2016

# Modeling of the Women's Reproductive Behavior and Predicted Probabilities of Contraceptive Use in Bangladesh

Islam, Md. Rashedul

University of Rajshahi

# MODELING OF THE WOMEN'S REPRODUCTIVE BEHAVIOR AND PREDICTED PROBABILITIES OF CONTRACEPTIVE USE IN BANGLADESH

**By**

**Md. Rashedul Islam**

*A Thesis Submitted in Fulfillment of the Requirements for the Degree of* ***Doctor of Philosophy*** *in* ***Statistics*** *to the Department of Statistics, University of Rajshahi, Bangladesh*

**Department of Statistics**
**University of Rajshahi**
**Rajshahi, Bangladesh**

**January 2016**

# MODELING OF THE WOMEN'S REPRODUCTIVE BEHAVIOR AND PREDICTED PROBABILITIES OF CONTRACEPTIVE USE IN BANGLADESH


***By***

***Md. Rashedul Islam***

**Department of Statistics**
**University of Rajshahi,**
**Rajshahi, Bangladesh**


**January 2016**


**Supervisor:**

**Dr. Md. Nurul Islam**
**Professor**

**Co-supervisor:**

**Dr. Md. Monsur Rahman**
**Professor**

**Department of Statistics**
**Rajshahi University**
**Rajshahi-6205**
**Bangladesh**

DEDICATED TO MY

BELOVED PARENTS

&

RESPECTABLE TEACHERS.

cwimsL¨vb wefvM
ivRkvnx wekwe`¨vjq
ivRkvnx, evsjv‡`k

ivRkvnx wekwe`¨vjq
University of Rajshahi

Phone : (0721) 711122
Fax : (0721) 750194

DEPARTMENT OF STATISTICS
Rajshahi University
Rajshahi, Bangladesh

# CERTIFICATE

This is to certify that the thesis entitled "**MODELING OF THE WOMEN'S REPRODUCTIVE BEHAVIOR AND PREDICTED PROBABILITIES OF CONTRACEPTIVE USE IN BANGLADESH**" Submitted in the fulfillment of the requirements for the award of the degree of Doctor of Philosophy in Statistics at Rajshahi University, Rajshahi-6205, Bangladesh. This research is a faithful record of the bonafide work by Md. Rashedul Islam bearing Roll no.12213, Registration.no.7264, Session (Ph.D.): 2012-2013 has completed the research work for the full period and that thesis embodies the results of his investigation conducted the period he worked as an Ph.D. student under our direct supervision and no part of this thesis has been submitted to any other University or Institution for any degree or diploma. To the best of our knowledge the data presented in this thesis is genuine and original.

We have gone through the final draft of this thesis, and recommend its submission for the degree of "Doctor of philosophy" in Statistics.

**Supervisor**

**Prof. Dr. Md. Nurul Islam**
Phone- 088-0721-750041 (Office)
Fax: 088-0721-750194
Mobile- 01715-078277
E-mail: mnurul58@yahoo.com

**Co-supervisor**

**Prof. Dr. Md. Monsur Rahman**
Phone- 088-0721-711122(Office)
Fax: 088-0721-750194
Mobile- 01716438485
E-mail: monsur_st_ru@yahoo.com

# DECLARATION

I do hereby declare that the thesis entitled "**MODELING OF THE WOMEN'S REPRODUCTIVE BEHAVIOR AND PREDICTED PROBABILITIES OF CONTRACEPTIVE USE IN BANGLADESH**" submitted to the Department of Statistics, Rajshahi University for the degree of Doctor of Philosophy in statistics is completely my own and original work. This work is carried out by me under the supervision and guidance of Professor Dr. Md. Nurul Islam & Professor Dr. Md. Monsur Rahman, Department of Statistics, University of Rajshahi, Rajshahi, Bangladesh. No Part of it in any form has been submitted to any other University or Institution for any type of degree, diploma or for other similar purposes.

(**Md. Rashedul Islam)**
Ph. D. Research Fellow
Department of Statistics
University of Rajshahi
Rajshahi-6205
Bangladesh

# ACKNOWLEDGEMENT

At the outset all praises and utmost gratitude to Almighty Allah, source of all power and knowledge, for giving me strength, patience and ability to accomplish my research work in time despite my personal troubles and hazards. All the progress, achievements and successes throughout my life are Allah's blessing.

I would like to express my deep appreciation and gratitude to my supervisor Professor Dr. Md. Nurul Islam and Co-supervisor Professor Dr. Md. Monsur Rahman, Department of Statistics, University of Rajshahi. Their understanding, constant encouragement, guidance, invaluable assistance, constructive criticism and support throughout the course of this work have made achievable. I have no words to convey sincere gratitude to them for their advice and suggestions at every step of this research work, for reviewing the dissertation repeatedly and reminding me to attend several seminars for the betterment of my research analyses.

I wish to express my sincere gratitude to Professor Dr. Md. Ripter Hossain, Chairman Department of Statistics, University of Rajshahi, for providing me the opportunity to do my Ph.D. work and giving me access to all resources and facilities of this department.

I express my sincere thanks to Professor M. A. Razzaque, Professor Dr. M. A. Basher Mian, Professor Dr. S. K. Bhattacharjee, Professor Dr. Md. Asaduzzman Shah, Professor Dr. Mohammed Nasser, Department of Statistics, University of Rajshahi, for their valuable suggestions, helping and inspiring me at every stage of this work. I shall be remaining highly grateful to Dr. Md. Golam Hossain, Professor Dr. Md. Ayub Ali, who have contributed their time and wide expertise that have helped me troubleshoot the difficulties of the study work.

I gratefully acknowledge the assistance that I have received from Professor Dr. Md. Rafiqul Islam, Professor Dr. Nazrul Islam, Professor Dr. Md. Mostafizur Raman (Chairman), Department of Population Science and Human Resource Development, University of Rajshahi for their timely advices and continual encouragement that help me to go forward.

I wish to thank all the stuff of the Department of Statistics for their kind cooperation and assistance. Thanks are due to the technical staffs in the Computer unit of the department for their assistance.

I am grateful to Principal Md. Forhad Hossain and all my esteemed colleagues of the Birampur College, Birampur, Dinajpur for their encouragement. Especially, I am thankful to Sultan Mahamud Alamgir, Lecturer, Statistics Department, Birampur College for his kind help.

I am grateful to all my friends whose close association always kept me active throughout my research work. I am grateful of my relatives and well wishers that were the constant source of inspiration during my research work.

Lastly, I am grateful to my family members, especially, to my wife Mrs. Farhana Begum, daughter Riftia Islam Rawza and son Abdur Rahman Fahim for their tremendous sacrifice, constant encouragement, continuous inspiration throughout the course of my work.

**Md. Rashedul Islam**
Ph.D. Research Fellow
Department of Statistics
University of Rajshahi,
Rajshahi, Bangladesh

Rajshahi
January 2016

# ABBREVIATION

| | |
|---|---|
| AFW | : Average fetal wastage |
| ASEMFR | : Age Specific Ever Marital Fertility Rate |
| ASFR | : Age Specific Fertility Rate |
| ASMFR | : Age Specific Marital Fertility Rate |
| BBS | : Bangladesh Bureau of Statistics |
| BDHS | : Bangladesh Demographic and Health Survey |
| BFS | : Bangladesh Fertility Survey |
| CBR | : Crude Birth Rate |
| CEB | : Children Ever Born |
| CFI | : Comparative Fit Index |
| CPR | : Contraceptive Prevalence Rate |
| CPS | : Contraceptive Prevalence Survey |
| DHS | : Demographic and Health Survey |
| EA | : Enumeration Area |
| ERM | : Exponential Regression Model |
| GOB | : Government of Bangladesh |
| HPNSDP | : Health, Population and Nutrition Sector Development Program |
| ICDDR'B | : International Centre for Diarrheal Diseases and Control, Bangladesh |
| LAMP | : Long-Acting Permanent Method |
| LRM | : Linear Regression Model |
| MAM | : Mean Age at Marriage |
| MCM | : Modern Contraceptive Methods |

| | |
|---|---|
| MDG | : Millennium Development Goal |
| NGO | : Non-government Organization |
| MoHFW | : Ministry of Health and Family Welfare |
| NIPORT | : National Institute for Population Research and Training |
| OBM | : Original Bongaarts Model |
| PHC | : Population and Housing Census |
| PRF | : Proportional Reduction in Fertility |
| PRM | : Polynomial Regression Model |
| RBM | : Revised Bongaarts Model |
| SPSS | : Statistical Package for Social Science |
| SVRS | : Sample Vital Registration System |
| TF | : Total Fecundability |
| TFR | : Total Fertility Rate |
| UEC | : Contraceptive Use Effectiveness |
| UESD | : Utilization of Essential Service Delivery Survey |
| UN | : United Nations |
| UNICEF | : United Nations International Children's Fund |
| USAID | : United States Agency for International Development |
| VRS | : Vital Registration Survey |
| WHO | : World Health Organization |
| WI | : Wealth Index |

# ABSTRACT

Bangladesh is the most densely and is the 8th most populated country in the world. Over population or high density is one of the most important causes for both low and deteriorating living condition in Bangladesh Population is still growing. So, the situation is worsening with every passing year. Begging fully aware of the detritus effect of such rapid growths, the government, demographers, social workers, academicians, donor agencies and policy makers have declared population a problem of great importance and identified it as the number one problem in the agenda of governmental duties and functions.

Like many other developing countries Bangladesh emphasizes the importance of contraceptive use for reducing fertility as a part of her overall strategy to bring down the growth rate of total population. Family planning programs work in order to achieve demographic targets through the reduction of fertility. Unfortunately, in our country there has always been a gap between target fertility and it's getting at the terminal year of target period of all its plan period. Our country never gained either desired level of fertility (TFR) or contraceptive prevalence rate (CPR).

The fifth Five-Year Plan (1998-2003), where target TFR and CPR respectively had 2.5 and 60%. Whereas, the achievement had been TFR 3.0 children per woman and CPR had been 58%. It was followed by the second Sector-Wide Approach, the Health, Nutrition and Population Sector Program, which began in 2003 and expired in June 2011, where target TFR and CPR respectively had 2.1 and 65%. Whereas, the achievement had been TFR 2.3 children per woman and CPR had been 61%. Additionally, the Health Population Nutrition Sector Development Program plans to reduce the TFR to 2.0 children per woman by 2016.

To fulfillment such gaps there have raised questions about estimation equation used to project about CPR or contraceptive use effectiveness (UEC) in order to achieve TFR per woman at a desired level at the end of plan period or future.

Thus in this study, an attempt has been made to assess the modeling of the women's reproductive behavior and predicted probabilities of contraceptive use in Bangladesh using nationally representative data from Bangladesh Demographic and Health Survey (BDHS), 2011.

To improve our clear understanding of the fertility change, we critically examine the effect of major proximate determinants on fertility and their changing effects for the period 1975 to 2011. During these periods decomposing Original Bongaarts Model (OBM) and Revised Bongaarts Model (RBM) assesses the individual contribution made by each of the four intermediate variables to change the fertility. The study also examines how well these determinants predict fertility levels of Bangladesh.

Path model and binary logistic regression model have been used to find out the direct, indirect and combined (interaction) effects of the selected demographic, socio-economic factors on fertility. To achieve target fertility related with contraceptive prevalence rate (CPR) and contraceptive use effectiveness (UEC) four models viz., RBM and exponential regression model (ERM), polynomial regression model (PRM), linear regression model (LRM) have been applied.

Revised Bongaarts model indicates that between 1989 and 2011, the amount of decrement of total fertility rate (TFR) was about 38.4%, about 42% between 1989 and 2007, 36% between 1989 and 2004, about 34% between 1989 and 1999-2000, 10% between 2004 and 2007; but the amount of increment of TFR was 6.6% between 2007 and 2011.

The exogenous variables de-facto place of residence, current age of women, husband current age, education of women, wealth index have respectively 89%, 81%, 85%, 74%, 83% indirect effect on fertility. The endogenous variables women age at first marriage and women age at first birth have respectively 67% and 95%, other three endogenous variables sons who have died, women currently working and ever use contraception each has approximately 100% direct effect on fertility.

About 88% women never experienced son mortality, 10% experienced single son mortality and about 2% experienced two or more son's mortality. These percentages reflect the recent achievement in improving the child mortality level of Bangladesh

For achieving fertility level 2.2, 2.1, 2.08 and 2.0 it would raise mean age at marriage, approximately 21 years by estimating with polynomial regression model and approximately 23 years by estimating ERM. Now, target mean age at marriage is 23 years. This implies that to achieve replacement level fertility, one may raise mean age at marriage 23 years.

Achieving fertility level 2.2, 2.1, 2.08 and 2.05 there require increasing use of pill approximately 36%, 37%, 38% and 39% respectively estimating by ERM and approximately 30%, 31%, and for TFR level 2.08, 2.05 is approximately 32% estimating by PRM. Achieving fertility level 2.2, there require increasing use of condom 6% and for TFR 2.1, 2.08 and 2.05 require 6.3% increase estimating by ERM and achieving TFR 2.2, 2.1, 2.08 and 2.05 there require increasing respectively 5.24%, 5.36%, 5.38% and 5.42% estimating by PRM.

To achieve target TFR 2.1, 2.05 and 2.0 with use of total contraceptive prevalence rate (CPR) as taken 100% then modern contraceptive methods raise approximately 63%, 64% and 66% using ERM; and approximately 56%, 56.5%, and 57% respectively using PRM. These indicate that to achieve replacement level TFR, raise CPR approximately 63%.

The results indicate that if TFR 2.2 would reach with UEC: 0.87, 0.89, 0.90 and 0.91; raises the CPR's 63.17%, 63.06%, 63.01% and 62.96% respectively. Again, if TFR 2.1 would reach with CUE: 0.87, 0.89, 0.90 and 0.91; raises the CPR's 65.13%, 65.93%, 64.82% and 64.73% respectively.

For the achievement of target fertility 2.1, 2.05 and 2.0 it would perhaps require increase duration of amenorrhea period respectively 25%, 32%, 39% and duration of breastfeeding period respectively 6%, 7% and 8% on the basis of BDHS 2011.

# CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# Chapter One
# INTRODUCTION

## 1. Introduction

## 1.1 Geographical Setting

Bangladesh is unitary, independent and sovereign Republic as the People's Republic of Bangladesh. She is located in the northeastern part of South Asia. She covers an area of 1,47,570 square kilometers (56,977 square miles) with almost entirely surrounded by India, except for a short southeastern frontier with Myanmar and a southern coastline on the Bay of Bengal. She is situated between latitudes $20^0$ 34' and $26^0$ 38' north and longitudes $88^0$ 01' and $92^0$ 41' east. The limits of territorial waters of Bangladesh are 12 nautical miles and the area of the high seas extending to 200 nautical miles measured from the base lines constitutes the economic zone of the country. Bangladesh Standard time is GMT+6 hrs (Population data sheet, BBS).

In the year 1947, the independent states of Pakistan and India were created with the present Bangladesh territory as a part of Pakistan. Bangladesh emerged on the world map as a sovereign state, on March 26, 1971 after fighting a long term nine month war of liberation, which was ended on December 16, 1971. The territory now constituting Bangladesh was under the Muslim rule for over five and a half centuries from 1201 to 1757 A.D. Then, it was ruled by the British, after the defeat of the last sovereign ruler of Bengal, Nawab Sirajuddowla, at the Battle of Palashi on the fateful day of June 23, 1757. The British ruled over the entire Indian sub-continent including this territory for nearly 190 years from 1757 to 1947. During that period Bangladesh was a part of the British Indian provinces of Bengal and Assam. With the termination of the British rule in August, 1947 the sub-continent was partitioned into India and Pakistan. Bangladesh then became part of Pakistan and was known as East Pakistan. It remained so far about 24 years from August 14, 1947 to March 25, 1971.

Bangladesh mainly consists of low, flat and alluvial soil. The most significant feature of the landscape is the extensive network of large and small rivers that are of primary importance to the socio-economic life of the nation. Chief among these, lying like a fan on the face of the land, are the Ganges-Padma, Brahmaputra-Jamuna, Megna, Teesta, Surma and Karnaphuli (total 310 rivers including tributaries) rivers. All those rivers have 310 tributaries with a total length of about 24140 kilometers. The alluvial soil is thus continuously being enriched by heavy silts deposited by rivers during the rainy season.

The weather of Bangladesh is dominated by seasonal monsoons. The country experiences a hot summer season with high humidity from March to June; a somewhat cooler but still hot and humid monsoon season from July through early October; and a cool, dry winter from November to the end of February. The climate variations: in winter (November-February) temperature average maximum $29^0$C and average minimum $11^0$C, summer (March-June) temperature average maximum $34^0$C and average minimum $21^0$C and Monsoon (July-October), average rainfall 1194 mm to 3454 mm (BBS 2013; statistical pocket book p-4; April 2014). The fertile delta is frequented by natural calamities such as floods, cyclones, tidal bores, and drought.

The physical geography of Bangladesh may be considered in terms of two principal divisions: the flat alluvial plain comprising most of the country and the much smaller area of the Chittagong district and Chittagong Hill tracts in the south-East. The alluvial plain of Bangladesh, which constitutes about eighty percent of the greater plain of Bengal lies between the Indian foothills of the Himalayan Mountains on the North and the Bay of Bengal on the South. It is often regarded as deltaic in its entirety, making it the largest delta in the world. The land characteristics of the Bangladesh plain from North to South have sometimes between summed up by geographers as “old mud, new mud and marsh”. Most elevations are less than 30 feet about sea level, although, altitude up to 350 feet occur in the northern part of the plain.

During the summer monsoon (mid-May to mid-October) rains dominate the seasons in Bangladesh. The rainfall is high and falls in the range of 140 centimeters to 200 centimeters. The mean maximum temperature is $34^0$C (in July) and the mean minimum temperature is $11^0$C (in January). These factors make the climate very unpleasant with high relative humidity (86.5% in Chittagong in July) accompanying quite high temperature. Despite the return of sunny skies the uncomfortable hot humid weather persists up to October. Because of rain and flooding there is a super-abundance of standing water and this excess moisture helps to maintain an unpleasantly hot atmosphere. The coastal regions of Bangladesh are subject to damaging cyclones and floods almost every year.

The country consists of seven (7) administrative divisions, sixty four (64) districts and six hundred twenty-four (624) thana's and Upazila 487 (BBS, 2013, Statistical Pocket book of Bangladesh 2013, April 2014, p-8). Eleven (11) city corporation; 317 municipalities/Paurashava; 4571 unions; 40,509 words; 56,348 Mouza's; 87,310 villages and 3,21,73,630 households; average size of a household is 4.6 (BBS 2011, SVRS 2010, WB, IMF 2011, BDHS 2011; BBS Statistical Pocketbook of Bangladesh 2013, April 2014, p=8-9; LGRD Ministry and police head quarters). The majority about 88.8% of the people are Muslim of the population of Bangladesh, Hindus account for about ten percent (10%), and other religions constitute the remaining 1.2% and over 98.8% of the people speak Bangla (BBS Statistical Pocket book of Bangladesh 2013, April 2014, p-3).

The national language of Bangladeshi people is Bangla, which is spoken and understood by all. Bangla is the mother language of Bangladesh, but to establish Bangla as the mother language, Bangalees has to sacrifice their lives; a number of People were martyrized in February 21, 1952 to establish the rights of mother language. In recognition of their supreme sacrifice, UNESCO declared 21st February as the" International Mother Language Day" throughout the world.

The national flag of the Republic consists of a circle colored red throughout its area, resting on a green rectangular background. The length to width ratio of the rectangle is 10:6 and the circle has a radius of one fifth of the length. Its center is placed on the intersecting point of the perpendicular drawn from the nine-twentieth part of the length of the flag and the horizontal line drawn through the middle of its width. Prescribed sizes of flag for buildings are: 305 cm X 183 cm, 152 cm X 91 cm and 76 cm X 46 cm and for cars are: 38 cm X 23 cm and 25 cm X 15 cm.

The national anthem of Bangladesh comprises the first ten lines of '**Amar Sonar Bangla**' of Rabindra Nath Tagore. The national emblem of the republic is the flower "Shapla" (Nymphaea nouchali) resting on the water having on each side an ear of paddy and being surmounted by three connected leaves of jute with two stars on each side of the leaves.

The capital of the republic is Dhaka. Currency of the country is known as Taka (Tk). The citizens of Bangladesh are known as Bangladeshis.

## 1.2 Urbanization, education

As compared to the developing nations, the level of urbanization in Bangladesh is very low. Despite the low level of urbanization, the rate of growth of urban population has been exceedingly high over the recent years. Such rapid growth of urban population is attributable largely to the rural-urban migration by the poor or landless peasants because of over-pressure on the country's limited agricultural land which has been creating housing, sanitation, transport, employment and many other problems in urban places, particularly in cities.

