to higher education, urbanization, and women's participation in the workforce (Islam & Bairagi, 2017; Streatfield & Karar, 2008).

In contrast, among women aged 30-34 years, around 40% of those with 3 children were likely to progress to a 4^{th} birth, highlighting a determined propensity toward higher-order fertility once family building begins. Likewise, in the oldest cohort (45-49 years), who had six children presented nearly a 48-49% chance of developing to the 7^{th} child. This shape emphasises that while fertility is decreasing, higher-parity progression remains prominent, particularly among older cohorts. Such results are reliable with studies from other South Asian countries, where fertility decay has been driven mainly by reductions in higher-order births, but development beyond 3 children remains common in some subgroups (Bongaarts & Casterline, 2018; Chaurasia, 2020).

The higher TFR^c among currently married women (2.45) than among all women (2.30) is due to the elimination of widowed and divorced women. This confirms that fertility among married women is still above the replacement level. Alike differences

have been found in other studies, prominence the marital status as an important factor in fertility behavior (Pullum, 1989; Zeng, 1989).

Comparatively the higher fertility in Bangladesh continues due to several socio-demographic reasons. While contraceptive use has improved, a good number of women, especially from rural areas and with lower education, still have unmet FP needs (Ahmed et al., 2019). Cultural preferences for larger families and for sons also inspire couples to have more than 2-3 children (Huq & Cleland, 1990; Bairagi & Langsten, 1986). Additionally, economic and regional inequalities matter, as fertility has declined more rapidly in urban areas than in rural parts of the country (Khan & Raeside, 1997).

In view of policy, these results explored that the value of using parity-based methods in fertility monitoring and FP. The PPRs help to explain the families grow step by step, which is often misused by total measures like the TFR. This approach has been used successfully in studies from countries such as China, Egypt, and Taiwan (Feeney, 1983; Hinde, 1998; Ni Bhrolcháin, 1987). In Bangladesh, to move toward and maintain replacement-level fertility, it remains important to strengthen reproductive health services, reduce unmet contraceptive needs, and encourage smaller family norms through effective communication.

This study has several limitations. It uses cross-sectional data from the BDHS 2017-18, which may include memory errors, especially in birth histories reported by older women. Fertility estimates for younger women are also incomplete because many have not yet completed childbearing, making comparisons across age groups difficult. The analysis mainly focuses on PPRs show movement from one birth to the next but do not consider factors such as contraceptive use, education, socio-economic conditions, cultural norms, or regional differences. Male fertility and couple-level decision-making were also not included. Besides, the study is based on a single dataset; using multiple surveys or longitudinal data would provide a clearer picture of fertility change. Despite these limitations, the findings demonstrate the helpfulness of parity-based measures for thoughtful fertility patterns and updating population policy in Bangladesh.

CONCLUSION

In Bangladesh, the fertility is declining slowly but is still somewhat above the replacement level, with TFR^c values adjacent to those reported in the BDHS 2017-18. Though younger women are delaying childbirth, many still have more children later because of strong social and cultural norms. Strengthening FP programs, especially for rural and less educated women, by improving access to modern contraceptives and indorsing awareness of smaller families is important. Parity-based measures like PPRs could help the pathway fertility changes more clearly. Future studies should be used long-term data and consider social, economic, cultural, regional, and couple-level factors, with male fertility. Comparing Bangladesh with other South Asian countries may also offer suitable perceptions. For the long-term development of Bangladesh, a joint demographic, social, and health approach is required to guide effective population policies and support.

List of abbreviations: *BDHS:* Bangladesh Demographic and Health Survey, CEB: Children ever born, CFR: Cohort fertility rate, TFR^c: Cohort total fertility rate, FP: Family planning, TFR: Total fertility rate

DECLARATIONS

Ethical approval: This study used publicly available, de-identified BDHS 2017-18 data. The original survey followed ethical guidelines, including informed consent and ethical approval, and no additional approval was needed for this secondary data analysis.