In spite of the spread of education in the developing countries over the last 40 years, a vast majority of the population of Bangladesh is still illiterate. According to BDHS 2011 report, net enrollment ratio in primary education for female 76.6%; for male 73% and for both 74.8%. In Bangladesh, literacy rate of 15-24 years old for female 81.9%; for male 67.8% and for both 74.9%.

According to census report 2011, literacy and education for all ages of population in Bangladesh is 47.68%; for male 49.82%, for female 45.54%. Literacy and education for rural population is for both sexes 44.70%; for male it is 46.81%, for female it is 42.59%. Urban population literacy and education rate for both sexes 60.19%; for male it is 62.59% and for female it is 57.83%. Literacy rate for $7^+$ ages of Bangladeshi people for both sexes is 56.09%; for male it is 58.76%, for female it is 53.44%. In rural areas $7^+$ ages literacy rate for both sexes 52.82%; for male 55.44% and for female 50.20%. In urban areas $7^+$ literacy rate for both sexes is 69.58%; for male 72.54% and for female it is 66.68% (BBS, Census report 2011).

## 1.3 Ethnic, Religion and Culture

Ethnically, Bangladesh is homogeneous, having only one major ethnic group (98.8), known as Bangalees. There are some ethnically different tribal people in the mountainous regions of the country constituting 1.2%. Islam is the predominant religions of with 88.8%, Hinduism about 10%, and others constitute about 1% (BBS: Statistical Pocketbook of Bangladesh 2013, April 2014).

The country is more or less culturally homogeneous. The national language of Bangladesh is Bangla, which is spoken and understood by all. However, English is widely spoken by people in the literate communities. Bangladesh is heir to a rich cultural legacy of about two thousands or more years.

The cultural traditions can be viewed in innumerable tangible and intangible heritages in archaeological sites, in sculptures, in stones and terracotta, in architectures, museums, archives, libraries, classical music, songs and dance, paintings, dramas, folk's arts, festivals, games and ethnic cultural activities. The simplicity and friendliness of the people of Bangladesh are examples of unprecedented communal harmony among different religions from time immemorial.

## 1.4 Marriage

In Bangladesh, marriage means the prescribed legal union between a man and a woman, establishing them in new social roles as husband and wife. Pre-marital cohabitation does not exist and it is looked upon as a social evil. Marriage is a desirable event and a universal phenomenon in Bangladesh.

Early marriage for women in Bangladesh is widespread and most of them become married by the time they are before age of 20. Although the legal age for marriage is 18 for women by the law of our country. In rural Bangladesh, there is a common belief that a girl aged 20 years is too old to marry. Constraints on marriage that did not exist before are, however, now making an appreciable change-shortage of land, unemployment, etc. Also marriage among the highly educated elite is becoming less desirable as they are capable of making themselves free from the contractually of arranged marriages. As early as possible a girl must to go to her husband's household. For parents a past puberty unmarried daughter is considered a danger because of the secret desire to indulge in illicit coitus that might be in their daughter's mind, which may result in social scandal and for which the parents may be socially condemned and have to face rancor and social boycott. If a daughter's marriage is delayed, the parents feel guilty and being to think of her as a burden. Parents of girls who can arrange early marriages for their daughters feel very proud.

A mature girl may cherish illusive fatness about events related to sexually pleasure and wishes to find a husband as soon as possible so that she can comfortably establish a happy home with children and can lead a life with proper rights and esteem. Whenever a mature unmarried girl finds that friends in her age group friends are married she becomes unhappy and wishes to be married soon and like her friends she wants to have a husband, children and her own happy home where she can legitimatize her prestige. Men and women who never marry are excluded from many social activities, which make them feel that they have somehow failed to get a partner. Socially they are stigmatized due to their unusual marital status (Aziz et. al, 1985; Malony et. al, 1981; Chowdhury, 1984; Shaikh, 1990; Islam, & Abedin, 2001; Islam, S.2010).

For the man, age at marriage is not rigidly determined but is usually decided by his ability to independently support a family. It is also determined by his position in the family. If he is the eldest or the only son, he will be expected to get marrying early. Traditionally, the main occupation is cultivation and the eldest son inherits or shares his father's land. Therefore, employment outside the family is not an important criterion for marriage for the son. Marriage in Bangladesh is mostly arranged by the father and other relatives or guardians. Usually parents or in the absence of parents, close elderly relatives, approach him/her for his/her consent to a proposed marriage. The young male/young woman passes on his/her opinion through a friend. While the selection is made by the parents or near relatives, the consent of both partners, that is, the bride and bridegroom, in front of witnesses is essential for the marriage to be considered valid.

Islam, which is the predominant religion of Bangladesh, attaches great importance to the family by strengthening the ties binding its members and safeguarding it against undermining influences. Hence marriage is considered an important social institution and is almost universal in Bangladesh. In the Islamic sharia or law, marriage is obligatory for persons who are able to manage with its financial burdens. There are certain restrictions that must be followed in finding a suitable spouse according to Islamic law.

The marriage ceremony usually takes place at the house of the bride or a place mutually decided on by families of the bride and groom. The actual marriage ceremony is usually performed by the Kazi (according to Islamic rights). In this ceremony, assent to marriage is obtained directly from the groom in case of the bride; this is obtained from her representative, known as Ukil. Two male witnesses are required to validate the legal aspect of the marriage. In Islam, marriage is considered an agreement and the terms are required to be fully document on Nikah Namma (registration form). According to the Muslim Family Law Ordinance of 1961, the following information is to be recorded on the marriage registration form: ( i ) year of marriage (ii ) name of the locality (union/town committee ) (iii) age of bride and groom (iv) marital status of the bride at the time of marriage (v) amount of Mahor in takas and (vi) date of marriage according to the Arabic calendar.

According to the Muslim marriage, a husband is required to give a certain amount of Mahor to his wife at the time of marriage). The balance of Mahor is in any case required must be paid with or without divorce for the marriage to be legal. She has the right to forgive all or some of the unpaid portion if she wishes. The amount is decided taking into consideration, among other things, the social positions of the bride and the groom. The law of dower is drawn directly from the Holly Quran where it is stated: “As the woman in marriage surrenders her person, so the man must also surrender- besides some of his independence at least part of his property according to his means".

Since marriage under Muslim law is an agreement, divorce is allowed. Under the traditional Muslim law, divorce can be obtained in one of the following ways:

i. Through mutual consent of the husband and the wife without the intervention of the court.
ii. By a judicial decree at the suit of the wife and
iii. By the husband at his will by simply pronouncing the intention to do so in front of witnesses, without the intervention of the court.

In the case of divorce, the husband has sole claim over the children, if any. Remarriage following divorce is permissible by law but a divorce person finds it difficult to find a suitable spouse. A strong social stigma exists in marrying a divorced person. Usually a divorced woman, if she marriages, will marry a divorced or widowhood man or an old man who has never married.

The marriage law and customs of the Muslims who constitute about 90 percent of the total population have been discussed briefly so far. There is a little need then, to draw attention to some aspects of marriage customs and laws of the Hindus, who constitute about 9 percent of the total population. The Hindu marriage system differs from the Muslim's marriage system in some respects and marriage usually takes place within a caste. It may be mentioned that there are four main castes among the Hindus. Marriage arrangements are, however, in similar in both the Islamic and Hindus religions in Bangladesh, having been influenced by local custom.

A match-maker plays a vital role in Bangladesh on marriage. He is the media of communication between the two parties involved and any query or demand has to be passed through him. On many occasions he has to face attacks and counter-attacks from both sides. This is a thankless job, but without a match-maker intervening, marriage negotiation is almost unthinkable in both rural and urban Bangladesh.

The universality of marriage and low age at marriage is related to the religious affiliation and lower status of females in the society. Pre-marital sex is strictly prohibited and unacceptable in this society.

## 1.5 Reproductive Behavior in Bangladesh

Bengali peasant culture is suffused with a pro-fertility ethos, which evolved over 3,000 years of adaptation and symbolic relationship between man and the land. The culture has become highly successful in its ecological setting. The various great religions are superimposed but rural beliefs about fertility and the human body are more fundamental and cut across them.

Human fertility and land fertility are analogous. A woman is the field and the seed is nourished by her juices before birth and by her milk after birth.

Muslims commonly say that every mouth brings its own food, and each person's food is pre-allocated before his birth. Therefore, some conclude that land can indefinitely support those souls to be born. Such pro-fertility beliefs were at one time functional, but because life expectancy is now over 70 years (BBS, December 2015), they have become dysfunctional. It is thought by Muslims to be a moral duty to have and raise children and to increase one's kinship and lineage groups. The bodily substances shared by the breeding group are said to be transmitted by the male semen and female semen, which mix at conception.

Muslims consistently have higher fertility than Hindu and give negative advice about population control double as much as Hindus. But these differences have disappeared through motivation. The most fertile group is the rural middle class and urban labor class, who are mostly Muslim cultivators. Their higher fertility is not just because of religious affiliation, but because they are enmeshed in the matrix of peasant life that evolved with a pro-fertility bias.

Having children is a compulsory duty in Islamic tradition and children must be raised in the religion; this is also advocated in Hindu tradition. Muslims say if there are several sons one can be given for religious education. Many children will have more voices to praise Allah and in the day of the judgment, the Prophet (s :) will be pleased to see long lines of worshipers. Children have a duty to care for the parent's funerals. An infant who dies in innocence will plead in heaven for its parents to be let in. The female is blamed for childlessness, like a barren field without nutrients. Children are needed for old age support and this need may be increasing with more landlessness. Children who do not support aged parents are said to be beasts and accursed. Sons are more desirable and more of them bring diversity of income and make the kinship group large and strong, but daughters require dowry to be married.

Among the reasons for people wanting more children, the first is sex preference. Sex preference operates as a relatively stronger reason for wanting more children among females than among males. Most people want several children for undefined personal fulfillment, which is couched in terms of moral duty, family prosperity or future support. When there will be an increase in the level of happiness and convenience. If one does not have children, his possession of property is meaningless.

A male child is favored. If the males in a family are few then the size of the lineage segment (bangsa) becomes small. Males are future earners, but females are economically unproductive. Parents have to spend a lot on arranging marriages of daughters. So for economic reasons a male child is preferred. Nowadays a girl is viewed as a problem in the family. If parents could control the sex of children born, then more couple would decide to have a male child first. A son is essential for continuity of the lineage and old age security.

## 1.6 Population size, growth, fertility, mortality and density

Bangladesh is the most densely populated country and is the 8th most populated country in the world. She contains 2.18% total population of the world (WHO, WB 2014). According to 2011 population and housing census (PHC), the population of the country stood at about 14,98,00,000 with a population density of 1,015 persons per square kilometer, which is the highest population density in the world (BBS, 2012b). According to world population report the total population of Bangladesh is 15, 64, and 73,000 (source: World official population clock, June 18, 2015).

The Bangladesh Population Policy indicates that the population should stabilize at 210 million by 2060, if replacement-level fertility is reached by 2010. This estimate of population size is reasonably consistent with the World Bank projections from 1994 (Bos *et al*., 1994), and the United Nations projections 1996 (United Nations, 1996), both of which estimated a mid-21$^{st}$ century population of 218 million. However, there is wide disparity between the estimates of the Bangladesh Government and others on the time when the population would stabilize. The World Bank boldly forecast a final stationary population of 263 million by mid-22$^{nd}$ century (2150), whereas others have not projected beyond the mid-21$^{st}$ century. Recently however, the United Nations has revised there estimate for 2050 by 25 million (or 11 percent) to 243 million, apparently on the basis of the decade long fertility plateau (United Nations, 2004).

Bangladesh has undergone a remarkable demographic transition over the last 45 years. In 1971-1975, women in Bangladesh were having on average 6.3 children. The total fertility rate (TFR) declined to 5.1 fifteen years later, and to 4.2 in 1989-1991. The TFR plateaued at around 3.3 for most of the 1990s, when the three earlier BDHS surveys took place. The Bangladesh fertility rate has declined slightly to 3 children per woman (BDHS, 2004). Comparison of the Bangladesh TFR, with fertility rates in other Asian countries that have implemented a demographic and health survey (DHS), indicates that, with a TFR of 3, Bangladesh is in the mid-range among the countries-below Nepal (4.1 in 2001), Cambodia (3.8 in 2000), and the Philippines (3.5 in 2003), but above India (2.8 in 1998-1999), Indonesia (2.6 in 2002-2003), and Vietnam (1.9 in 2002).

During the past century, the population of Bangladesh has increased exponentially. Between 2001 and 2011, about 19.8 million people were added to the population, which represents a 15 percent increase and a 1.37 percent annual growth rate. Between the 2001 and 2011 censuses, life expectancy in Bangladesh increased by about two years for males and by more than three years for females. Female life expectancy is slightly higher than male life expectancy 69 years versus 67 years and according to statistical pocketbook of Bangladesh, male life expectancy 67.9 years, female life expectancy 70.3 years (BBS, 2013, p-8, pub April 2014).

Population projected for July 2019 (in millions), total: 167.39; male: 85.86; female: 81.51 (Bangladesh data sheet, BBS 2011).Sex ratio: 100.3 male per 100 female (Census, 2011). Population aged 0-14 years for both sexes is 33.1%; female population aged 15-49 years 54.3%; population $60^+$ years for both sexes 6.7%; CBR per 1,000 population is 19.2; TFR (birth per women of 15-49 years) 2.12 children per women; GRR is 1.05 and NRR is 1.04 (BBS, SVRS 2010, BDHS 2011).

Infant and under-5 mortality rates for the past five years are 43 and 53 deaths per 1,000 live births, respectively. At these mortality levels, one in every 23 Bangladeshi children dies before reaching his / her first birthday, and one in every 19 children does not survive to his / her fifth birthday. As under-5 mortality continues to decline, Bangladesh is on track to achieve the MDG- 4 target of 48 deaths per 1,000 live births by the year 2015. Infant mortality has declined by 51% over the last 18 years, while child mortality and under-5 mortality have declined by 78% and 60%, respectively, over the same period. The neonatal mortality rate for the past five years has been 32 deaths per 1,000 live births, which is three times the post neonatal mortality rate, 10 deaths per 1,000 live births. The prenatal mortality rate is 50 deaths per 1,000 pregnancies (BBS, 2012b; BDHS 2011).

The country is now experiencing a demographic alteration. The continuous decline of the natural growth rate is expected to lead to a smaller population increase in the coming decades. In comparison with other countries in the region, this population growth rate places Bangladesh in an intermediate position between low-growth countries, such as Thailand, Sri Lanka, and Myanmar, and medium-growth countries, such as India and Malaysia (BBS, 2011a).

The 2010 projections by the United Nations estimated that the population of Bangladesh in 2050 would be about 194 million if medium modification and 226 million if high modification (UN, 2010).

According to the National Population Policy, Bangladesh aims to achieve replacement level fertility by 2015 (MoHFW, 2009). Additionally, the Health Population Nutrition

Sector Development Program (HPNSDP) plans to reduce the Total Fertility Rate (TFR) to 2.0 children per woman by 2016 (MoHFW, 2011).

Bangladeshi women have a pattern of early childbearing. Childbearing begins early in Bangladesh, with almost half of women giving birth by age 18 and nearly 70 percent giving birth by age 20. The rural-urban difference in fertility is greater in the age groups 15-19 and 20-24. According to current fertility rates, on average, women will have 25 percent of their births before reaching age 20, 56 percent during their twenty-four, and 17 percent during their thirties. As expected, the TFR for rural women with 2.5 births which is higher than for urban women with 2.0 births per woman.

Fertility varies widely by administrative divisions. According to BDHS 2011, fertility in Dhaka division 2.2 births per women, Barisal division 2.3 births per women. Fertility is lowest in Khulnadivision1.9 births per woman, followed by Rajshahi and Rangpur divisions are at 2.1 births per woman, and highest in Sylhet division 3.1 births per woman and Chittagong division 2.8 births per women. Bangladesh's current Health, Population and Nutrition Sector Development Program (HPNSDP) aim to reduce fertility to 2.0 births per woman by 2016; Khulna has reached that level already, and Rajshahi and Rangpur are very close.

Over population or high density is one of the most important causes for both low and deteriorating living condition in Bangladesh Population is still growing and the situation is worsening with every passing year. Begging fully aware of the detritus effect of such rapid growths, the government, demographers, social workers, academicians, donor agencies and policy makers have declared population a problem of great importance and identified it as the number one problem in the agenda of governmental duties and functions.

## 1.7 Family Planning Program

Family planning was introduced in Bangladesh (then East Pakistan) in the early 1950s.The government of Bangladesh, recognizing the urgency of the goal to achieve moderate population growth, adopted family planning as a government sector program in

1965.The policy to reduce fertility rates has been repeatedly reaffirmed by the government of Bangladesh since the country's independence in 1971.

The first Five-Year Plan (1973-1978) emphasized "the necessity of immediate adoption of strong steps to slow down the population growth" and reiterated that "no civilized measure would be too strong to keep the population of Bangladesh on the smaller side of 15 crore for sheer ecological viability of the nation" (GOB, 1994). Beginning in 1972, the family planning program received virtually unanimous, high-level political support. All subsequent governments that have come into power have identified population control as the top priority for government action. This political commitment plays a crucial role in the fertility decline in Bangladesh.

Family planning programs in Bangladesh have considerable impact on the practice of contraceptive and consequently in the reduction of fertility. A major cause of declining fertility in Bangladesh has been the steady increase in contraceptive use over the last forty years.

The contraceptive prevalence rate (CPR) has steady grown in Bangladesh since 1975. In 1975, only eight percent of currently married women reported using a family planning method, as compared with 53.8 percent in 1999-2000 BDHS ( Mitra *et al*., 2001 ) and with 58 percent in 2004 BDHS surveys, 61 percent in 2011 BDHS, a greater than sevenfold increase in fewer than four decades(NIPORT *et al*., 2009, 2012b).

Overall, 61 percent of currently married Bangladeshi women age 15-49 years is currently using a contraceptive method. Fifty two percent use a modern method, and 9% use a traditional method. The pill is the most widely used method 27%, followed by injectables 11%, periodic abstinence 7%, male condoms 6%, and female sterilization 5%. About 1 percent each uses the IUD, male sterilization, implants, and withdrawal.

**Differentials of contraceptive use:** In Bangladesh, use of contraceptives varies by the woman's number of living children. Contraceptive use increases sharply as the number goes up, from 24% among married women with no children to 65% among women with one or two children. It continues to increase to 69% among women with three or four children but decreases to 58% after five or more children. This decrease in use may be caused by declining fecundity associated with the older age of high-parity women.

The pill is the most widely used method among all categories of women. Contraceptive use varies by place of residence. While use of contraception continues to be higher in urban areas 64% than in rural areas60%, the gap is narrowing; in the 2007 BDHS it was 62% in urban areas and 54% in rural areas (NIPORT *et al*, 2009). The urban-rural differential in contraceptive use is primarily the result of greater use of condoms in urban areas than in rural areas which are10% compared with 4%. Contraceptive uses among geographic divisions are a high of 69% in Rangpur; in Barisal 65%; in Chittagong 51%; in Dhaka 61%; in Khulna and Rajshahi 67% and to a low of 45% in Sylhet.

There is a small variation in contraceptive use by women’s education. Contraceptive pills are favored by women of all educational levels 21% to 32%. Women with no education are more likely to use female sterilization than educated women. Women in the lowest two educational quintiles are the most likely to report using male sterilization. After the pill, injectables are favored by women with no education through secondary incomplete level 10% to 14%. In contrast, male condom use is the second most popular method among women with secondary or higher education18%.There is no significant variation in overall contraceptive use by economic status of women with 61% of women in the highest wealth quintile use contraceptives compared with 62% of women in the lowest wealth quintile. Use of condoms increases with wealth quintile, while use of injectables declines as wealth increases.

## 1.8 Nutritional Status and Breastfeeding Practices

Better nutrition is a pre-condition for the national development of any country. Poor nutritional status is a key health problem in Bangladesh. Although problems related to poor nutrition affect the entire population, women and children are especially at risk because of their unique physiology and socio-economic characteristics. A woman of poor nutritional status, which indicated by a low body mass index, short stature, anemia, or other micronutrient deficiencies, has a heightened risk of obstructed labor, having a child with low birth weight, producing low quality breast milk, and dying from postpartum hemorrhage. Probability of dying, in general, is very high for both the woman and her child.

For a new born child, the period from birth to age ‘two years’ is especially important for optimal growth, health, and development. Unfortunately, this period is often marked by protein-energy and micronutrient deficiencies that hamper with optimal physical growth and cognitive development. Common illnesses such as diarrhea and acute respiratory infections are also common in young children (Black *et al*., 2008).

Malnutrition in adults results in reduced productivity, increased susceptibility to infections, slow recovery from illness, and for women, increased risk of adverse pregnancy outcomes (Cesar *et al*., 2008). Young children and women of reproductive age are especially vulnerable to nutritional deficits and micronutrient deficiencies. At the individual level, inadequate or inappropriate feeding patterns lead to malnutrition. Numerous socioeconomic and cultural factors influence patterns of feeding and nutritional status.

Poor nutrition is a critical health problem in Bangladesh. About half of children age 6-59 months suffers from anemia; four-in-ten are stunted; and one in three is underweight. Bangladesh has one of the worst burdens of childhood malnutrition in the world (CIA, world fact book2011; USAID; WHO world tuberculosis report 2012; BDHS 2011).

Bangladesh’s children’s nutritional status has improved somewhat since 2004. The level of stunting has declined from 51% in 2004 to 41% in 2011. The proportion of underweight children has declined from 43% in 2004 to 36% in 2011. The pattern and change in wasting has been small and inconsistent. Wasting increased from 15% in 2004 to 17% in 2007, and declined to 16% in 2011. The MDG target for nutrition in Bangladesh is to reduce underweight among children under age 5 to 33% (General Economic Division/Bangladesh Planning Commission, 2012). If the current pace of decline is sustained, the target can be achieved (BBS, BDHS 2011).

Breastfeeding is almost universal in Bangladesh. Early initiation of breastfeeding is important for both the mother and the child. It is encourages for bonding between the mother and her newborn child. There are a number of reasons to encourage early breastfeeding. Mothers benefit from early suckling because it stimulates breast milk production and facilitates the release of oxytoxin, which helps to contract the uterus and reduce postpartum blood loss. The first breast milk contains colostrum, which is highly nutritious and has antibodies that protect the newborn from diseases.

In Bangladesh, overall, 47% of children are breastfed within one hour after birth, and 90% are breastfed within one day after delivery (BBS, BDHS 2011). The BDHS 2011 report indicates no marked differences in the timing of initial breastfeeding within one hour of birth, either by the sex of the child or by urban-rural residence. Notable variations, however, can be seen by geographic divisions. The proportion of children breastfed within one hour of birth is highest in Sylhet division 54%; in Barisal 43.6%, in Chittagong 46.2%, in Khulna 45.7%, in Rajshahi 53.5%, in Rangour 50.8% and lowest in Dhaka 43%.The percentage of children who started breastfeeding within one day of birth was in 2007 BDHS 89% and in 2011 BDHS 90%.

## 1.9 Research Perspectives

Bangladesh is one of the developing countries which have been experiencing accelerated population growth in recent decades. The ever-growing population is putting severe constraints on national efforts to improve the overall living conditions of the people. The high rate of growth is presumably due to sustained high level of fertility and declining mortality as in other developing countries.

High population growth in the recent decades in the world, in general, in the developing countries in particular, has drawn attention of several researches because of its indirect relationships with and important bearing on the socio-economic development. There is now a general recognition that rapid population growth in developing countries is jeopardizing all the developmental efforts in ameliorating the socio-economic conditions in these countries. For large increase in population of limited land space as that of other resources would not only lead to an increasing presser on land but also may create ecological imbalance.

Moreover, sustained population growth, more consumption, less saving, high social overhead cost, less investment, reduced output per worker, less job opportunities- all leading to a vicious circle of poverty and fatalism (Demney, 1972; 154; Mueller, 1977; Birsall, 1977; Islam MN 1996; Raman & Nasrin, 2009; Raman, M. S. *et al*., 2015; Sweeney *et al*., 2015).

Planner in the developing countries previously maintained that, like the presently developing countries of the world, it would be possible to make socio-economic development without taking into cognizance the population variable. But they proved to be not correct because the initial conditions (Low rate of natural increase, high man/land/resource ratio etc.). Which helped the developing countries in maintaining balance between population growth and development were quite different from those now prevailing in the developing countries. Consequently, population variables are increasingly being taken into account in formulating socio-economic planes and developing strategies and policies in order to promote balanced and rational development.

Thus with equal level of development, other determining factors may cause variation in the fertility level among nations and even among regions within the same nation. Moreover, socio-cultural considerations may be pre-determining the economic considerations in some countries or region in determining the level of fertility in contrast of others. Thus, study of fertility and its determinants is the prime importance not only for its own sake, but also in understanding the mechanism through which it works and its subsequent relationship with other components of the population growth and related matters.

The decline of fertility in the developed countries, Ryder maintains that low fertility has been achieved in Western Europe through four transitional phases: high nuptiality-high marital fertility; low nuptiality- high marital fertility; low nuptiality-low fertility; high nuptiality-low fertility; whereas Eastern Europe has cut the sequence by omitting the two intermediate stages.

Hence, age at marriage and proportion marrying occupy a very important place in studies related to policy interventions for reducing fertility in countries with sustained high fertility like Bangladesh (Duza and Baldin, 1977; Nortman and Hofstatter, 1978). Levels and patterns of fertility considerably vary in various sub-groups of the same population. Study of differential fertility is useful in identifying the factors, which determine fertility levels among various subgroups. It is also helpful in projecting more accurately population size of entire country. Not only can this but such a study which family planning programs can be concentrated.

Differentials fertility includes ecological factors, regional differences, urban-rural setting, educational attainment, economical status, occupation, employment of women, religion, caste, race, age and sex structure, participation of NGO’s etc., therefore, for differential fertility study several factors combined together are always taken into consideration.

Recent studies have identified many reasons for plateauing and slow decline of fertility in Bangladesh. High demand for children with strong son preference and unwanted fertility play an important role in determining actual level of fertility (Islam *et al*., 2002). Pritchet (1994), in his classical study, argued that to reduce fertility in a population, desired fertility, which depends on development, culture etc., is important, and a family planning program and even contraception use itself have a very minor role to play in decreasing fertility in a population. So, the policies that improve the socio-economic conditions and reduce the demand for children are the most important and sustainable way to reduce fertility.

During the first half of the last century the population increased by 45 percent. This slow increase resulted from a combination of high birth rates and high death rates. In the second half of the twentieth century population growth was rapid, and the population tripled during this period. The relatively young age structure of the population indicates continued rapid population growth in the future. One-third of the population is under 15 years of age, 63 percent are age 15-64 years, and 4 percent are age 65 or older (CIA, 2008) This young age structure creates built-in “population momentum,” which will continue to generate population increases well into the future, even in the face of rapid fertility decline. Projections indicate that the population will increase rapidly even after attaining replacement-level fertility because of the echo effect of the high fertility experienced in the past.

Recent and very substantial upward revision of the mid-century population by the United Nations seems unduly pessimistic, because a five-year delay in attaining replacement-level fertility adds only 3 percent to the population at any point in time. Nevertheless, Bangladesh still faces many decades of continued population growth. Efforts to slow that growth need to continue, both through the family planning program and, increasingly, through social and health interventions that will facilitate further fertility decline.

In order to improve our understanding of the causes of fertility decline in Bangladesh, it is necessary to analyze the mechanisms through which socio-economic variables interact with biological and behavioral factor to influence fertility. As biological and behavioral factors affect fertility directly and all other socio-economic factors affect fertility through them, they are termed as 'Proximate determinants' of fertility.

In this study, also an attempt is made to explore the relative and comparative importance of the effect of different proximate determinants of fertility using Original Bongaarts Model (OBM) and Revised Bongaarts Model (RBM) in Bangladesh. Also, estimate proximate determinants role on fertility decline.

In the prevalence of contraceptive use study, most of the researchers had used multiple regressions or logistic regression model analysis techniques for presenting their research work. In the results, they discussed only the significance of the coefficients of independent variables or association within the dependent and independent variables of interest [Castro M.T., & Jejeebhoy S.J., Oxford: Clarendon Press, 1993, 1995; Sajid, A. and M.M. Franklin White. 2005, Pakistan. JCPSP, 15(7) p 422-425; Omariba, D. W., 2006 Kenya, J BiosocSci, 38(4) p 449-479; Nurul Islam et., al, Advances in Life Sciences 2014, 4(2): p 44-51]. Coefficient of independent variable may not be showed how much contribution of that variable in the acceptability of dependent variable; rather than it is contributed or not.

To overcome this shortcoming, we will have worked out the predicted probabilities of contraceptive use through logistic, polynomial, exponential, linear regression models and Revised Bongaarts Model. These probabilities provide the degree of assessment of contribution of independent variables in prevalence of contraceptive use as dependent variable. A number of multivariate logistic regression models are also analyzed to highlight the prominent predictor variables which explained the contraception use behavior of the respondents.

## 1.10 Review of Literature

Bangladesh's women's reproductive behavior had characterized by high fertility and comparatively high mortality. Study conducted in the early sixties reported total fertility rates as seven in Bangladesh (Afzal, 1967; Alauddin and Faruque, 1983). Since the mid sixties, several surveys reveal the persistence of fertility patterns, a characterized, which had been corroborated by the fertility surveys (Sirageldin *et al*, 1975; BFS, 1978).

A solid understanding of the women's reproductive behavior (i.e., fertility behavior) is a necessary part of the foundation for the sound population policies. A good deal of research has been devoted to reach such an understanding. An extensive literature on "modeling of the women's reproductive behavior and predicted probabilities of contraceptive use" exists. These sections have been set out the major bodies of the past research about modeling of the women's reproductive behavior and predicted probabilities of contraceptive use and highlight the gaps that are revealed.

Bangladesh has undergone a remarkable demographic change over the last four decades. The total fertility rate has declined from about 6.3 in the 1975 BFS to 2.3 in 2011 BBS, BDHS 2011. From various sources suggest that the CBR stagnant around 52 per thousand populations until the mid-1960s and in recent years there has been a modest decline in CBR in Bangladesh. Policy makers interested in achieving lower fertility in developing countries may see manipulation of marriage patterns as a potentials useful means of reaching that end but the relationship of marriage patterns to fertility reveals that in some countries later marriage reduces a women's reproduction largely by limiting her opportunity for childbearing.

**Serageldin *et al*., (1975)** seriously questioned the likelihood of success of the service delivery efforts along to generate demand for the birth control in Bangladesh. They argued that the demand for the birth control could only be induced through transformation in the socio-economic conditions that generate demand for large families, or in short, that "development was the best contraceptive".

**Cain (1978)** had- a case study of " The Household Life Cycle and Economic Mobility in Rural Bangladesh", conducted between 1976-1978, in a rural area of Bangladesh. He estimated the mean age at first marriage was 24.0 years for males and 16.0 years for females. He also found that the higher the age at marriage of males the larger was the age difference between husband and wife, which often leads to a wife becoming widowed at a young age.

**Ahmed (1979)** had a study about women who married after the age of 20 years were more liberal in attitude towards abortion in Bangladesh. Shahidullah (1980) studied the differentials nuptiality patterns in Bangladesh using the 1975-76 Bangladesh Fertility Survey data. He estimated the proportions married, the mean and median age at first marriage, average age difference between husband and wife at first marriage, and the socio-economic differentials of age at marriage for rural and urban areas in Bangladesh. He also estimated the rates of divorce and widowhood in rural and urban areas.

**Abedin (1982)** had estimated the mean and median age at first marriage in rural community of Bangladesh. He has estimated various nuptiality parameters recursion Coal's nuptiality models and using these values estimated the frequency of first marriage and risk of first marriage.

**Choudhury RH. (1983)** reported that the relationship between certain aspects of the status of women that is education, work experience and age at marriage, and the use of contraception and fertility, using data collected by Bangladesh Fertility Survey (BFS) of 1975. The analysis was presented separately for rural and urban areas "Results of the tests in brief were as follows: (a) education is found to be strongly correlated with the use of contraception within each sub-group of the study population. Education is positively related with use of contraception and negatively with fertility. (b) Age at marriage was found to be the most important factor explaining fertility for every sub-group of the study population. Couples marrying at higher age were likely to have fewer children and (c) work experience had very little or no effect on current use of contraception and fertility.

**Bongaarts (1987)** model, estimated that 8 percent increase in contraception use would be needed to bring down TFR from 5.3 to 4.8 and 17 percent increase in contraception will be needed to bring down TFR from 5.3 to 4.3, these reductions could be produced by raising the minimum age at marriage to 18 and 21 years respectively.

**Thein *et al*., (1988)** found despite the legal age at marriage, many girls being married before they reach the age of 15 years. This had suggested that introducing legislation to increase age at marriage has little impact unless social traditions are changed. In this respect, access to higher education for female students would have greater impact. Findings from a female scholarship program suggest that more highly educated girls tend to marry later.

**Cleland (1989)** examined the fertility decline in Bangladesh and show that there is a patriarchal society in which most women are in purdah, their status is low, and they are dependent on their father's, brothers and sons. Families and individuals face many risks for which relatives, especially adult sons, are only available insurance. This is a complex of conditions generally considered and these conditions led many component observes as recently as the decade to believe that in Bangladesh there could not be a significant demand for family planning services and lower fertility before substantial structural changes occurred. Indeed, they remain a basis for the plausible idea that further gains will be difficult and that a plateau will be reached in fertility levels long before the recent decline brings fertility to replacement levels.

**Kabir and Rab (1990)** had analyzed Coal's index, $I_m$ (the index of proportion married) to see the change in marriage patterns. The index of proportion married among women in the childbearing ages is divided by comparing the experiencing Hutterite Schedule of marital fertility rates; with the number of children all women bear subject to the same fertility schedule. The interpretation of the index is straightforward. The proportion-married index indicates how much marriage contributes to the overall fertility of the given population.

**Islam *et al*., (1991)** had estimated the fertility inhibiting effect of the three most important proximate determinants: marriage, contraception and lactational infecundability. The analysis shows that although the fertility level of Bangladesh is declining, it is still very high (around 5 births per women). They suggest that fertility reducing effect of the marriage variable is also increasing but at a very slow rate. In fact, the fertility inhibiting effect of marriage and lactational infecundability are compensating each other.

**Chowdhury and Bairagi (1992)** estimate the effect of age at marriage on fertility using Matlab data. They suggest that most of the girls who married before age 12 or 13 years were not fecund at the marriage and their age specific fecund ability, at least for first 10 years of married life, is not different from that of women married at a higher age. They also estimated the average first birth interval, which has been almost two years (1.9 years) for women whose age at first marriage was 18 years, most of the births, which took place to the mothers before age 20 could be averted. Applying these result to age specific birth rates, and assuming that age at first marriage on CBR and TFR has been estimated. The results showed that CBR would be reduced by 13 percent and TFR by 9 percent. If the minimum female age at marriage could be raised to 21, which is the minimum age at marriage set for males in the Bangladesh Population Policy, CBR could be reduced by 32 percent and TFR by 20 percent.

**Islam SM, Khan HT, Khan HM. (1993)** had reported that the effects of selected socio-economic and demographic factors on fertility in a rural area of Bangladesh. It has been revealed that age at first marriage and coital frequency has direct significant effects while ever use of contraception and duration of breast-feeding have direct positive significant effects on total parity. Total effects of wife's education and age at first marriage on fertility are found to be negative while those of religion and household income on fertility are found to be positive.

**Amin *et al*., (1994)** have observed that total marital fertility rate fall by around 10 percent from 5.3 percent in 1990. Similarly, the average number of children ever born and percentage pregnant declined from 4.3 and 11.7 percent in 1983 to 3.7 and 10.6 percent in 1991, respectively. They also showed between 1983 and 1991, the decline in total marital fertility was higher among urban residents and educated women than that of rural resident and uneducated women respectively.

**Islam (1996)** indicated by application of Bongaarts model that there was a downward trend in all the proximate indices. He estimated that between 1975 and 1989, the amount of decrement of fertility was about 23 percent and it was about 31 percent in between 1975 to 1991. Islam concluded that this was primarily caused by an increase in the use and effectiveness of contraception. He also investigated the fertility differentials by various demographic and socio-economic status of women, education of husband and occupation of husband. He suggested that socio-economic variables have positive or negative effect on proximate variables, which in turn affect reproductive performance. He concluded that age at marriage and education have strong determinant of fertility and higher age at marriage, educational level affect on fertility decreasing.

**Khan HT, Raeside R. (1997)** reported using data from the 1989 BFS to determine the significance of influences on the probability of birth in the year preceding the survey. In the survey a total of 11905 ever-married women of reproductive age were asked questions related to fertility aspects of women. Variables selected in this study were grouped into demographic, socio-economic, cultural and decision making variables. Findings from the study indicate that the mother’s age, whether contraception has ever been used, the death of a child at any time, whether the women has ever worked, religion, region of residence, and female independence are the important covariates for explaining recent fertility in Bangladesh.

Models are developed for the probabilities of a women giving birth in urban and rural areas, dependent on her demographic and socio-economic conditions. They also developed models for contraceptive use which is applicable in urban- rural Bangladesh. This modeling contributes to a better understanding of fertility changes in Bangladesh and the differentials between urban and rural fertility. It is indicated that a continued fertility decline is likely.

**Razzaque A. (1999)** examines wife-husband preference for children and subsequent fertility for a period of five years in the treatment and comparison areas of Matlab, Bangladesh. The two data sets used were the In-depth Survey (1984) and the Demographic Surveillance System (1994-89). In the case of wives' preferences for children, subsequent childbearing was 13.8 percent higher than desired in the treatment area and 44.7 percent higher than desired in the comparison area. After controlling for all variables in the model, the likelihood of giving birth was 1.78 times higher for wives who wanted no more children, but whose husbands did want more, compared with couples where neither husband nor wife wanted more children. For couples where the wife wanted more, but the husband did not want more children, the likelihood of giving birth was 0.63 times that of couples where both the husband and wife wanted more children. This finding suggests that to enhance the decline in fertility in these two areas of Matlab, it will be necessary to motivate both wives and husbands to cease childbearing.

**Abdur Razzaque and Peter Kim Streafield (2000)** have studied the past, present and future fertility in Bangladesh. They observed that the population of Bangladesh has been much increases in the second half of the 20$^{th}$ century, 41 million in 1950 to 120 million in 1998. This huge increase population mainly due to mortality decline after the war-II with improvement of medical science and public health measures. However, in Bangladesh, fertility decline at a very low level of socio-economic development. The study used two data sources: Matlab Demographic Surveillance, ICDDRB and Demographic and Health Survey of Micro International, 1993-94, 1996-97, 1999-2000. They observed that in the past, fertility was high because familial, social and economic conditions were favorable to many rather than few children but recent data shows widespread motivation for small family size and it is mainly due to increase in the direct economic cost of living. Such appreciable decline in fertility was possible mainly due to the family planning program have been successful.

**Ray (2000)** stated that slowing down of fertility levels in Bangladesh confirms that the socio-economic rationale for limiting fertility is even more important today, if anything. This is evident from persistent socio-economic differentials in desired family size, observed fertility and in the proximate determinants (Contraceptive use, age at marriage and mean duration of insusceptibility). The lack of further decline in the birth rate despite increasing contraceptive prevalence, although much more slowly, is because current fertility preferences measured by mean ideal family in 1999-2000 of 2.5 are still high relative to replacement level fertility (TFR of 2.1) especially among the poor, firmed the "micro inertia" of fertility.

**Bairagi (2001)** conducted a study in Matlab, a research unit of ICDDRB and found that the fertility in Matlab converges to the desired fertility. The Matlab couples used different proximate determinants of fertility, including contraception and abortion, in this converging process. The study does not support the hypothesis that an MCH-FP project alone can bring fertility down to any low level, and the view that the Government of Bangladesh will be able to bring population growth down by 25 percent by increasing only the CPR from its present 51 percent to 71 percent. It was concluded in the study that a change in the desired family size and gender preference, along with family planning and reproductive health services, is apparently essential to have a further decline in fertility to complete the fertility change in Bangladesh.

**Islam and Abedin (2001)** examined the effect of women's education on age at marriage of the females and as well as on fertility. They showed that education is one of the important social variables of fertility differentials. It is an achieved status of individuals, which does not change over time like some other variables and is expected to give individuals an alternative source of new normative orientations as opposed to traditional ones. Women engaged in such activity contribute in rising age at marriage and thereby affect fertility to reduce.

**Vera Zlindar, Rober Gardner (2001)** observed, why increasing contraceptive use doesn't always results in an immediate decline in total fertility rate. They showed that other direct factors also affect fertility. The CPR is not the only predictor of what will happen to fertility levels. The level of contraceptive use is one of the fertility strongest factors affecting the level of fertility linear regression of 105 countries comparing fertility levels and contraceptive use levels found 77 percent of the variation in fertility is explained by variation in contraceptive use and remaining 23 percent of the variation in total fertility is also important.

**Islam, Islam and Chakraborty (2002)** focused on the exploration of the reality underlying the fertility change in Bangladesh. They have identified a number of factors responsible for unchanging of fertility in Bangladesh since 1993-94, which are due to population momentum effects, shifting of childbearing towards younger ages, shifting towards adoption of a less effective method mix, no substantial improvement in child survival status and reduction in postpartum infecundability period. They mentioned that the actual level of fertility in Bangladesh in 1999/2000 after adjusting for tempo effect would be close to 4, as compared to that of 3.8 in 1996/97. They analyzed statistical characteristics such as location, dispersion and skewness of age specific fertility distribution, which indicate an emerging pattern: (a) the fertility is tending towards young age during the recent past, (b) the births are occurring at a relatively lower span in recent times, that is , the births are taking place at shorter distance from the central tendency of fertility, and (c) the fertility curve is now less skewed to the right, indicating that more births are taking place within a shorter span now than before.