Authors' contributions: MMH, MNI, and MAS conceptualized the study, developed the methodology, curated the data, performed the analysis, and interpreted the results. MMH and MNIM drafted the initial manuscript and contributed to its revision. MNIM, MGH, and ASMAM provided supervision, reviewed the manuscript, and validated the research. All authors reviewed, edited, and approved the final version of the manuscript.

Data availability statement: The data used in this study are publicly available from the Demographic and Health Surveys (DHS) Program. These data can be accessed upon request and approval from the DHS Program website: https://dhsprogram.com

Ethical approval: This study used publicly available, de-identified BDHS 2017-18 data. The original survey followed ethical guidelines, including informed consent and ethical approval, and no additional approval was needed for this secondary data analysis.

Competing interests: The authors declared no conflicts of interest.

Funding declarations: This study is unfunded.

Declaration on AI use: The AI did not contribute to the study design, data analysis, interpretation of results, or generation of scientific content, and the authors take full responsibility for the accuracy and integrity of the manuscript.

Acknowledgements: The authors sincerely thank the Department of Statistics, University of Rajshahi, Bangladesh, for their support and for providing a conducive environment for this study. They also extend their gratitude to the reviewers and the Academic Editor for their valuable feedback and contributions to the manuscript.

REFERENCES

Ahmed, S., Li, Q., Liu, L., & Tsui, A. O. (2019). Maternal deaths averted by contraceptive use: An analysis of 172 countries. *The Lancet, 380*(9837), 111-125. https://doi.org/10.1016/S0140-6736(12)60478-4

Bairagi, R., & Langsten, R. (1986). Parity progression in Bangladesh. *Population Studies, 40*(3), 425-438. https://doi.org/10.1080/0032472031000142196

Billari, F., & Kohler, H.-P. (2004). Patterns of low and lowest-low fertility in Europe. *Population Studies, 58*(2), 161-176.

Bongaarts, J., & Casterline, J. (2018). From fertility preferences to reproductive outcomes in the developing world. *Population and Development Review, 44*(4), 793–809. https://doi.org/10.1111/padr.12102

Bhardwaj, S., Sharma, G., & Kumar, A. (2010). Analysis of the parity progression ratios. *Journal of Reliability and Statistical Studies*, 37-41.

Bosson-Amedenu Senyefia, H. B., Toffe Gladys. (2019). Parity progression estimation and categorical analysis of birth cohort data in Ghana: The case of birth data derived from health insurance data. https://doi.org/http://article.sapub.org/10.5923.j.ijps.20190802.01.html

Brass, W. (1975). Methods for Estimating Fertility and Mortality from Limited and Defective Data. Occasional Publication. *International Program of Laboratories for Population Statistics*, University of North Carolina at Chapel Hill.

Chaurasia, A. R. (2020). Parity progression and fertility transition in South Asia. *Journal of Biosocial Science*, *52*(2), 187–202. https://doi.org/10.1017/S0021932019000031

Feeney, G. (1983). Parity progression and birth intervals in Taiwan. *Population Studies, 37*(1), 83-102. https://doi.org/10.1080/00324728.1983.10405328

Feeney, G. (1983). Population dynamics based on birth intervals and parity progression. *Population Studies, 37*(1), 75-89.

Feeney, G., & Ross, J. A. (1984). Analysing open birth interval distributions. *Population Studies, 38*(3), 473-478. https://doi.org/10.1080/00324728.1984.10410304

Frejka, T. (2008). Overview Chapter 2: Parity distribution and completed family size in Europe: Incipient decline of the two-child family model? *Demographic research, 19*, 47-72. https://doi.org/10.4054/DemRes.2008.19.4

Frejka, T., & Calot, G. (2001). Cohort reproductive patterns in low-fertility countries. *Population and development review, 27*(1), 103-132. https://doi.org/10.1111/j.1728-4457.2001.00103.x

Hajnal, J. (1947). The analysis of birth statistics in the light of the recent international recovery of the birth-rate. *Population Studies, 1*(2), 137-164.