**Bongaarts (2003)** a study of completing fertility transition in 57 less developed countries, found that as the transition proceeds, educational differentials in wanted fertility tend to decline and differentials in unwanted fertility tend to rise. He also concluded that educational composition of the population remains a key predictor of overall fertility in late transitional countries and that low levels of schooling could be a cause of slow change of fertility.

**Eltigani (2003)** in a study of causes of slow change of fertility in Egypt indicated that the reproductive behavior of women from high and middle standards households is largely responsible for slow change of fertility. He mentioned that the key for future decline in desired number of children below the current level of 3 children depends on the reproductive preferences of women.

**Agyei-Mensah, S. (2005)** investigated the causes of constant fertility change in Ghana, during the period 1998-2003. Fertility desires was given as a plausible reason. He mentioned that reducing fertility from levels of 6 to 8 down to 4 to 5 may not be so difficult, because most couples do not want the burden a lots of children surviving (6+). But the further step down below 4 children makes couples anxious and insecure.

**Bongaarts (2005)** in an examination of causes of the slow change of fertility in seven mid-transition countries: Bangladesh, Colombia, Dominican Republic, Ghana, Kenya, Peru and Turkey revealed a systematic pattern of leveling off or near leveling in a number of determinants. The findings suggest no major deterioration in contraceptive access during the stall, but levels of unmet need and unwanted fertility are relatively high. At the onset of the stall the level of fertility was low relative to the level of development in all but one of the stalling countries.

**Sabina F R (2006)** studied about "Emerging Changes in Reproductive Behavior among Married Adolescent Girl in an Urban Slum in Dhaka, Bangladesh". Structural and social inequalities, a harsh political economy and neglect on the part of the state have made married adolescent girls on extremely vulnerable group in the urban slum environment in Bangladesh. The importance placed on newly married girls' fertility results in high fertility rates and low rates of contraceptive use. Ethnographic fieldwork among married adolescent girls, aged 15-19, was carried out in a Dhaka slum from December 2001 to January 2003, including 50 in-depth interviews and eight case studies from among 153 married adolescent girls, and observations and discussions with family and community members. Cultural and social expectations meant that 128 of the girls had borne children before they were emotionally or physically ready. Twenty-seven had terminated their pregnancies, of which 11 reported they were forced to do so by family members. Poverty, economic conditions, marital insecurity, politics in the household, absence of dowry and rivalry among family, co-wives and in-laws made these young women acquiesce to decisions made by others in order to survive. Young married women's status is changing in urban slum conditions. When their economical productivity takes priority over their reproductive role, the effects on reproductive decision-making within families may be considerable.

**Aya Goto, Seiji Yasumura, Junko Yabe and Michael R Reich (2006)** studied about "Influences of Unintended Pregnancy on Child Rearing" Addressing Japan's Fertility Decline. They found that unintended pregnancy was associated with a higher risk of negative child-rearing outcomes, including lower mother-to-child attachment, increased negative feelings of mothers and a lower level of participation of fathers in child rearing. Unintended pregnancy exacerbates the real and perceived burdens of child rearing. Researchers believe the government needs to address the social challenges affecting people's family lives, which underpin low fertility, rather than focus on fertility decline. They suggest adopting a comprehensive approach to improve the lives of young couples, with a focus on adolescents, including life-skills education to prepare for adulthood, marriage and parenthood.

**Azhar Saleem and G. R. Pasha (2008)** in their study "Modeling of the women's reproductive behavior and Predicted Probabilities of Contraceptive Use in Pakistan" found the predicted probabilities of contraceptive use, through logistic regression model, by using the most significant factors which are affecting the contraceptive use in Pakistan were also worked out. The findings indicate that, an improvement in husband-wife educational level, results in greater spouses 'communication about family planning and increased the use of contraception. The husbands' desire for more children, a preference for the next child, and the women's poor education attainment level are the main factors affecting the contraceptive use in Pakistan. It is recommended that the predicted probabilities must be computed in the prevalence of contraceptive studies because results precisely provide the degree of assessment of the acceptability of contraception.

**NIPORT *et al*., (2009)** analyses shows that Bangladesh has made important progress over the past few decades. This is particularly true in the social sector which led some observers to call it 'a near miracle' (Huq 1991). Many of the inequities and deprivations that characterized this nation historically has either been corrected or reduced significantly. In human development, life expectancy has increased by over 50% - from about 45 years in the early 1970s to over 65 years currently. More importantly, women now live a longer life than men, as expected biologically and experienced around the world. The infant mortality rate has reduced from about 150 per 1,000 live births three or four decades ago to 51 in 2007.

**Tasnim Khan and RanaEjaz Ali Khan (2010)** in their study "Fertility Behavior of Women and Their Household Characteristics: A Case Study of Punjab, Pakistan" showed that the total fertility rate in Pakistan is as high as 5.4, that is result of low contraceptive prevalence rate of only 28 percent. By using probit model on primary data taken from a sample of 1000 women (15-49 years) from two districts of Punjab (Pakistan), i.e. Bahawalpur and Lahore, they have analyzed the factors related to household characteristics which are responsible for low contraceptive prevalence among married women. The husband education, income of the husband, husband's age at marriage, number of living children, and number of sons, household income, and urbanity of the household are major determinants of contraceptive prevalence among women; while son preference and number of living daughters in the household defer the contraceptive use. In the short-term implementation of minimum marriage age act and the stress on rural areas may be effective to increase the contraceptive use. For the long-term, provision of education and employment along with awareness about gender equity need policy attention.

**Nashid Kamal (2010)** in his study "Women's Autonomy and Uptake of Contraception in Bangladesh "finds that although mobility and decision making do not have any major influence on the contraceptive use of women in Bangladesh, her working status does have substantial effect. The government should therefore create more job opportunities for women who would enable them to have further their lives in different dimensions and have more control on their fertility. Sylhet, Barisal and Chittagong regions lag behind in contraceptive use. Creating more opportunities for women in these areas in the form of jobs, microcredit, more emphasis on girl's education may also be considered positive inputs for increasing fertility decline. Currently, all the garment industries and other opportunities for female workers are centered on Dhaka, the capital. More decentralization is needed to create job opportunities for women, especially in those regions of the country where fertility is currently high. It is obvious from this study, that women's participation in the job market will pave way for further fertility decline.

**Hasinur Rahaman Khan and J. Ewart, H. Shaw (2011)** saw a very few multilevel analyses have been done in Bangladesh using contraceptive binary data, and these analyses have found significant multilevel effects either at lower levels (clusters, households, blocks) or middle level (districts) but not at higher level (such as division. Their study found that for such hierarchical structured data the multilevel effects are significant and have to be taken into consideration in logistic regression modeling, which leads to multilevel logistic regression modeling. As a result, this multilevel analysis enables the proper investigation of the effects of all explanatory variables measured at different levels (clusters and divisions) on the response variable 'currently using contraception', and finally the model produces appropriate estimates and conclusions about the parameters. A major reason for significant multilevel effects for such data might be dependencies between individual observations, due to sampling not being taken randomly but cluster sampling from geographical areas being used instead.

**Jeffrey Edmeades, Rohini Prabha Pande, Tina Falle and Suneeta Krishnan (2011)** in their study "Son preference and sterilization use among young married women in two slums in Bengaluru city, India" found the ways in which women's sterilization decisions are influenced by the combination of a preference for male children and a desire for smaller family size among young married women in two urban slums in Bengaluru, India. While both son preference and an emphasis on sterilization are well-known demographic characteristics of most South Asian countries, relatively little research has been conducted that links the two. We take advantage of a longitudinal survey of 416 unsterilized married women aged 16-25 to explore how having sons and the number of children influence a woman's sterilization decision. Discrete-time event history techniques are used to estimate two models: the first examines the effect of having sons and number of children separately, and the second examines them in combination in the form of an interaction. The results suggest sterilization is motivated by son preference mainly at lower parities and by concerns about family size at higher parities.

Understanding how sterilization and other reproductive behaviors' are influenced by the interaction of family size and sex preferences will help policy-makers and programmers to meet the needs of women while continuing to address discriminatory behavior against females.

**Farina P., Ortensi L.E. (2012)** at "Contraceptive use among migrant women in Italy: a multilevel approach" have found the mean age of the women interviewed is 32. Some variability exist among nationalities, with a higher percentage of women aged 40 and over among Ukrainian and Moldavian that have also an overall higher age at arrival. The level of education is quite high, with grater prevalence of University graduated among Egyptians (37%) and eastern Europeans, especially those from Ukraine (35.2%) and Moldova (27.9%). The percentage of married women varies widely among nationalities with higher percentages among women mostly characterized by family migration such as women from India (87.6%), Bangladesh (79.9%) or Egypt (79.8%). For these same nationalities also highest prevalence of housewives is observed. Median age at first intercourse is 19, but this value is generally lower among women from sub-Saharan Africa with the exception of women from Somalia.

The percentage of non-users among sexually active women varies widely among nationalities with higher percentages among Pakistani, Indian and Africans. Highest rate of use of modern methods are found among women from Bangladesh, Ethiopia and Sri Lanka. Migrant women are very familiar to contraceptive methods as the results of decades of Family planning policies in their home country. They "export" at least one of the methods prevailing in country of origin. It is worth noting a specialization of methods, such as the injections among sub-Saharan African, the sterilization among Asians as well as withdrawal prevailing in some East European countries. The preferred methods are pill and condom due to its cheapness and readily availability. Non-users among women at risk (women who need contraception to space or limit) are only 6%.This level of unmet need is a negligible proportion comparing to the estimated for world (11%), Africa (21%), Asia and Latin America (10%).The need to limit prevails among migrant women, with one notable exception represented by Sub Sahara Africans for which the need is mainly to space the births, being their demand for children relatively high.

**Wenjuan Wang, Soumya Alva, Rebecca Winter, Clara Burgert, ICF International Calverton, Maryland, USA (USAID, 2013)** in their study on "Contextual Influences of Modern Contraceptive Use among Rural Women in Rwanda and Nepal "the results from this study indicate the relevance for family planning programs of the community context in which women live. The demand for family planning services is influenced not only by women's individual and household socioeconomic characteristics, but also by the community's socioeconomic development, its access and exposure to family planning, the gender norms of local community members regarding decision-making for family planning and health issues, and community norms regarding marriage and childbirth. As this study has shown, based on an analysis of Rwanda and Nepal, the role of these contextual characteristics also is not necessarily consistent across countries.

**Zakir Husain (2014)** in his study "Modern Contraceptive Use among Illiterate Women in India, Does Proximate Illiteracy Mater?" have arrived conclusion as some evidence of transmission of information (Basu-Foster proximate illiteracy effect) related to family planning methods from a literate person to his illiterate partner. This is very important, given the asymmetry between partners with respect to reproductive decisions and the tendency of men to act as "gate keepers" of family welfare (Char *et al.*, 2009). However, such transmission is not across the board, but is observed to occur significantly only among specific cases and among specific communities. Another major finding is that such transmission tapers down as we increase the level of education of the male partner. This is very important for policy design, as it implies that even a small level of investment in education generates substantial externalities in the sphere of reproductive health. It also implies that a strategic option before policy makers in enveloping South Asian countries is to refocus family planning programmes away from women to men, seeking to re-educate them about benefits of contraceptives and provide them information about alternative methods through inter-personal communication with health workers.

**Abdurahman Mohammed *et al.*, (2014)** in their study "Determinants of modern contraceptive utilization among married women of reproductive age group in North Shoa Zone, Amhara Region, Ethiopia" found that the modern contraceptive prevalence rate among currently married women was 46.9%. Injectables contraceptives were the most frequently used methods (62.9%), followed by intrauterine device (16.8%), pills (14%), norplant (4.3%), male condom (1.2%) and female sterilization (0.8%). Multiple logistic regression model revealed that the need for more children (AOR 9.27, 95% CI 5.43-15.84), husband approve (AOR 2.82, 95% CI 1.67-4.80), couple's discussion about family planning issues (AOR 7.32, 95% CI 3.60-14.86). Similarly, monthly family income and number of living children were significantly associated with the use of modern contraceptives. Modern contraceptive use was high in the district. Couple's discussion and husband approval of contraceptives use were significantly associated with the use of modern contraceptives. Therefore, district health office and concerned stakeholders should focus on couples to encourage communication and male involvement for family planning.

**Islam, M. S. *et al*., (2014)** in their study, they examined the effects of inter-spousal communication on contraceptive use and method choice in Bangladesh. A total 451 married men aged 15-49 were interviewed from Narsingdi municipality, Bangladesh. Bivariate analysis as chi square test was applied to examine the relationship between spousal communication as well as other socio-demographic variables on contraceptive use. Binary logistic regression was applied to examine the effect of spousal communication on contraceptive use and multinomial logistic regression was applied to examine the effect of spousal communication on method choice. Binary logistic regression showed that inter spousal communication on family planning has strong positive effect on current contraceptive use and multinomial logistic regression showed that inter spousal communication has positive effect on choosing modern and tradition method than none using any method. However, age of husband, age of women, number of living children, media exposure, knowledge on contraception, husband and women occupation, and couple's income were also associated with contraceptive use and method choice in Bangladesh.

**Rafiqul Islam *et al*., (2015)** in their study, they define migration is a process that occurs between two geographical places of population with high ambition and many objectives. Rural to urban migration is responsible for two-third of the increment of urban population annually in Bangladesh. The purpose of the study is to identify the direct and indirect effects of some selected socio-economic and demographic variables on female migrants. For this study, the data is collected using three-stage sampling technique from Meherpur Sadar Thana under Meherpur district, Bangladesh. To fulfill the objectives, path model analysis was to estimate the direct, indirect and joint contribution of socio-economic and demographic variables on females' decision of migration. It is found that age at first marriage, religion and occupation of respondent have significant direct negative effects while educational qualification of respondent have direct positive effects on female migration.

**Raman, M. S. *et al*., (2015)** in their study "awareness, treatment, and control of diabetes in Bangladesh" they found that the overall, age-standardized prevalence of diabetes was 9.2%. Among subjects with diabetes, 41.2% were aware of their condition, 36.9% were treated, and 14.2% controlled their condition. A significant inequality in diabetes management was found from poor to wealthy households: 18.2% to 63.2% (awareness), 15.8% to 56.6% (treatment), and 8.2% to 18.4 % (control). Multilevel models suggested that participants who had a lower education and lower economic condition were less likely to be aware of their diabetes. Poor management was observed among non-educated, low-income groups, and those who lived in the northwestern region.

**Islam, M. R. *et al*.,** (2015) in "Fertility Situation in Bangladesh: Application of Revised Bongaarts Model" estimate approximately correct value of total fertility rate (TFR) used data obtained from 1975-2011, nationwide demographic surveys. Their analyses clearly indicate that contraceptive practice is playing the key role in fertility change in Bangladesh. The findings of the study provide a basis for drawing out some policy adoption and prescribe some recommendations for further decrease in TFR of Bangladesh.

## 1.11 Objectives of the study

In an empirical analysis of data on Asian countries, Smith (1976) demonstrated a change in the fertility pattern. He also observed that urbanization; expansion of education and creation of non-agricultural occupations causes rapid change in the marriage pattern and fertility and the timing of family formation.

After 1971, marking independence of Bangladesh, the government made efforts to further enhance the pace of the social development program. Therefore if the existing theories of social change are true, changes of the level of fertility in Bangladesh may be expected. With this conceptual background this study intends to test the following hypothesis:

(i) If modernizing institutions such as urbanization, industrialization, education, communication and mass media have the capacity of enhance individual value systems (Inkeles *et al*., 1974), if the country has been undertaking polices for implementation and expansion of such modernizing institutions and if individuals are exposed to such institutions, then an increasing trend in the age at marriage can be anticipated in the country and reduce the level of fertility.

(ii) If urbanism is a way of life, then the age at marriage in the urban areas will be higher than in rural areas and increasing trend of age at marriage will be faster in the urban areas than rural areas. Specially, the higher opportunities for women's education, jobs and participation in alternative activities have a direct impact on the age at marriage as well as fertility level.

(iii) If cultural differences, ecological differences, differences in pace of development and Socio-Economic compositional differences have an effect on individuals' value judgments, individuals' decision making processes, and individuals' outlook on social life, then differences in age at marriage and level of fertility between regions are expected to be observed. Specially, differential patterns of urbanization, education, religious distribution and sex differential child or infant mortality create differences in the level of age at marriage as well as the trend of age at marriage and level of fertility and contraception.

(iv) Efforts are necessary to motivate people to have a smaller family size and extend more family planning facilities in order to reduce the high rate of population growth in the country. Re-distribution of Socio-economic facilities such as medical facilities, educational facilities and employment opportunities; especially for females, will eventually levels-off the regional variations in the level of fertility and hence reduce the overall level of fertility in the country. Integrated socio-economic development and family planning activities are thus necessary to slow down the rate of population growth. While socio-economic development will generate necessary motivation towards desire for smaller family size, family planning facilities will help in translating the desire.

The Government of Bangladesh has taken up the basic need strategies as one of the means of achieving the target set in population policies from time to time. However, in spite of various regional, economic, socio-economic and cultural impediments notable progresses are expected to achieve during the near past in the areas of population, in general; and in the areas of marriage, fertility, contraceptive use, maternal and child health and diseases in particular.

The present study is undertaken with a goal to explore the women's reproductive behavior and predicted probabilities of contraceptive use that are taken place in the country in response to various development programs and also investigate the factors mostly responsible for giving rise to current levels of marital fertility. The study requires in-depth analyses to explore the inherent peculiarities of fertility and contraceptive use; which stems from the speculation those in recent times both the aforesaid phenomena have shown some changes in their levels, trends and differentials.

Broadly speaking, the specific objectives of the present study are as follows:

(i) To find out the demographic changes (rates, particularly fertility rates) at the national, sub-national and regional levels.

(ii) To find out a dynamic picture of women's reproductive behavior in Bangladesh.

(iii) To recognize and analyze the direct and indirect factors those determine the levels, trends in fertility and contraceptive use.

(iv) Examining the proximate determinants of fertility with their consequences on fertility.

(v) To find out predicted probabilities of contraceptive use for achieving fertility.

## 1.12 Organization of the study

The study is organized in eight chapters. Following the Introductory Chapter, which contain a brief description about Bangladesh and its population, marriage and reproductive behavior, review of literature and objectives of the present study.

Chapter two contains description about data sources used in the study. Techniques adopted in course of analyses of data.

Chapter three contains univariate analysis of levels, trends in fertility patterns on the basis of various indicators of fertility in Bangladesh by means of cohort and period fertility and contraception.

Chapter four contains bi-variate analysis of fertility and contraception where attempts are made to provide comprehensive information about the components, which significantly affect on fertility and contraceptive use.

Chapter five provides a study on the biological aspects of fertility analyzed by means of Revised Bongaarts model of the proximate determinants of fertility.

Chapter six contains a study of some selected variables on fertility and contraception with the analyses of the path model and binary logistic regression model.

Chapter seven contains prediction of factors to achieve target fertility with the analyses of Revised Bongaarts model and by exponential, polynomial and linear regression models.

The study completed by providing summary, limitations and policy recommendations of the findings and some interpretation regarding further research in chapter eight.

# Chapter Two
# DATA SOURCE AND ANALYTICAL METHODOLOGY

## 2. Introduction

The present study covers a period of 40 years, from 1975 to 2011. Admittedly, vital registration survey (VRS) had been functioning in the country on a national basis on 1981 to 1998 in each year under Bangladesh Bureau of statistics (BBS), and sample vital registration system (SVRS), on 1999 to 2011 in each year under BBS. Bangladesh has a long history of census taking and quite a few nationwide surveys on fertility and contraception have been conducted. Mainly, these are Bangladesh Fertility Survey (BFS) of 1975 and 1989 and Contraceptive Prevalence Surveys (CPS's): 1979, 1981, 1983, 1985, 1989 and 1991. Eventually, the data of the present study are taken from three sources, viz. (a) Bangladesh Population Census of 1981, 1991, 2001 and 2011; and (b) BFS's of 1975 and 1989; and (c) the Bangladesh Demographic and Health Surveys (BDHS's), conducted during 1993-1994,1996-1997,1999-2000, 2004, 2007 and 2011.

The BDHS's are nationally representative surveys. The BDHS's were conducted under the authority of National Institute for Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare. The surveys were implemented by Mitra and Associates a Bangladeshi research firm located in Dhaka, Technical assistance was provided by the MEASURE DHS ICF International Calverton, Maryland, U.S.A. Financial support for the survey was provided by the U.S. Agency for International Development (USAID)/ Bangladesh.

The 2011 BDHS is the sixth DHS survey conducted in Bangladesh. All ever-married women age 12-49 who were usual members of the selected households and those who spent the night before the survey in the selected households are eligible to be interviewed and all ever-married men age 15-54 who were usual members of the selected households or who spent the night before the survey in the selected households were eligible for individual interview in the survey.

## 2.1 Selection of Sample Size

The complete list of enumeration areas (EAs) covering the whole country prepared by the Bangladesh Bureau of Statistics (BBS) for the 2011 population census of the People's Republic of Bangladesh. An EA is a geographic area covering on average 113 households. The sampling frame contains information about the EA location, type of residence like urban or rural, and the estimated number of residential households. The choice of total size for the 2011 BDHS was made after balancing analytical requirements against factors of cost and logistic feasibility.

The survey was conducted in 18,000 residential households, 6,210 in urban areas and 11,790 in rural areas. The sample was expected to result in about 18,072 completed interviews with ever-married women, 6,426 in urban areas and 11,646 in rural areas. One in three households in the survey was selected for a male survey. Based on the 2007 data, the average number of ever-married women age 13-49 per household was assumed to be 1.10 in urban areas and 1.05 in rural areas. The household response rate was fixed at 96 percent for both urban and rural areas and the women's individual response rate was 98 percent for both urban and rural areas.

## 2.2 Sampling Design

The sample for the 2011 BDHS covered the entire population residing in private dwelling units all over Bangladesh. Administratively, she is divided into seven divisions. Each division is further sub-divided into progressively smaller zilas, thanas, unions, wards, and villages. An EA is either a village, or a group of small villages, or a part of a large village. These divisions allow the country as a whole to be easily separated into small geographical area units with an urban-rural designation. In Bangladesh, 25.9 percent of the households are in urban areas: 8.4 percent are in city corporations, and 17.5 percent are in other than city corporations and the rest are in rural areas.

A new household listing operation was carried out by Mitra and Associates in all selected EAs from 22 May to 5 October 2011. The listing was initially done 19 teams of two persons each. The number of teams was reduced to six towards the end of the listing operation. The survey interviewers were instructed to interview only the pre-selected households; no replacements or changes were allowed in order to prevent bias.

Sample was stratified and selected in two stages. Each division was stratified into urban and rural areas. The urban areas of each division are further stratified into two strata: city corporations and other than city corporations. Because Rangpur Division has no city corporations, a total of 20 sampling strata were created. Samples of EAs were selected independently in each stratum in two stages. Implicit stratification and proportional allocation were achieved at each of the lower administrative levels by sorting the sampling frame within each sampling stratum before sample selection, according to administrative units in different levels, and by using a probability proportional to size selection at the first stage of sampling.

In the first stage, 600 EAs were selected, with probability proportional to the EA size and with independent selection in each sampling stratum, 207 in urban areas and 393 in rural areas. In the second stage of selection, a fixed number—30 households per cluster—were selected with an equal probability systematic selection from the newly created household listing.

## 2.3 Questionnaire

The 2011 BDHS used five types of questionnaires:

(a) A Household Questionnaire, (b) a Woman's Questionnaire, (c) a Man's Questionnaire, (d) a Community Questionnaire, and (e) two Verbal Autopsy Questionnaires to collect data on causes of death among children under age 5.

The contents of the household and individual questionnaires were based on the MEASURE DHS model questionnaires. These model questionnaires were adapted for use in Bangladesh during a series of meetings with a Technical Working Group (TWG) that consisted of representatives from NIPORT, Mitra and Associates, International Centre for Diarrheal Diseases and Control, Bangladesh (ICDDR, B), USAID/Bangladesh, and MEASURE DHS. Draft questionnaires were then circulated to other interested groups and were reviewed by the 2011 BDHS Technical Review Committee. The questionnaires were developed in English and then translated and printed into Bangla.

The Household Questionnaire was used to list all the usual members and visitors in the selected households. Some basic information was collected on the characteristics of each person listed, including age, sex, education, and relationship to the head of the household. The main purpose of the Household Questionnaire was to identify women and men who were eligible for the individual interview. In addition, information was collected about the dwelling unit, such as the source of water, type of toilet facilities, materials used to construct the floors and walls, and ownership of various consumer goods.

The Household Questionnaire was also used to record for eligible individuals:

- Height and weight dimensions
- Anemia investigation results
- Measurements of blood pressure and blood glucose.

The Woman's Questionnaire was used to collect information from ever-married women age 15-49.

Women were asked questions on the following topics:

- Background characteristics, e.g., age, education, religion, and media coverage.
- Reproductive record
- Use and source of family planning methods
- Antenatal, delivery, postnatal, and newborn care
- Breastfeeding and infant feeding practices
- Child immunizations and childhood illnesses
- Marriage
- Fertility preferences

- Husband's background and respondent's work
- Awareness of AIDS and other sexually transmitted infections
- Food security.

The Man's Questionnaire was used to collect information from ever-married men age 15-54.

Men were asked questions on the following topics:

- Background characteristics, including respondent's work.
- Marriage
- Fertility preferences
- Participation in reproductive health care
- Awareness of AIDS and other sexually transmitted infections

The Verbal Autopsy Questionnaires were developed based on the work done by an expert group led by the WHO, consisting of researchers, data users, and other stakeholders under the sponsorship of the Health Metrics Network (HMN). The verbal autopsy tools are intended to serve the various needs of the users of mortality information.

Two questionnaires were used to collect information related to the causes of death among young children; the first questionnaire collected data on neonatal deaths (deaths at 0-28 days), and the second questionnaire collected data on deaths between four weeks and five years. These questionnaires were administered to mothers who reported the death of a child under age 5 in the five-year period prior to the 2011 BDHS survey or care taker who were knowledgeable about the symptoms and treatment preceding the death. The questionnaires contained both structured, pre-coded questions and non-structured; open-ended questions.

The following topics were enclosed in the Verbal Autopsy Questionnaires:

- Identification including detailed address of respondent
- Informed consent

- Detailed age description of deceased child
- Respondent's account of illness/events leading to death
- Maternal history, including questions on prenatal care, labor and delivery, and obstetrical complications
- Information about accidental deaths
- Detailed signs and symptoms preceding death
- Mother's health and contextual factors
- Information on treatment module and information on direct, underlying contributing causes of death from the death certificate, if available.

## 2.4 Training and Field Work for Data Collection

To describe Enumeration Areas (EAs), and to administer Community Questionnaires, 47 people were trained to carry out the listing of households. To obtain locational coordinates for each selected EA, they were also trained in the use of global positioning system (GPS) units. The training lasted from May 11-21, 2011. A household listing operation was carried out in all selected EAs from May 22 to October 5, 2011 in four phases, each about three weeks in length. Originally, 19 teams of two persons each were deployed to carry out the listing of households and to administer the Community Questionnaires. The number of teams was reduced to 15 in the second and third phases and to 6 in the final phase. In addition, six supervisors were deployed to check and verify the work of the listing teams.

Four supervisors, 10 interviewers, and 4 biomarker staff were trained for the Household, Woman's and Man's Questionnaires in March 2011 for pre-tested. Based on observations in the field and suggestions made by the pre-test teams, revisions were made to the wording and translations of the questionnaires, where the questionnaires were pre-tested on 100 households, 100 women, and 70 men in one urban and one rural cluster in Comilla District and one urban and one rural cluster in Dhaka.

The main survey training was conducted from June 6 to July 5, 2011. On the project, 173 fieldworkers were recruited based on their educational level, prior experience with surveys, maturity, and willingness to spend up to six months. Training included:

1. Lectures on how to conduct an interview and complete the questionnaires,
2. Mock interviews by participants, and
3. Field practice.

For the 2011 BDHS, fieldwork carried out 16 interviewing teams, each consisting of one supervisor, one field editor, five female interviewers, two male interviewers, and one logistics staff member. Starting on July 8, 2011 and ending on December 27, 2011 data collection was implemented in five phases. In addition, from January 2-19, 2012 there were re-visits to collect blood samples from respondents interviewed during Ramadan who had agreed to participate in blood testing, but declined to be tested during Ramadan.

The quality of data ensured through four quality control teams, each comprise of one male and one female staff person. In addition, NIPORT monitored fieldwork using extra quality control teams. The quality of data also monitored through field check tables generated concurrently with data processing. This was an advantage because the quality control teams able to advise field teams of problems detected during data entry. In particular, tables generated to check various data quality parameters. Fieldwork also monitored through visits by representatives from USAID, ICF International, and NIPORT.

## 2.5 Processing of Data

Data processing consisted of office editing, coding of open-ended questions, data entry, and editing of inconsistencies found by the computer program. The data processing began shortly after the start of fieldwork. The data were processed by 16 data entry operators and two data entry supervisors. The concurrent processing of the data was an advantage since the quality control teams were able to advise field teams of problems detected during the data entry. Data processing commenced on July 23, 2011 and ended on

January 15, 2012. It was carried out using the Census and Survey Processing System (CSPro), a joint software product of the U.S. Census Bureau, ICF International, and Serpro S.A. The completed 2011 BDHS questionnaires were periodically returned to Dhaka for data processing at Mitra and Associates offices.

## 2.6 Coverage of the sample

Table 2.1 shows the results of the household and individual women's and men's interviews. From a total of 17,964 selected households, 17,511 were found to be occupied. Interviews were successfully completed in 17,141 households, or 98 percent of all the occupied households. A total of 18,222 ever married women age 12-49 were identified in these households, and 17,842 were interviewed, yielding a response rate of 98 percent.

In one-third of the households, ever-married men over age 15 were eligible for interview. Of the 4,343 eligible men, 3,997, or 92 percent, were successfully interviewed. The 2011 response rates were similar to those in the 2007 BDHS. The principal reason for non-response among women and men was their absence from home despite repeated visits to the household. The response rates do not vary notably by urban-rural residence.

**Table- 2.1: Results of the household and individual interviews.**

| BDHS Characteristics | 2011 Residence | | | 2007 Residence | | |
|---|---|---|---|---|---|---|
| | Urban | Rural | Total | Urban | Rural | Total |
| Household interviews | | | | | | |
| Household sampled | 6,210 | 11,754 | 17,964 | 3,993 | 6,826 | 10,819 |
| Household occupied | 6,035 | 11476 | 17,511 | 3,849 | 6,612 | 10,461 |
| Households interviewed | 5,868 | 11,273 | 17,141 | 3,821 | 6,579 | 10,400 |
| Household response rate[1] | 97.23 | 98.23 | 97.89 | 99.27 | 99.5 | 99.42 |
| Household non-response rate | 2.77 | 1.77 | 2.11 | 0.73 | .5 | .58 |
| Individual interviews: Women | | | | | | |
| Eligible women | 6,390 | 11,832 | 18,222 | 4,230 | 6,948 | 11,178 |
| Eligible women interviewed | 6,196 | 11,646 | 17,842 | 4,151 | 6,845 | 10,996 |
| Eligible women response rate[2] | 96.96 | 98.43 | 97.91 | 98.13 | 98.52 | 98.37 |
| Eligible women non-response | 3.04 | 1.57 | 2.09 | 1.87 | 1.48 | 1.63 |
| Individual interviews: Men | | | | | | |
| Eligible men | 1,586 | 2,757 | 4,343 | 1,559 | 2,515 | 4,074 |
| Eligible men interviewed | 1,437 | 2,560 | 3,997 | 1,443 | 2,328 | 3,771 |
| Eligible men response rate[2] | 90.61 | 92.85 | 92.03 | 92.56 | 92.56 | 92.56 |
| Eligible men non-response | 9.39 | 7.15 | 7.97 | 7.44 | 7.44 | 7.44 |

**Source:** BDHS- 2011 and 2007, Table 2.1 Results of the household and individual interviews.
[1]Household interviewed/Household occupied; [2]Respondents interviewed/Eligible respondents.

## 2.7 Background Characteristics of Women and Men

Before executing any statistical analysis, it is important to know the characteristics or nature of the related data. Therefore, it is necessary to pay attention to the background characteristics of the researchable data at the beginning of the analysis. It is significant to investigate each variable individually and to decide whether an individual variable is concentrated in a particular group or having considerably large number of missing observations or remain ill defined. In that case those particular variables will be required to be extracted from this study. The variables that are considered for this study can broadly be grouped into:

i. **Demographic Characteristics:** Current age of respondents (women's), women's age at first marriage, husband's age, region of women, age of women at first birth, ideal number of children, husband's sex preference, spousal sex preference for the next child, ideal number of boys, ideal number of girls, ideal number of either sex, respondents fertility desire, husbands fertility desire.

**ii.** **Socio-economic Characteristics:** Education of respondents (women's), husband's education level, type of place of residence, occupation of respondents, husband's working status, wealth index; discuss FP with husband, preferred future method, decision maker for using contraception and intention.

iii. **Socio-Cultural Characteristics:** Religion, length of breast feed of children, etc.

Two dependent variables are selected for this study:

1. Children ever born CEB (i.e. index of fertility), and
2. Contraceptive use.

## 2.8 Limitations and Justification of the quality of data

The data of BDHS 2011 are affected by two types of error i) non-sampling errors and ii) sampling errors. Non-sampling errors are the results of mistakes that made in implementing at the time of data collection and data processing, such as failure to locate and interview correct household, misunderstanding about the questions on the part of either from interviewer or respondent; and data entry errors. Although numerous efforts were made during implementation of the 2011 BDHS to minimize these type of errors; non-sampling errors are impossible to avoid completely and difficult to evaluate statistically.

On the other hand, sampling errors can be evaluated statically. The sample of respondents selected in the BDHS is only one of many samples that could have been selected from the same population, using the same design and expected size. Each of these samples would yield results that differ somewhat from the results of the actual sample selected. Sampling errors are a measure of the variability between all possible samples. Although the degree of variability is not known exactly, it can be estimated from the survey results.

A sampling error is usually measured in terms of the standard error for a particular statistic (mean, percentage etc.), which is the square root of the variance. The standard error can be used to calculate confidence intervals within which the true value of the population can reasonably be assumed to fall. For example, for any given statistic will fall within a range of plus or minus two times the standard error of that statistic in 95% of all possible samples of identical size and design.

If the sample of respondents have been selected as a simple random sample, it would have been possible to use straightforward formulas for calculating sampling errors. However, the BDHS sample is the result of a two-stage stratified design, and consequently, it was necessary to use more complex formulae.

The computer software used to calculate sampling errors for the BDHS data is the ISSA Sampling Error Module (SAMPERR). This module used the Taylor linearization method of variance estimation for survey estimates that are means or proportions. The jackknife repeated replication method is used for variance estimation of more complex statistics such as fertility and mortality rates. The results are summarized in APPENDIX B in the BDHS 2011.

From the results it is observed that in general, the relative standard error for most estimates of the country as a whole is small, except for estimates of very small proportions and it is evident that the quality of data is appreciable.

## 2.9 Preliminaries of the Major Proximate Determinants

There has been a growing interest in quantifying the changes in fertility in Bangladesh at the recent past. Application of Bongaarts' model for identification of changes in terms of proximate variables seems to be rewarding on many occasions. The model is necessarily multiplicative in nature and requires data, among others, on proportion married, extent of the use effectiveness of contraception, prevalence of induced abortion and lactational infecundability.

In this section, an attempt is made to assess the above parameters on fertility change and their contribution thereof, with recourse to Bongaarts' model for proximate determinants of fertility. The special interest of this section is to study the contribution of these indices on the decline of fertility. The model is briefly discussed below:

## 2.10 Original Bongaarts Model (OBM)

To quantify the fertility inhibiting effects of four major proximate determinants, Bongaarts' developed a model, which is now widely used in fertility analysis. Bongaarts' model of estimating the effect of different proximate determinants assumes that the natural reproductive capacity (that is total fecundity rates, TF) of women is nearly the same for all women, but their actual reproductive performance is modified by four major proximate determinants.

In his model Bongaarts' (1978) expressed total fertility rate TFR, is the product of four indices measuring the fertility inhibiting effect of these four indices and the total fecundity rate (TF). The TF is the average number of live births expected among women who during their entire reproductive period, remain married, do not use contraception, do not have any induced abortion and do not breastfeed their children (Bongaarts', 1982). According to Bongaarts model, the TFR can be written as –

$$TFR = C_m \times C_c \times C_a \times C_i \times TF \quad \text{---------------------------------------------------} \quad (1)$$

Where, $C_m$ is the index of proportion married

$C_c$ is the index of non-contraception

$C_a$ is the index of induced abortion, and

$C_i$ is the index of lactational infecundability.

TF is the total fecundability

$C_m$ = 1; if all women of reproductive age are married

= 0; in the absence of marriage.

$C_c$ = 1; in the absence of contraception

= 0; if all fecund women use cent percent effective contraception

$C_a$ = 1; in the absence of induced abortion

= 0; if all pregnancies aborted

$C_i$ = 1; in the absence of lactation and postpartum abstinence

= 0; if the duration of infecundability is infinite.

The estimation procedure of the indices of intermediate fertility variables are as follows:

Index **of Proportion Married ($C_m$)**

The index of proportion married is estimated by the equation

$$C_m = \frac{\sum m(a)g(a)}{\sum g(a)} \quad \text{-----------------------------------------} \quad (2)$$

Where m(a) is the age-specific proportion of females currently married and g(a) is the age-specific fertility rate.

Equation (2) can also be written as-

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

So that,

$$TFR = C_m \times TM \quad \text{-----------------------------------------} \quad (3)$$

The index $C_m$ gives the proportion by which TFR is smaller than TM, as the result of non-marriage, $C_m = 0$, if nobody is married, and $C_m$=1, if all women are married during the entire reproductive period.

Here,

TM = Σ g(a)

= Total marital fertility rate, equal to the number of births a women would have at the end of the reproductive years if she were to be bear children at prevailing age-specific marital fertility rates and remain married during the entire reproductive period (based on the fertility of married women aged 15-49). If $C_m$=1, then TFR=TM and hence, the difference between TM and TFR are account for by the effects of the marriage.

**Index of Non-Contraception ($C_c$)**

To estimate the effect of contraception on marital fertility, the following equation expresses marital fertility as the interaction of contraceptive practice and natural fertility.

$$TM = C_c \times TNM \quad \text{------------------------------------------------------------} \quad (4)$$

Where, TNM is the total natural marital fertility rates which are equal to TM in the absence of contraception and induced abortion. Equation (4) simply states that TM is smaller than TNM by a proportion $C_c$, with the value of $C_c$ depending on the prevalence of contraception that is the extent of use effectiveness of contraception; that is, the extent of use effectiveness of contraception (induced abortion is assumed absent for the moment).

When no contraception is practiced, $C_c$ = 1, and when all non-sterile women in the reproductive years are protected by 100 percent effective contraception; $C_c$ = 0, and then TM = 0. If all couples, who practice contraception is assumed non-sterile, the index $C_c$ can be written as-

$$C_c = 1 - s \times u \times e \quad \text{---------------------------------------------------------} \quad (5)$$

Where, u is the average proportion of married women currently using contraception (average of age specific use rate). e is the average contraceptive effectiveness and a value for s = 1.08 obtain by Henry (1961) is likely to provide a good approximation for many countries (Bongaarts', 1978). To relate the index of contraception to the total fertility rate, equation (3) becomes-

$$TFR= C_m \times C_c \times TNM \quad \text{-----------------------------------------------} \quad (6)$$

This equation gives the total fertility rate from the natural marital fertility rate by taking into account the fertility reducing impact of contraception and marriage measured by the index of $C_c$ and $C_m$ respectively.

**Index of Induced Abortion ($C_a$)**

Although reliable measurements of the prevalence of induced abortion is practiced in many societies, even in cases where good estimates are available, it has proven difficult to determine the reduction in fertility that is associated with the practice of induced abortion.

Estimates of number birth averted by induced abortion are largely based on numerical exercises using mathematical reproductive models. The most detailed studies of this topic have been made by Potter (1976), whose work has demonstrated as the following:

In the absence of contraception, an induced abortion averts about 0.4 births, while about 0.8 births are averted when moderately effective contraceptive is practiced. To generalize from these findings the births averted per induced abortion B, may be estimated with the following equation- $B=0.4\ (1+u)$ ----------------------------- (7)

A convenient overall measure of the incidence of induced abortion is provided by the total abortion rate (TA), equal to the average number of induced abortions per women at the end of the reproductive period, if induced abortion rates remain at prevailing levels through the reproductive period (excluding induced abortions to women who are not Married).

The reduction in fertility associated with a given level of total abortion rate is calculated as-

$$A = B \times TA$$

$$= 0.4\ (1+u) \times TA$$

Where 'A' equals the average number of births averted per women by the end of the reproductive years. The index of induced abortion is defined as the ratio of the observed total fertility rate (TFR), to the estimated total fertility rate without induced abortion, TFR+A; that is

$$C_a = \frac{TFR}{TFR + A} \quad \text{-------------------------------------------------------------} \quad (8)$$

The index $C_a$ equals the proportion by which fertility is reduced as the consequence of the practice of induced abortion (Note that $C_a$ declines with increasing incidence of induced abortion). Modifying equation (6) accordingly, the relationship between TFR and TNM becomes- $TFR = C_m \times C_c \times C_a \times TNM$ ----------------------------------- (9)

**Index of Lactational Infecundability ($C_i$)**

In modern western population lactation is generally short and many women do not lactate at all. In traditional societies in Africa, Latin America and Asia, lactation is usually long and lasts until the next pregnancy occurs.