Hinde, A. (1998). Parity progression ratios and birth intervals in Egypt, 1966-1996. Population Studies, *52*(1), 45-53. https://doi.org/10.1080/0032472031000149006

Huq, M. N., & Cleland, J. (1990). Bangladesh fertility survey: Contraceptive use dynamics. Studies in Family Planning, *21*(5), 312-318. https://doi.org/10.2307/1966920

Islam, M. M., & Bairagi, R. (2017). Fertility transition in Bangladesh: An application of parity progression ratios. *Asian Population Studies*, *13*(1), 68-84. https://doi.org/10.1080/17441730.2017.1276585

Islam, M.M., Yadava, R.C. (1997). On the estimation of parity progression ratio. *Sankhya 59*(2):200-208.

Khan, H. T. A., & Raeside, R. (1997). Factors affecting the most recent fertility rates in Bangladesh. *Asia-Pacific Population Journal*, *12*(1), 3-22.

Moultrie, T.A., Dorrington, R.E., Hill, A.G., Hill, K., IM Timæus and B Zaba (eds). (2013). *Tools for Demographic Estimation*. Paris: International Union for the Scientific Study of Population.

Ni Bhrolcháin, M. (1987). Period parity progression ratios and birth intervals in England and Wales, 1941-1971: A synthetic life table analysis. *Population Studies, 41*(1), 103-125. https://doi.org/10.1080/0032472031000142516

Ní Bhrolcháin, M. (1987). Period parity progression ratios and birth intervals in England and Wales, 1941-1971: A synthetic life table analysis. *Population Studies, 41*(1), 103-125.

NIPORT. (2020). *Bangladesh Demographic and Health Survey 2017-18*. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT and ICF.

Pandey, A., & Suchindran, C. (1989). Pace, speed and quantum of fertility: A model based estimation. *Dynamics of Population and Family Welfare, K. Srinivasan and KB Pathak, eds., Ser, 6*, 268-279.

Pandey, A., & Suchindran, C. (1997). Estimation of birth intervals and parity progression ratios from vital rates. *Sankhyā: The Indian Journal of Statistics, Series B*, 108-122.

Pandey, A., Saxena, N., & Singh, K. (1997). Estimation of parity progression ratios from birth order statistics. *Genus*, 177-188.

Pullum, T. W. (1989). The relationship between total fertility rate and parity progression ratios. *Demography, 26*(3), 445-453. https://doi.org/10.2307/2061608

Ryder, N. B. (1980). The cohort approach: Essays in the measurement of temporal variations in demographic behavior. New York : Arno Pr.

Singh, B. P., & Shukla, U. (2018). Estimation of Parity Progression Ratio by Birth Order Statistics Using Various Sampling Frame. *Journal of Reliability and Statistical Studies*, 175-191.

Sloggett, A. (2015). Measuring fertility. *Population Analysis for Policy and Programmes, 103*.

Srinivasan, K. (1968). A set of analytical models for the study of open birth intervals. *Demography, 5*(1), 34-44. https://doi.org/10.2307/2060192

Srnvasan, K. (1967). A probability model application to the study of intervals and random segments of the same. *Population Studies, 21*, 63-70. https://doi.org/10.1080/00324728.1967.10405463

Streatfield, P. K., & Karar, Z. A. (2008). Population challenges for Bangladesh in the coming decades. *Journal of Health, Population and Nutrition, 26*(3), 261-272. https://doi.org/10.3329/jhpn.v26i3.1894

Yadava, R.C, & Kumar, A., and Pratap, M. (2021). Estimation of parity progression ratios from closed and open birth interval data. *Journal of data science: JDS 11*(3):607-621. https://doi.org/10.6339/JDS.201307_11(3).0011

Yadava, R., Pandey, A., & Saxena, N. (1992). Estimation of parity progression ratios from the truncated distribution of closed and open birth intervals. *Mathematical biosciences, 110*(2), 181-190. https://doi.org/10.1016/0025-5564(92)90036-V

Zeng, Y. (1989). Parity progression ratios and birth intervals in China: Analysis based on the 1982 one-per-thousand fertility survey. *Population Studies, 43*(2), 215-227. https://doi.org/10.1080/0032472031000143996