Lactation has an inhibiting effect on fertility and thus increases the birth interval and reduces natural fertility (Potter, 1965). A typical average birth intervals with and without lactation is given by-

$$C_i = \frac{20}{18.5 + i} \quad \text{-----------------------------------------------------------------} \quad (10)$$

Where, i is the average duration (in months) of infecundability from birth to the first post-partum ovulation (menses). An indirect estimates of i as developed by Bongaarts (1978) is given by-

$$i = 0.1753 \times \exp\left[0.1396 \times B - 0.001872 \times B^2\right]$$

Where, B is the average duration of breastfeeding in months.

The relationship between lactation and the total natural marital fertility rate becomes-

$$TNM = C_i \times TF$$

Where, TF is the total fecundity rate equal to the natural marital fertility rate in the absence of lactation. Then the model is represented including lactational infecundability as

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

## 2.11 Revised Bongaarts Model (RBM)

In original Bongaarts model we replace only the index "all fetal wastage" (combination of miscarriage, abortion and stillbirth) instead of the index "induced abortion" which is one of the proximate determinants of fertility. Other indices have remained same as proposed by Bongaarts original model. In the revised Bongaarts model (Md. Nurul Islam *et al.*, 2014, Fertility Analysis of Bangladesh Population Using the Revised Bongaarts Model, Journal of Advances in Life Sciences 4(2): 44-51) they considered all miscarriage or all fetal wastages together instead of only the index induced abortion in computed in the index, then the index might be termed as the index of fetal wastage and it indicated by $C_{fw}$. Then the proposed model becomes

$$TFR = C_m \times C_c \times C_{fw} \times C_i \times TF \text{------------------------------------------}(11)$$

Where, the index of fetal wastage ($C_{fw}$) is defined as the ratio of the observed total fertility rate to the estimated total fertility rate with all fetal wastage which is (TFR+AFW), that is

$$C_{fw} = \frac{TFR}{(TFR + AFW)}$$

Where AFW equals the average number of birth averted per woman by the end of the reproductive years for all fetal wastage and which is estimated by

$$AFW = 0.4 \times (1 + u) \times TFW.$$

Here, TFW is the total fetal wastage rate and AFW is the average number of all fetal wastage per woman at the end of the reproductive years.

## 2.12 Fertility Inhibiting Effect for Proximate Determinants

The difference between the total fecundity rate TF, taken as 15.30 in 2011 BDHS and the estimated TFR is attributed the result of the inhibitory effect of each variable. The total inhibiting effect is prorated by the proportion of the logarithm of each index to the sum of logarithm of all indices (Wang *et al*., 1987).

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

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

$$\text{Effect of Postpartum Infecundability} = \frac{[TF - TFR(estimated)] \times \log_e C_i}{\log_e C_m + \log_e C_c + \log_e C_i + \log_e C_{fw}}$$

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

Here, TFR (estimated) = $C_m \times C_c \times C_i \times C_{fw} \times 15.3$ ----------------------- (12)

## 2.13 Path Analysis

Path analysis is a standardized multiple regression analysis using a standardized form of dependent and independent/ predictor variables, with mean zero and unit variance in which a chain of relationships among the variables, arranged in an orderly manner, is examined through a series of linear regression equation.

Path analysis helps in estimating the magnitude of the linkage between interrelated variables and provides information about the underlying causal process (Freedman, 1987, 1997; Rogosa, 1987; Paul E. Meehl University of Minnesota & Niels G. Waller Vanderbilt University, Psychological Methods, 2002; Andrew F. Hayes 2009). The technique explores a chain of relationships among the variables by using standardized regression coefficient of a set of regression equation. However, the fundamental task here is to construct a path diagram in which direction indicated by **arrowheads** should be causally meaningful. This study employs a recursive path model relating to population and development variables.

### 2.13.1 Key Concepts and Terms of Path Analysis

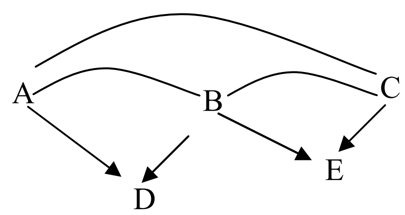
Note that path estimates may be calculated by OLS regression or by MLE (maximum likelihood estimation), depending on the computer package. Two-stage least squares (2SLS), discussed separately, is another path estimation procedure designed to extend the OLS regression model to situations where non-recursively is introduced because the researcher must assume the co-variances of some disturbance terms are not zero.

**Path Model**

A path model is a diagram relating independent, intermediary/mediatory and dependent variables. Single arrows indicate causation between exogenous or intermediary variables and the dependent (s). Arrows also connect the error terms with their respective endogenous variables. Double arrows indicate correlation between pairs of exogenous variables. Sometimes the width of the arrows in the path model is drawn in a width which is proportional to the absolute magnitude of the corresponding path coefficients.

**Causal Paths**

Causal paths to a given variable include (1) the direct paths from arrows leading to it, and (2) correlated paths from endogenous variables correlated with others which have arrows leading to the given variable. Consider this model:



This model has correlated exogenous variables A, B and C and endogenous variables D an E. Error terms are not shown. The causal paths relevant to variable D are the paths from A to D, from B to D and the paths reflecting common anteceding causes the paths from B to A to D and C to B to D. Paths involving two correlations (C to B to A to D) are not relevant. Likewise, paths that go backward (E to B to D or E to B to A to D) reflect common effects and are not relevant.

**Exogenous and Endogenous Variables**

Exogenous variables in a path model are those with no explicit causes (no arrows going to them, other than the measurement error term). If exogenous variables are correlated, this is indicated by a double headed arrow connecting them.

Endogenous variables, then, are those which do have incoming arrows. Endogenous variables include intervening causal variables, and dependents/ultimate endogenous variable. Intervening endogenous variables have both incoming and outgoing causal arrows in the path diagram. The dependent variable (s) have only incoming arrows.

**Path Coefficients/Path Weight**

A path coefficient is a standardized regression coefficient (beta) showing the direct effect of an independent variable on a dependent variables in the path model. Thus when the model has two or more causal variables, path coefficients are partial regression coefficients which measure the extent of effect of one variable on another in the path model controlling for other prior variables, using standardized data or a correlation matrix input. Recall that for bivariate regression, the beta weight (the b coefficient for standardized data) is the same as the correlation coefficient, as for the case of a path model with a variable as a dependent of a single exogenous variable (and an error residual term), the path coefficient in this special case is a zero-order correlation coefficient.

**Correlated Exogenous Variables**

If exogenous variables are correlated, it is common to label the corresponding double-headed arrow between them with its correlation coefficient.

**Disturbance Terms**

The residual or error terms, also called disturbance terms, reflect unexplained variance (the effect of unmeasured variables) plus measurement error. Note that the dependent in each equation is an endogenous variable (in this case, all variables except age, which is exogenous). Note also that the independents in each equation are all the variables with arrows to the dependent.

The effect size of the disturbance term for a given endogenous variable, which reflects unmeasured variables, is ($1-R^2$), and its variance is ($1-R^2$) times the variance of that endogenous variable, where $R^2$ is based on the regression in which it is the dependent and those variables with arrows to it are independents. The residual path coefficient is the square roots of ($1-R^2$). The correlation between two disturbance terms is the partial correlation of the two endogenous variables, using as controls all their common causes (all variables with arrows to both). The co-variance estimate is the partial co-variance; the partial correlation times the product of the standard deviations of the two endogenous variables.

### 2.13.2 Method of Path Analysis

Path analysis has been used by many social scientists in various fields of enquiry for quantifying and interpreting causal linear models. One of the main tasks in path analysis is to construct a path diagram in which variables are arranged in a meaningful manner for as such, arrows show the direction of influences. The path diagrams represent the hypothetical causal model of relationships between fertility and some of its determinants. It is not a method applied to a causal model formulated by the researcher on the basis of prior knowledge and theoretical considerations.

The assumptions that underlie the application of path analysis are:

i. The relations among the variables in the model are linear, additive and causal. Consequently, curvilinear, multiplicative, or interaction relations are excluded.

ii. Each residual is not correlated with the explanatory variables that precede it in the model.

iii. There is one-way causal flow in the system. That is, the reciprocal causation between variables is not considered.

Given the above assumptions, the method of path analysis reduces to the system of one or more multiple linear regression analysis. By the help of reduced multiple linear regression analysis, the path coefficients are estimated. Path coefficients are the standardized regression coefficients in a system of linear regression equations, indicating the direct effects of an independent variable on the dependent variable. To estimate the total effect and indirect effect, we use Alwen and Hauser's (1989; Rigdon, 1998; MacCallum & Austin, 2000) method. The residual path co-efficient can also be estimated from the regression equation as square root of ($1-R^2$), where $R^2$ (unadjusted) is the multiple correlation coefficient (square) of the regression equation.

Model Specification: In the path diagram, the causal links among the variables are assumed to be a conceptual framework conceived in advanced. It is to be noted that data set has no rule to play in deciding either the causal links between the variables or the variables to be included in the path analysis. The path diagram is developed based on a conceptual framework used in a study of determinants of fertility by Pathak and Murthy (1985).

According to the causal ordering of the variable we have denoted the factors as follows:

$X_1$ = De facto Place of Residence (DPR)

$X_2$ = Women current age (WCA)

$X_3$ = Husband's current age (HCA)

$X_4$ = Women educational attainment (WEDUA)

$X_5$ = Wealth index (WI)

$X_6$ = Women age at first marriage (WAFM)

$X_7$ = Women age of at first birth (WAFB)

$X_8$ = Sons who have died (SWHD)

$X_9$ = Women currently working (WCW)

$X_{10}$ = Ever use contraception (CONT)

$X_{11}$ = Index of fertility (CEB)

According to causal ordering of variables, we may divide the selected set of variables into three groups that are given below:

| | |
|---|---|
| Exogenous Variables | $X_1, X_2, X_3, X_4, X_5$ |
| Endogenous Variables | $X_6, X_7, X_8, X_9, X_{10},$ |
| Ultimate endogenous variable | $Y_1 = X_{11}$ |

This model is a recursive path model in which each variable is assumed to be dependent upon all prior causal variables. Under additional assumptions of linearity and additivity, the system of equation for the model can be written as:

$$X_6 = P_{61}X_1 + P_{62}X_2 + P_{63}X_3 + P_{64}X_4 + P_{65}X_5 + P_{6q}R_q$$

$$X_7 = P_{71}X_1 + P_{72}X_2 + P_{73}X_3 + P_{74}X_4 + P_{75}X_5 + P_{76}X_6 + P_{7r}R_r$$

$$X_8 = P_{81}X_1 + P_{82}X_2 + P_{83}X_3 + P_{84}X_4 + P_{85}X_5 + P_{86}X_6 + P_{87}X_7 + P_{8s}R_s$$

$$X_9 = P_{91}X_1 + P_{92}X_2 + P_{93}X_3 + P_{94}X_4 + P_{95}X_5 + P_{96}X_6 + P_{97}X_7 + P_{98}X_8 + P_{9t}R_t$$

$$X_{10} = P_{101}X_1 + P_{102}X_2 + P_{103}X_3 + P_{104}X_4 + P_{105}X_5 + P_{106}X_6 + P_{107}X_7 + P_{108}X_8 + P_{109}X_9 + P_{10u}R_u$$

$$X_{11} = P_{111}X_1 + P_{112}X_2 + P_{113}X_3 + P_{114}X_4 + P_{115}X_5 + P_{116}X_6 + P_{117}X_7 + P_{118}X_8 + P_{119}X_9 + P_{1110}X_{10} + P_{11V}Rv$$

Where $P_{ij}$'s are path coefficients from $X_i$ to $X_j$ and $R_q$, $R_r$, $R_s$, $R_t$, $R_u$, and $R_v$ are random disturbance terms (residual variables).

This system of equations are known as structural equations which gives us the estimates of path coefficients and represent the weight attached to each link in the casual chains and helps in understanding the important links between various variables considered in the causal model.

All the variables are transferred into normal forms by subtracting the respective means and dividing by their respective standard deviations. Then multiple linear regression method is applied for each causal relationship. The regression coefficients thus obtained are the path coefficients.

Path coefficients shall shows in Figure and the different types of effects and their percentages will be present on Tables in chapter six.

## 2.14 Logistic Regression

Binomial (or Bi-nary) logistic regression is a form of regression which is used when the dependent variable is a dichotomy and the independent variables are of any type. Multinomial logistic regression (MLR) exists to handle the case of dependents with more classes than two. MLR allows the simultaneous comparison of more than one contrast, that is, the log odds of three or more contrasts are estimated simultaneously, Garson (2009). The logistic regression model assumes that the categorical response variable has only two values, in general, 1 for success and 0 for failure. The logistic regression model can be extended to situations where the response variable has more than two values, and there is no natural ordering of the categories.

Natural ordering can be treated as nominal scale, such data can be analyzed by slightly modified methods used in dichotomous outcomes and this method is called the multinomial logistic. If we have n independent observations with p- explanatory variables, and the qualitative response variable has k categories, to construct the logits in the multinomial case, one of the categories must be considered the base level and all the logits are constructed relative to it. Any category can be taken as the base level, so we will take category k as the base level. Since there is no ordering, it is apparent that any category may be labeled k.

When multiple classes of the dependent variable can be ranked then the ordinal logistic regression is preferred to multinomial logistic regression. Continuous variables are not used as dependent variables in the logistic regression.

Logistic regression can be used to predict a dependent variable on the basis of continuous and /or categorical independent variables and to determine the percent of variance in the dependent variable explained by independents; to rank the relative importance of independents; to assess interaction effects; and to understand the impact of covariate variables. Logistic regression applies maximum likelihood estimation after transforming the dependent into a logit variable (the natural log of the odds of the dependent occurring or not). In this way, logistic regression estimates the probability of a certain event occurring. Note that, logistic regression calculates changes in the log odds of the dependent, not changes in the dependent itself as ordinary least squares (OLS) regression do.

Let, $Y_i$ denote the dependent variable in logistic regression is usually dichotomous, that is, the dependent variable can take the value 1 with a probability of ever used contraceptive method, will be regarded as probability of "success" p, or the value 0 (Zero) with a probability of never use contraceptive method, will be regarded as probability of "failure" 1-p. This relationship between the predictor (independent) and response (dependent) variables is not a linear function in logistic regression, instead of the logistic regression function is used, which is the logit transformation of p.

If Y denotes the outcomes variable which is dichotomous (taking values 0 or 1) and X denotes the value of the independent variable, then the specific form of the logistic regression model is

$$E\ (Y/x) = \frac{e^{\beta_0 + \beta_1 x}}{1 + e^{\beta_0 + \beta_1 x}}$$

In order to simplify notation, we can use the quantity p(x) = E(Y/x) to represent the conditional mean of Y for a given x when the logistic distribution is used.

A well-known transformation of p(x) known as the logit transformation is defined as

$$\text{logitp(x)} = \text{In}\left[\frac{p(x)}{1-p(x)}\right]$$

$$\text{or, g(x)} = \text{In}\left[\frac{e^{(\beta_0+\beta_1 x)}/\left\{1+e^{\beta_0+\beta_1 x}\right\}}{1/\left\{1+e^{(\beta_0+\beta_1 x)}\right\}}\right]$$

$$\text{or, g(x)} = \text{In}\left[\frac{e^{(\beta_0+\beta_1 x)}/\left\{1+e^{\beta_0+\beta_1 x}\right\}}{1/\left\{1+e^{(\beta_0+\beta_1 x)}\right\}}\right]$$

$$= \beta_0 + \beta_1 x$$

The specific form of the logistic regression model can be expressed as:

$$\text{p(x)} = \frac{e^{\beta_0+\beta_1 x}}{1+e^{\beta_0+\beta_1 x}}$$

In multiple logistic regression models, the probability function can be defined as:

$$p = p(x_i) = \Pr(y_i = 0/\ X = x_i) = \frac{e^{\beta_0+\beta_1 x_{i1}+\beta_2 x_{i2}+......+\beta_p x_{ip}}}{1+e^{\beta_0+\beta_1 x_{i1}+\beta_2 x_{i2}+....+\beta_p x_{ip}}}$$

$$= \frac{e^{x_i\beta}}{1+e^{x_i\beta}}\ ;\ (i = 1, 2, ......., n)\ \text{------------------------}\ (1)$$

And, $1\text{-}p_i = 1\text{-}p(x_i) = 1\text{-}\Pr(y_i = 0/\ X = x_i) = \Pr(y_i = 1/X = x_i) = \frac{1}{1+e^{x_i\beta}}$ ------------(2)

Where, $X_i$ is the i-th row of X.

The logit transformation of p(x) is then

$g(x) = \text{logit } p(x) = \log_e[p(x)/\{1\text{-}p(x = X_i\beta)\}$; (i = 1, 2, .........,n)---------------------(3)

Here, $\beta = (\beta_1, \beta_2, ........., \beta_p)^T$ is a $(p \times 1)$ vector of regression parameters. If we include the intercept term $\beta_0$, then $\beta = (\beta_0, \beta_1, \beta_2... \beta_p)$, and

$$L_i = \log_e\left[\frac{p(x)}{1-p(x)}\right] = X_i\beta = (1, x_{i1}, x_{i2}, ....., x_{ip})\begin{pmatrix}\beta_0\\ \beta_1\\ .\\ .\\ .\\ \beta_p\end{pmatrix}$$

$$= \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + ................+ \beta_p x_{ip}$$

$$= \sum_{i=1}^{n} x_{ij}\beta_j \quad \text{-------------------------------------------------------} \quad (4)$$

Where $X_{i0} = 1$ (i = 1, 2... n), and $\beta_j$ is the parameter relating to $X_{ij}$. The function (4) is a linear function of both the variable X and the parameter, β. L is called the logit and hence the model (4) is called logistic regression model.

### 2.14.1 Estimation Technique

The most common method used to estimate unknown parameters in linear regression is least squares. Under usual assumptions, least squares estimators have some desirable properties. But when least squares method is applied to estimate a model with dichotomous outcome the estimators no longer have these same properties. In such situations, the general method for estimating the parameters of logistic regression models is the method of maximum likelihood.

In logistic regression, the likelihood equation is non-linear and explicit function of unknown parameters. Therefore, we use a very effective and well-known iterative method, Newton-Raphson method.

Now, let us consider a single regression model as

$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$ ; (i = 1, 2, ............., n.) ---------------- (i)

Where $Y_i$ is a dichotomous variable, it takes two values 0 and 1.

So, $Y_i$ is a Bernoulli random variable. So, the p.d.f. of $Y_i$ is given by

$$f_i(Y_i) = p_i^{Y_i}(1-p_i)^{1-Y_i} \; ; \qquad (Y_i = 0 \text{ or } 1) \text{ ------------ (ii)}$$

$$i = 1, 2, \ldots, n$$

Where $p_i$ is a probability that define as

$$p_i = \frac{e^{\beta_0+\beta_1 x}}{1+e^{\beta_0+\beta_1 x}}$$

$$\therefore \frac{p_i}{1-p_i} = e^{\beta_0+\beta_1 X} \text{ --------- (iii)}$$

Implies, $\log_e\left(\frac{p_i}{1-p_i}\right) = \log_e\left(e^{\beta_0+\beta_1 X}\right)$

Since those are assumed to be independent, the joint probability density function is

$$g(Y_1, Y_2, \ldots, Y_n) = \prod_{i=1}^{n} f_i(Yi)$$

$$= \prod_{i=1}^{n} p_i^{Y_i}(1-p_i)^{1-Y_i} \text{ ------------ (iv)}$$

Since the logarithm is a monotonic function, so, taking logarithm on (iv), we get

$$\log_e[\,g(Y_1, Y_2, \ldots, Y_n)\,] = \log_e\left(\prod_{i=1}^{n} p_i^{Y_i}(1-p_i)^{1-Y_i}\right)$$

$$= \sum_{i=1}^{n}\left[Yi\log_e p_i + (1-Y_i)\log_e(1-p_i)\right]$$

$$\log_e [\ g(Y_1, Y_2, \ldots\ldots\ldots, Y_n)\ ] = \sum_{i=1}^{n}\left[Y_i\{\log_e p_i - \log_e(1-p_i)\} + \log_e(1-p_i)\right]$$

$$= \sum_{i=1}^{n}\left[Y_i \log\left(\frac{p_i}{1-p_i}\right) + \log(1-p_i)\right]$$

$$= \sum [Y_i(\beta_0 + \beta_1 X_i) + \log\left(\frac{1}{1+e^{(\beta_0+\beta_1 X_i)}}\right)]$$

$$I_i \text{ (say)} = \sum_{i=1}^{n}\left[Y_i(\beta_0 + \beta_1 X_i) - \log\{1+e^{(\beta_0+\beta_1 X_i)}\}\right]$$

$$= \sum_{i=1}^{n} Y_i(\beta_0 + \beta_1 X_i) - \sum_{i=1}^{n}\log\{1+e^{(\beta_0+\beta_1 X_i)}\} \quad \text{-----} \quad \text{(v)}$$

Now, differentiating eq.(v) with respect to $\beta_0$ and $\beta_1$ respectively,

$$\frac{\delta I_i}{\delta\beta_0} = \sum_{i=1}^{n} Y_i - \sum\left[\frac{e^{\beta_0+\beta_1 X_i}}{1+e^{\beta_0+\beta_1 X_i}}\right]$$

or, $\dfrac{\delta I_i}{\delta\beta_0} = \sum_{i=1}^{n} Y_i - \sum_{i=1}^{n} p_i$ and

$$\frac{\delta I_i}{\delta\beta_1} = \sum_{i=1}^{n} X_i Y_i - \sum_{i=1}^{n}\left[\frac{X_i e^{(\beta_0+\beta_1 X_i)}}{1+e^{(\beta_0+\beta_1 X_i)}}\right]$$

or, $\dfrac{\delta I_i}{\delta\beta_1} = \sum_{i=1}^{n} X_i Y_i - \sum_{i=1}^{n} X_i p_i$

$$\frac{\delta I_i}{\delta\beta} = \begin{pmatrix} \dfrac{\delta I_i}{\delta\beta_0} \\ \dfrac{\delta I_i}{\delta\beta_1} \end{pmatrix} = \begin{pmatrix} \sum_{i=1}^{n} Y_i - \sum_{i=1}^{n} p_i \\ \sum_{i=1}^{n} X_i Y_i - \sum_{i=1}^{n} X_i p_i \end{pmatrix}$$

$$= X^T Y - X^T p$$

$$= X^T(Y-p) \quad \text{---------} \quad \text{(vi)}$$

Where,

$$X=\begin{pmatrix} 1 & X_1 \\ 1 & X_2 \\ \vdots & \vdots \\ \vdots & \vdots \\ 1 & X_n \end{pmatrix}, \qquad Y=\begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ \vdots \\ Y_n \end{pmatrix}, \qquad p=\begin{pmatrix} p_1 \\ p_2 \\ \vdots \\ \vdots \\ p_n \end{pmatrix}$$

Now, we put $\frac{\delta I_i}{\delta \beta}=0$, then we get

$$x^T(Y\text{-}p) = 0 \quad \text{-------------} \quad \text{(vii)}$$

or, $X^TY = X^Tp$

or, $\hat{Y}=\hat{p}$,

The solution to eq$^n$. (vii) will satisfy

$$X^T(Y-\hat{Y})=0 \quad \text{-------------} \quad \text{(viii)}$$

Equation (viii) is generally solved by using Newton-Raphson method. This entailes first determining,

$$\frac{\delta}{\delta\beta}(X^TY-Y^Tp)=\frac{\delta}{\delta\beta}\left\{X^T\left(Y-p\right)\right\}=-\frac{\delta}{\delta\beta}X^Tp=-\left[\frac{\delta}{\delta\beta}p\right]X$$

But we have,

$$p_i=\frac{e^{(\beta_0+\beta_1X_i)}}{1+e^{(\beta_0+\beta_1X_i)}}$$

$$\frac{\delta p_i}{\delta\beta_0}=\frac{\left\{1+e^{(\beta_0+\beta_1X_i)}\right\}e^{(\beta_0+\beta_1X_i)}-e^{(\beta_0+\beta_1X_i)}e^{(\beta_0+\beta_1X_i)}}{\left\{1+e^{(\beta_0+\beta_1X_i)}\right\}^2}$$

$$=\frac{e^{(\beta_0+\beta_1X_i)}}{\left\{1+e^{\beta_0+\beta_1X_i}\right\}}\times\frac{1}{e^{(\beta_0+\beta_1X_i)}}$$

$$= p_i(1-p_i)$$

$$\therefore \quad \frac{\delta p_i}{\delta \beta_i} = \frac{\left\{X_i e^{(\beta_0 + \beta_1 X_i)}\right\}}{\left\{1 + e^{(\beta_0 + \beta_1 X_i)}\right\}^2}$$

$= X_i p_i (1-p_i)$

$$\therefore \quad \frac{\delta p}{\delta \beta} = X^T W$$

Where, W= diag.

And $X^T = \begin{pmatrix} 11\cdots\cdots\cdots\cdots 1 \\ X_1 X_2 \cdots X_n \end{pmatrix}$

$$\therefore \quad \frac{\delta p}{\delta \beta} X = X^T W X$$

Iterative estimates of β are then obtained as

$$\hat{\beta} = \left(X^T W X\right)^{-1}\left(X^T W Z\right) \quad \text{-------------} \quad (ix)$$

With Z playing the role of Y in this iteratively reweighted least squares approach. Specifically,

$$Z_i = \hat{\eta} + \frac{Y_i + \hat{p}_i}{\hat{p}_i (1 - \hat{p}_i)}$$

With $\eta_i = \log_e\left(\frac{p_i}{1 - p_i}\right)$. Notice that $\hat{\eta}_i$ plays an important role of $Y_i$ and $\frac{(Y_i - \hat{p}_i)}{\hat{p}_i (1 - p_i)}$ is the residual corresponding to $Y_i$ divided by the estimated variance of $Y_i$.

If we wish to write eq$^n$. (ix) in an equivalent form that shows the updating of $\hat{\beta}$, we may write Z as:

$$Z = X\hat{\beta}^{(i)} + W^{-1} e$$

with $e = Y - \hat{p}_i$, we then obtain

$$\hat{\beta}^{(i+1)} = \left(X^T W X\right)^{-1} X^T W \left(X\hat{\beta}^{(i)} + W^{-1} e\right)$$

$$= \hat{\beta}^{(i)} + \left(X^T W X\right)^{-1} X^T e \quad \text{-------------} \quad (x)$$

The updating formula given by $eq^n$. (x) is used until the estimates converge.

The first step is to obtain the initial estimates; $\beta^{(0)}$. Various approaches are used to obtain these. As originally derived by Lachebrunch (1975) and displayed by Hosmer and Lemeshow (1989), the initial estimates obtained using the discriminant function are given by

$$\hat{\beta}^{(0)} = \begin{pmatrix} \hat{\beta}_0^{(0)} \\ \hat{\beta}_1^{(0)} \end{pmatrix} = \begin{pmatrix} \log_e\left(\dfrac{\hat{\theta}_1}{\hat{\theta}_0}\right) - 0.5\left(\hat{\mu}_1^2 - \hat{\mu}_0^2\right) \div \hat{\sigma}^2 \\ \dfrac{\hat{\mu}_1 - \hat{\mu}_0}{\hat{\sigma}^2} \end{pmatrix}$$

Here, $\hat{\mu}_0 = \overline{X}_0$ and $\hat{\mu}_1 = \overline{X}_1$, where $\overline{X}_0$ and $\overline{X}_1$ are the average of the n-values when Y=0 and Y=1 respectively. And $\hat{\theta} = \overline{Y}$ and $\hat{\theta}_0 = 1 - \hat{\theta}_1$

And $\hat{\sigma}^2 = \dfrac{(n_0 - 1)s_0^2 + (n_1 - 1)s_1^2}{n_0 + n_1 - 2}$,

Where $s_0^2$ and $s_1^2$ are the usual sample variances computed using Y = 0 and Y = 1 respectively, and $n_0$ and $n_1$ are the corresponding sample sizes.

### 2.14.2 Testing significance of the coefficients

To assess the effect of independent variables on the dependent variable, we have to follow some procedures incorporated with logistic regression model, such as

(1) Likelihood ratio test.

(2) Wald test.

(3) Score test.

We have used Wald test to test our hypothesis

$H_0$ : The contribution of the covariates in the model is equal to zero.

vs. $H_1$ : At least one of them is non zero.

**Wald Test:**

The Wald test statistic is an alternative test which is used to test the significance of individual logistic regression coefficients for each independent variable that is, to test the null hypothesis in logistic regression that a particular logit (effect) coefficient is zero. For dichotomous independents, the Wald statistic is the squared ratio of the unstandardized logit coefficient to its standard error.

When the overall null hypothesis $H_0 : \beta_1 = \beta_2 = \text{-----} - - = \beta_p = 0$ , is rejected we may decide that at least one $\beta_i$ is non-zero. Then to identify significant coefficient, we have to perform the test procedures for any specific parameter and Wald test plays this role. This test procedure is known after the name of Wald who has given this test procedure in 1943. The assumption of this test is the same as those of the likelihood ratio test. The test statistic is obtained by comparing the maximum likelihood estimate of any slope parameter to be estimate of its standard error.

Let us set the null hypothesis

$$H_0 : \beta_j = 0$$

$$\text{vs,} \qquad H_1 : \beta_j \neq 0 \quad \text{for } j = 1, 2, 3, ...., p$$

Then the univariate Wald statistic is defined as

$$W_j = \frac{\hat{\beta}_j}{SE\left(\hat{\beta}_j\right)}$$

where $\hat{\beta}_j$ is the M.L.E. of $j^{th}$ coefficient and S.E. ($\hat{\beta}_j$) denote the standard error of $\hat{\beta}_j$. Under the null hypothesis that the slope parameter is zero, this statistic follows a standard distribution. Let, $\alpha$ be the level of significance and $Z_{\alpha/2}$ be the critical value of standard normal distribution. Then we accept the null hypothesis if $-Z_{\alpha/2} < Z_j < Z_{\alpha/2}$ ; otherwise it will be rejected at $\alpha$% level of significance.

The multivariate analogue of the Wald test can be expressed as

$$W = \hat{\beta}^T \left[\operatorname{var}\left(\hat{\beta}\right)\right]^{-1}$$

$$= \beta(X^T WX)\beta$$

Which is distributed as chi-square with (p+1) degrees of freedom under the hypothesis that each of the (p+1) coefficients is zero. Since we are interested only in the slope coefficient, the multivariate Wald test for the slope coefficients can be obtained by eliminating $\beta_0$ and $\beta$ and the corresponding first row and first column from $(X^T WX)$.

### 2.14.3 Interpretation of Parameters

Interpretation of parameters in logistic regression model is not as straightforward as in linear regression model. So it is relevant to present a little discussion about it. Since the logit transformation of g(x) is linear in parameters, we can interpret the parameters using the arguments of linear regression. Thus the interpretation may be described as follows:

We know that the logit transformation of a logistic regression model is

$$p(x) = \frac{e^{(\beta_0 + \beta_1 x_1 + \cdots\cdots + \beta_p x_p)}}{1 + e^{(\beta_0 + \beta_1 x_1 + \cdots\cdots + \beta_p x_p)}} \quad \text{is linear in parameters.}$$

That is,

$$g(x) = \log_e \left[ \frac{p(x)}{1 - p(x)} \right]$$

$$= \beta_0 + \beta_1 x_1 + \ldots\ldots\ldots\ldots + \beta_p x_p$$

So, arguing analogously as in the case of linear regression model, we can say that $\beta_j$ (j= 1, 2, 3, .........., p) represents the rate of change in $\log_e \left[ \frac{p(x)}{1 - p(x)} \right]$ for one unit change in $X_j$ (other variables remaining).

The interpretation of parameters in logistic regression has another interesting aspect. In fact, this is the proper interpretation. To describe this, we first consider that the independent variables ($X_j$) are dichotomous. This case is not only simplest but also it gives the conceptual foundation for all other saturations. The description is as the following:

**Interpretation of Parameters in terms of Odds Ratio**

We begin our consideration of the interpretation of logistic regression coefficients with the situation where the independent variable is nominal scale and dichotomous (that is, measured at two levels). This case provides the conceptual foundation for all the other situations.

We assume that the independent variable, x, is coded as either zero or one.

The difference in the logit for a subject with x=0 and x=1 is

$$g(1)-g(0) = \{\beta_0+\beta_1\} - \{\beta_0\} = \beta_1$$

The algebra shown in this equation is straightforward. We present it in this level of detail to emphasize that the first step in interpreting the effect of a covariate in a model is to express the desired logit difference is equal to $\beta_1$ in order to interpret this result; we need to introduce and discuss a measure of association termed the odds ratio.

The possible values of the logistic probabilities may be conveniently displayed in a 2×2 table as shown in table 6.2 (e). The odds of the outcome being present among individuals with X = 0 is defined as $\frac{p(0)}{1-p(0)}$, similarly the odds of the outcome being present among individuals with X = 1 is defined as $\frac{p(1)}{1-p(1)}$. The odds ratio, denoted O, is defined as the ratio of the odds for X =0 to the odds for X = 1, and given by the equation-

$$O = \frac{\frac{p(1)}{1-p(1)}}{\frac{p(0)}{1-p(0)}}$$

Substitution the expressions for the logistic regression model shown in table below:

**Table 2.2: Value of the Logistic Regression Model when the variable is Dichotomous.**

| Outcome variable (Y) | Independent Variables (X) | |
|---|---|---|
| | X = 1 | X = 0 |
| Y = 1 | p(1) = $\frac{e^{(\beta_0+\beta_1)}}{1+e^{(\beta_0+\beta_1)}}$ | p(0) = $\frac{e^{\beta_0}}{1+e^{\beta_0}}$ |
| Y = 0 | 1-p(1) = $\frac{1}{1+e^{(\beta_0+\beta_1)}}$ | 1-p(0) = $\frac{1}{1+e^{\beta_0}}$ |
| Total | 1.0 | 1.0 |

$$O = \frac{\left[\frac{e^{(\beta_0+\beta_1)}}{1+e^{(\beta_0+\beta_1)}}\right]}{\left[\frac{e^{\beta_0}}{1+e^{\beta_0}}\right]} \times \frac{\left[\frac{1}{1+e^{\beta_0}}\right]}{\left[\frac{1}{1+e^{(\beta_0+\beta_1)}}\right]}$$

$$= \frac{e^{(\beta_0+\beta_1)}}{e^{\beta_0}}$$

$$= e^{\beta_1}$$

Hence, for logistic regression with dichotomous (also with polychotomous) independent variables coded 0 or 1 or 1, 2, 3, 4, 5, etc., the relation between the odds ratio and the regression coefficient is

$$O = e^{\beta_1} \quad \text{- - - - - - ------------------------} \quad (5)$$

This simple relationship between the coefficient and the odds ratio is the fundamental reason why logistic regression has proven to be such a powerful analytical research tool.

The odds ratio is a measure of association which has found wide use, especially in epidemiology, as it approximates how much more likely (or unlikely) is for the outcome to be present among those with x = 1 (or 2, or 3 or 4, or 5), then among those with x= 0. For example, if y denotes the presence or absence of lung cancer and if x denotes whether the person is a smoker, then O = 2, estimate that lung cancer is twice more likely to occur among smokers than non-smokers in the study population. As an another example, suppose y denotes the presence or absence of heart disease and x denotes whether or not the person engage in regular demanding physical exercise. If the estimated odds ratio is O = 0.5, then occurrence of heart disease is one half as likely to occur among those who exercise than among those who do not in the study population.

The interpretation give for the odds ratio is based on the fact that in many instances it approximates a quantity called the relative risk. The parameter is equal to the ratio p(1)/p(0). It follows from Table 2.2 that the odds ration approximates the relative risk if $[1-p(0)]/[1-p(1)] \approx 1$. This holds when p(x) is small for both 1 and 0.

**Confidence Interval for Odds Ratio**

Along with the point estimate of a parameter, it is a good idea to use a confidence interval (C.I.) estimate to provide additional information about parameter value. In the case of the odds ratio, or, for a 2×2 table there is an extensive literature dealing with this problem, much of which is focused on method when the sample size is small. The reader who wishes to learn more about the available exact and approximate methods should see the papers by Fleiss (1979) and Gart and Thomas (1972). A good summary may be found in the text by Breslow and Day (1980), Kleinbaum, Kupper, and Morgenstern (1982), and Rothman and Greenland (1998).

The odds ratio, O, is usually the parameter of interest in a logistic regression due to its ease of interpretation. However, its estimate $\hat{O}$, tends to have a distribution that is skewed. The skewness of the sampling distribution $\hat{O}$, is due to the fact that possible values range between 0 and 1, with the null value equaling 1. In theory, for large enough sample sizes the distribution $\hat{O}$, is normal. Unfortunately, this sample size requirement typically exceeds that of most studies. Hence, inferences are usually based on the sampling distribution of in

O = $\hat{\beta}_1$ , which tends to follow a normal distribution for much smaller sample sizes.

A 100(1-α)% confidence interval (CI) estimate for the odds ratio is obtained by first calculating the endpoints of a confidence interval of the coefficient $\hat{\beta}_1$, and then exponentiation these values. In general, the endpoints are given by the expression

$$e^{\left[\hat{\beta}_1 \pm z_{\alpha/2} \times S\hat{E}\left(\hat{\beta}_1\right)\right]}$$

The results of bivariate analysis, chi-square test and logistic regression results shall produce and analyzed in chapter six.

## 2.15 Trend extrapolation methods of projection

Trend extrapolation methods consist of mathematical functions which extend the trend observed over a specified base period into the future. Functions commonly mentioned in the demographic literature include the linear model, polynomials such as quadratic and cubic curves, the power function, the hyperbolic curve, exponential and modified exponential curves, the logistic curve and the Gompertz curve. Further discussion and worked examples of trend extrapolation models can be found in Davis (1995), George *et al*. (2004), Klosterman (1990, chapters 2 and 3), Openshaw and van der Knapp (1983), Smith *et al*. (2001, chapter 8), Tekse (1975), UN (1952, chapter 5) and Wang (2007). In some cases the parameters of trend extrapolation models are determined by user-defined methods. An example is to take a weighted average of past trends, such as that applied by Voss and Kale (1985, cited in Chi and Voss 2011).

From these mathematical functions, I took linear model, quadratic polynomial model and exponential model for our analyses and projection.

### 2.15.1 Projection by fitting of polynomial regression model

Polynomial regression is a form of linear regression where the relationship between independent variables x's and the dependent variable y is modeled as two order polynomial. Polynomial regression fits a non-linear relationship between values of x's and the corresponding conditional mean of y, denoted by E(y/x). It is used to describe non-linear phenomena such as climate prediction, progress of the use of contraceptive method and progress of disease epidemics, etc. Polynomial regression is used here to similar projection as will have done for linear regression model. The underlying model corresponding to each variable is as the following:

$$Y = \beta_0 + \beta_1 X + \beta_2 X^2 + \varepsilon_i \quad \text{-------------------------------------------------} \quad (1)$$

Where X's are years and Y is the value of TFR or other values of determinants of fertility for different censuses, surveys of different time period and $\varepsilon_i$'s are error terms.

The practice of fitting regression equation to the data of TFR and CPR, contraceptive use effectiveness (CUE) and other proximate determinants of which TFR (TFR=Y) is a dependent variable is not a new one. Revised Bongaarts Model (Islam *et al.*, 2014) examining the strength of relationship between TFR and CPR, between TFR and CUE by fitting a regression line of dependent variable Y on independent variables X's. It is used here for projecting different variables of fertility. The model also utilized to project future fertility and contraceptive prevalence rate (CPR).

### 2.15.2 Projection by fitting of exponential regression model

Generally it is assumed that use of different factors of human population increases exponentially. It exists if these growths are proportional to their existing amounts. Exponential growth starts slowly and then increase faster as the population factors increases. In exponential growth, there is no upper limit. Exponential growth of population (TFR, CPR, CUE, others determinants of fertility and contraceptives) occurs when a population have a continuous increase (or some time decreases) throughout time and are never hindered by insufficient supply or stopped the process.

The exponential regression model is defined as

$$Y_i = \beta_0 \text{Exp}(\beta_1 X_i) + \varepsilon_i \text{ ------------------------------------------------------(2)}$$

Where X's are years and Y is the value of TFR or other values of determinants of fertility and contraception for different censuses, surveys of different time period and $\varepsilon_i$'s are error terms.

The practice of fitting regression equation to the data of TFR and CPR, contraceptive use effectiveness (CUE) and with other proximate determinants of which TFR is a dependent variable is not a new one. Revised Bongaarts Model (Islam *et al.*, 2014) examining the strength of relationship between TFR and CPR, between TFR and CUE by fitting a regression line of dependent variable Y on independent variables X's. It is used here for projecting different variables of fertility and contraception. The model also utilized to project future fertility and contraceptive prevalence rate (CPR).

**2.15.3 Projection by fitting of linear regression model**

To project different determinants of fertility and contraceptive use, a simple linear regression equation is used of the form,

$$Y = \alpha + \beta X_i + \varepsilon_i \text{ ---------------------------------------------------(3)}$$

Where Y (for example, in particular, total fertility rate, TFR) is the dependent variable; $x_i$ (for example, in particular contraceptive prevalence rate, CPR) are independent variables and $\varepsilon_i$ are error terms. Estimates of $\alpha$ and $\beta$ are made by the method of least squares using data of Y's and X's from several surveys and censuses of 1975 to 2011 time period.

# Chapter Three

## LEVELS AND TRENDS OF FERTILITY AND CONTRACEPTION

### 3.1 Introduction

One of the major objectives of the present study is to look at the fertility level and the changes thereof in context of the people of Bangladesh. It is well recognized that marriage in Bangladesh is universal. It takes place at an early age and almost all marriages of the females as well as of the males in particular, are completed within a short span because within the marriageable span marriage progresses very fast (Abedin, S 1982; Kabir, M 1990, Islam, M. 1996). Such peculiarities of the marriage pattern might be changed with time due to the development in the socio-economic conditions of the people both at the individual and collective levels.

There is evident that the fertility of women in Bangladesh was having on average 6.3 children in 1971-1975. It is declined to 2.3 children per women in 2011 (BDHS 2011, pub. January 2013). Again, fertility behavior within marriage has changed in a countervailing manner. The marital fertility perhaps also has changed due to probable change in the marriage pattern.

The present chapter is concentrated to investigate the trends in the marriage pattern as well as in fertility and contraception for a period of 40 years from 1975 to 2011.

The objectives are to:

i. Investigate the levels, trends of fertility and contraception

ii. Analyze the distribution of marriage pattern such as age specific fertility rates (ASFR), age specific ever marital fertility rate (ASEMFR), age specific marital fertility rate (ASMFR) and contraception.

The trends in marriage pattern are investigated by means of proportion married and trends in fertility by means of crude birth rate (CBR), total fertility rate (TFR), trends in pregnancy rate; trends of contraceptive methods and its uses, obtained at different points of time. The cohort and the period fertility and their changes over time would investigate by means of children ever born (CEB) and age specific fertility rates (ASFR), age specific ever marital fertility rate (ASEMFR), age specific marital fertility rate (ASMFR) respectively. Such changes in marriage and fertility cover a period of 40 years from 1975 to 2011.

## 3.2 Demographic, Socio-Economic and Cultural Characteristics

The history of census taking in the area which now forming Bangladesh dates back to more than 140 years. The first population census was taken in 1872, as a part of the undivided India and the second in 1881 and the subsequent census every 10 years thereafter until 1961. The next census was conducted in 1974 instead of 1971 owing to the war of liberation. The latest census was under taken in 2011 whose detailed results were published.

Demographic, socio-economic and cultural variables play a vital role in this type of study. It is important to handle these types of variables very carefully.

### 3.2.1 Age distribution

The age distribution of the respondents is a very important factor in determining a country's socio-demographic well-being. Age of respondents have a strong positive relationship with the human fertility behavior especially with the age group. Information on the socio-demographic characteristics of women and men interviewed in the survey is essential for the interpretation of findings presented later in the report.

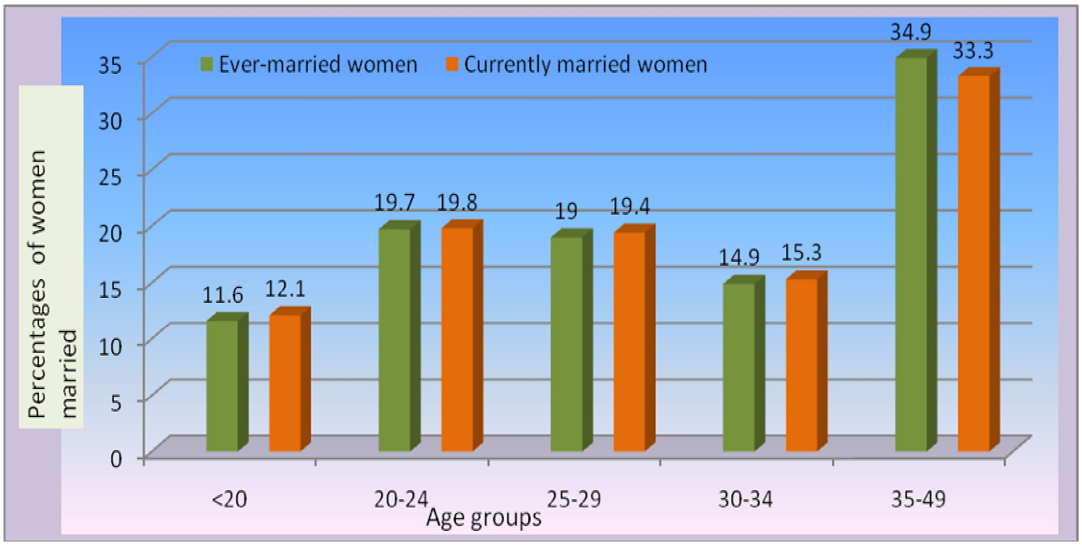
**Table 3.1: Percent distribution of women by age groups: Using BDHS 2011 Recoding Data.**

| Current age group | Ever-married women | | Currently married women | |
|---|---|---|---|---|
| | Number of women | percent | Number of women | percent |
| <20 | 2,062 | 11.6 | 2,045 | 12.1 |
| 20-24 | 3,514 | 19.7 | 3,333 | 19.8 |
| 25-29 | 3,394 | 19.0 | 3,260 | 19.4 |
| 30-34 | 2,654 | 14.9 | 2,564 | 15.3 |
| 35-49 | 6,218 | 34.9 | 5,594 | 33.3 |
| Total | 17,842 | 100.0 | 16,796 | 100.0 |

**Source:** NIPORT, Mitra and Associates, and ICF International, January 2013; 2011 BDHS.

Table 3.1 and Figure 3.1 shows the age distribution of ever-married and currently married women respondents. Approximately, ninety-four percent ever-married women in the age 15-49 years are currently married. The age distribution of ever-married women is very similar that found in the 1993-1994, 1996-1997, 1999-2000, 2004, 2007 and 2011 BDHS surveys; a little more than half under 30 years of age.

**Figure 3.1: Percent distribution of ever-married and currently married women by age groups: Using BDHS 2011 Recoding Data, Bangladesh.**



### 3.2.2 Marital Composition

In the most society, marriage is recognized as an important, socio-demographic event, which marks the beginning of the process of family formation and child bearing. Thus marital status represents as a social characteristic of any population, related to various matters of a social significance and bears important social values.

Women once married, tend to remain in marital union unless dissolved by death or divorce or distributed by separation. So, it is reflects at a point of time the nuptiality pattern of a population and reveals the behavior of the society concerning the age at marriage, as well as the dissolution of unions through divorce and widowhood.

Table 3.2 and Figure 3.2 show the percentage distribution of women current marital status 15-49 by age. In Bangladesh, a substantially greater proportion of men than women age 15-49 have never married: 36 percent of men compared with 15 percent of women. The proportion who has never married falls sharply with age among women. Among women, the decline is from 54 percent in the age group 15-19 to less than 1 percent among women age 35 or older. The low proportion of women age 25-29 who have never been married, that is 3% indicates that marriage is universal in Bangladesh and that more than nine in ten women marry before age 30.

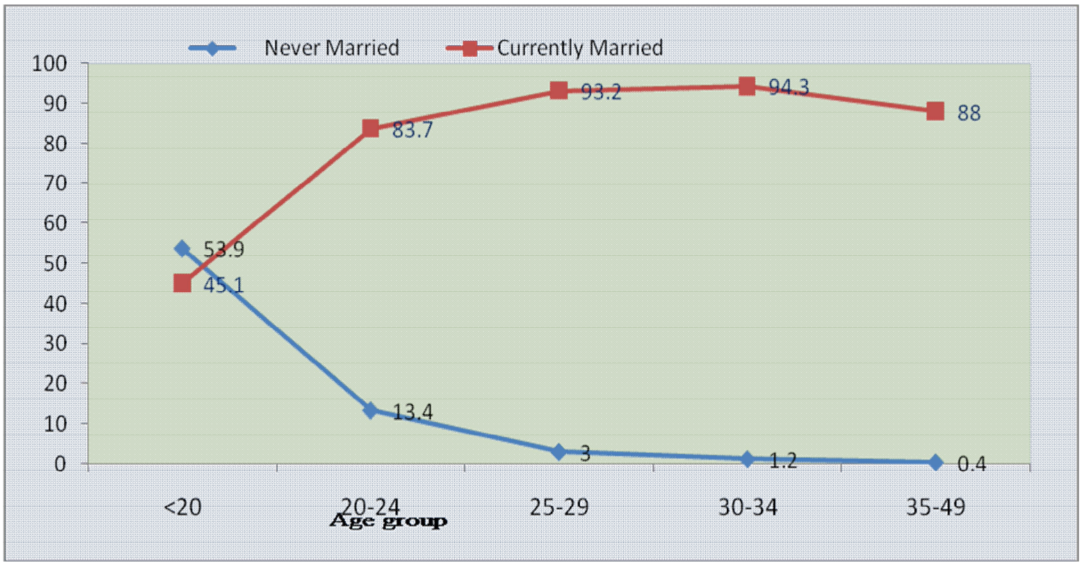
Eight in ten women (80 percent) are currently married. Three percent of women age 15-49 are widowed. The proportion of women who are widowed increases sharply with age and are mostly limited to older age groups. More than 8% percent of women age 35-49 are widowed. Divorce and separation are uncommon in Bangladesh. Two percent of women age 15-49 are either divorced or separated of the same age. The proportion divorced or separated does not vary markedly by age group among women.

**Table 3.2: Percent distribution of women by current marital status, according to age 2011.**

| Age at first marriage | Current marital status | | | | | |
|---|---|---|---|---|---|---|
| | Never | Married | Divorced | Separated | Widowed | Total |
| <20 | 53.9 | 45.1 | 0.6 | 0.4 | 0.0 | 100.0 |
| 20-24 | 13.4 | 83.7 | 1.3 | 1.2 | 0.4 | 100.0 |
| 25-29 | 3.0 | 93.2 | 1.0 | 1.4 | 1.3 | 100.0 |
| 30-34 | 1.2 | 94.3 | 1.0 | 1.7 | 1.8 | 100.0 |
| 35-49 | 0.4 | 88.0 | 1.2 | 2.0 | 8.4 | 100.0 |
| Total | 14.6 | 80.0 | 1.0 | 1.4 | 3.0 | 100.0 |

Authors' calculation

**Figure 3.2: Percent distribution of women by current marital status, according to age 2011.**




Finally, we may conclude and comment that the culture of Bangladeshi women is still characterized by universal marriage.

### 3.2.3 Children Ever Born

Children ever born (CEB) are most frequently used in fertility analysis. Alternatively, defines as completed parity or current parity. It is the number of live births per women as of the date of a survey. It is an indicator of the ‘quantity’ of fertility. For example, the reported number of children ever born to women age 35 to 49 years provides an estimate of cumulative fertility by the end of the reproductive period for the population. However, the number of CEB gives no indication of the tempo of fertility that is the pace at which women are experiencing births.

Table 3.3 and Figure 3.3 represent the distribution of currently married women by age and number of children ever born. It also represents the mean number of children ever born to women in each age group, an indicator of the momentum of childbearing. The mean number of children ever born for currently married women has 2.6 births on average. Allowing for mortality of children, Bangladeshi currently married women have on average 2.3 living children.

The mean number of children ever born for currently married women 2.33 (BDHS, 2011), which means that, on average, Bangladeshi women age 15-49 have had more than two births. Currently married women age 35-49 have given birth to an average of 4.06 children, of whom 3.51 survived. Among currently married women age 35-49, the average number of children who have died per women is 0.55.

Among currently married women, it is 0.26; that is, 26 percent of children born to currently married women had died. The proportion of CEB who have died increases with women’s age increases. Among currently married women, the proportion of CEB who have died increases from 3 percent for women age 15-19 to 26 percent for women age 35-49 years.

Forty eight percent of currently married women age 15-19 have never given birth. However, this proportion declines to 5 percent for currently married women age 25-29 and rapidly decreases further for older women, indicating that childbearing among currently married Bangladeshi women is nearly universal.

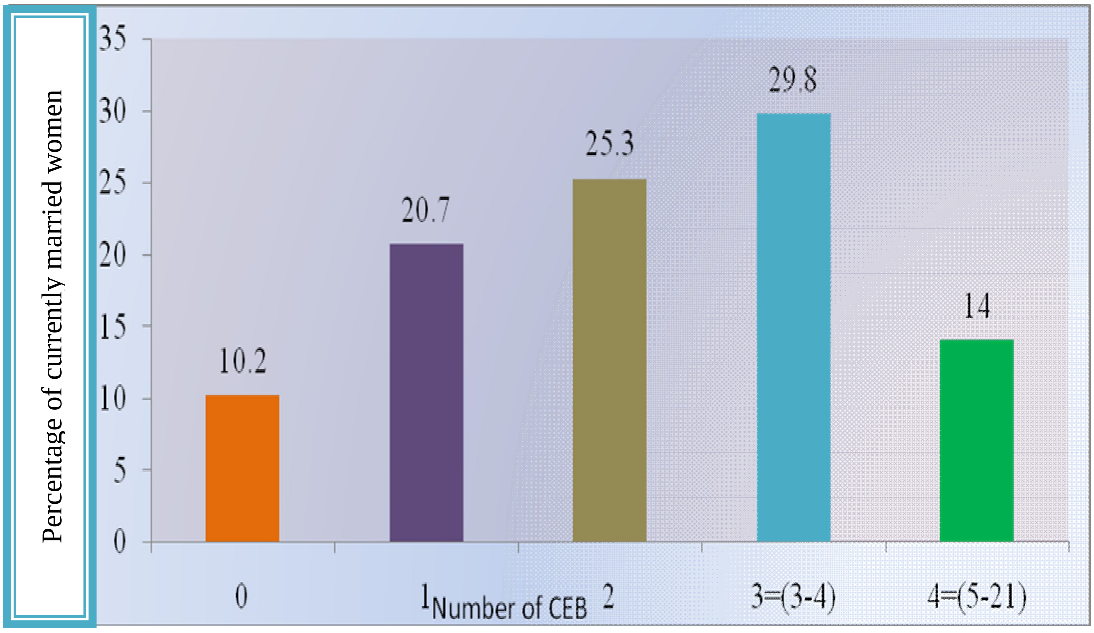
**Table 3.3: Percent distribution of currently married women by number of total children ever bore (CEB) and mean number of living children, Bangladesh 2011.**

| Age Group | Number of children ever born | | | | | | |
|---|---|---|---|---|---|---|---|
| | Currently Married Women | | | | | | |
| | **0** | **1** | **2** | **3-4** | **5+ =(5-21)** | Mean number of CEB | Mean number of living children |
| <20 | 48.0 | 44.9 | 6.5 | 0.6 | 0.0 | 0.63 | 0.60 |
| 20-24 | 13.8 | 45.0 | 31.0 | 9.9 | 0.3 | 1.43 | 1.35 |
| 25-29 | 4.8 | 19.2 | 41.2 | 31.6 | 3.2 | 2.27 | 2.12 |
| 30-34 | 2.9 | 9.1 | 31.0 | 45.5 | 11.6 | 2.98 | 2.72 |
| 35-49 | 2.2 | 5.4 | 17.2 | 42.5 | 32.8 | 4.06 | 3.51 |
| Total | 10.2 | 20.7 | 25.3 | 29.8 | 14.0 | 2.59 | 2.33 |

Authors’ calculation

The percentage of women, in their forties who have never had children provides an indicator of the level of primary infertility—the proportion of women who are unable to bear children at all. Since voluntary childlessness is rare in Bangladesh, it is likely that married women with no births are unable to have children. The BDHS results suggest that primary infertility is low, less than two percent. The mean number of children ever born among currently married women was 3.3 in 1996-1997; 3.13 in 1999-2000, 3.0 in 2004, 2.7 in 2007 and 2.3 in 2011.

**Figure 3.3: Percent distribution of number of the currently married women and mean number of living children, Bangladesh.**




## 3.3 Trends in proportion never married

In Bangladesh, a substantially greater proportion of men than women age 15-49 have never married: 36 percent of men compared with 15 percent of women. The proportions who have never married fall sharply with age among both women and men. Among women, the decline is from 54 percent in the age group 15-19 to less than 1 percent among women age 35 or older in BDHS 2011.

Table 3.4 shows trends in Bangladesh by age in the percentage of women who have never married, for the 1975-2011 period. The proportion of women who have never married affects fertility levels in a society like Bangladesh, where child bearing outside marriage is uncommon. The proportion of never-married women age 15-19 has increased from 30 percent in 1975 to 54 percent in 2011. Similarly, the proportion of never-married women age 20-24 first increased from 5 percent in 1975 to 19 percent in 1999-2000; then it declined steadily to 13 percent in 2011.

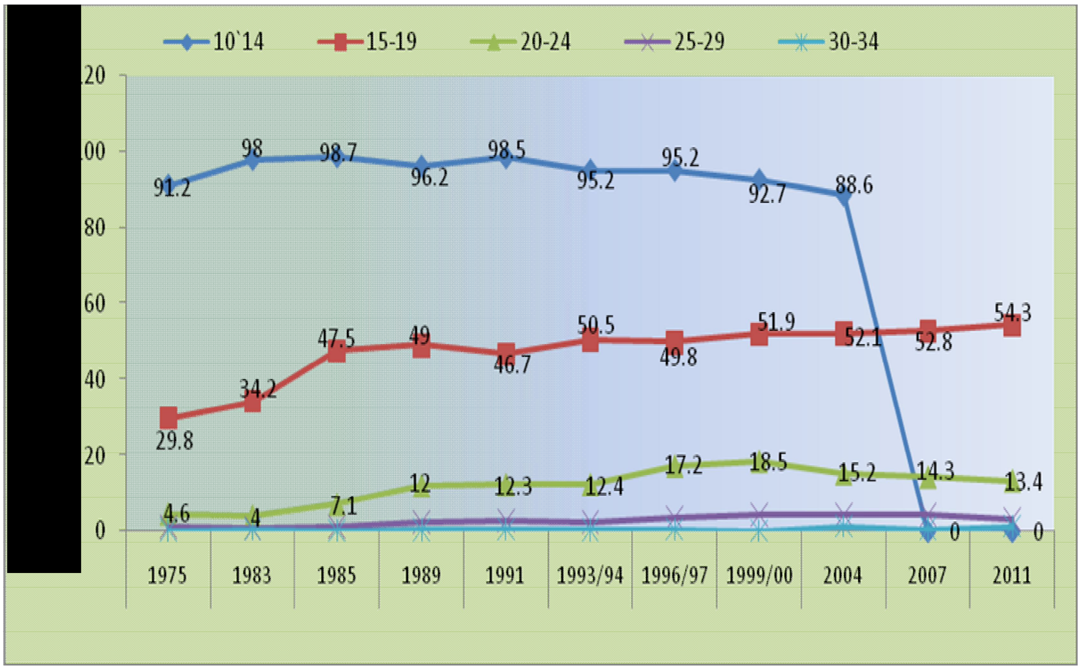
**Table 3.4: Percentage of never married women by age group in various surveys, Bangladesh 1975-2011.**

| Age at first marriage | BFS 1975 | CPS 1983 | CPS 1985 | BFS 1989 | CPS 1991 | BDHS 1993/94 | BDHS 1996/97 | BDHS 1999/00 | BDHS 2004 | BDHS 2007 | BDHS 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| <15 | 91.2 | 98.0 | 98.7 | 96.2 | 98.5 | 95.2 | 95.2 | 92.7 | 88.6 | u | u |
| 15-19 | 29.8 | 34.2 | 47.5 | 49.0 | 46.7 | 50.5 | 49.8 | 51.9 | 52.1 | 52.8 | 54.3 |
| 20-24 | 4.6 | 4.0 | 7.1 | 12.0 | 12.3 | 12.4 | 17.2 | 18.5 | 15.2 | 14.3 | 13.4 |
| 25-29 | 1.0 | 0.7 | 1.0 | 2.3 | 2.8 | 2.2 | 3.4 | 4.2 | 4.2 | 4.3 | 3.0 |
| 30-34 | 0.2 | 0.4 | 0.1 | 0.3 | 0.5 | 0.3 | 0.5 | 0.1 | 1.2 | 0.6 | 1.2 |
| 35-39 | 0.4 | - | - | 0.1 | 0.1 | 0.3 | - | 0.2 | 0.4 | 0.6 | 0.8 |
| 40-44 | 0.1 | 0.1 | - | 0.2 | 0.3 | 0.7 | - | - | 0.3 | 0.2 | 0.3 |
| 45-49 | - | 0.1 | - | 0.1 | - | 0.2 | - | - | - | 0.8 | 0.2 |

Note: - = Less than 0.1 percent, u = Unknown/not available; Source: 1975 BFS, (MHPC, 1978:49); 1983, 1985, 1989, and 1991 CPSs, (Mitra *et al.*, 1993:24); 1989 BFS (Huq and Cleland, 1990:43); 1993-1994 BDHS, (Mitra *et al*, 1994:72); 1996-1997 BDHS (Mitra *et al.*, 1997:82); 1999-2000 BDHS (NIPORT *et al.*, 2001:78); 2004 BDHS (NIPORT *et al.*, 2005: 93); 2007 BDHS (NIPORT *et al.*, 2009:77); NIPORT *et al.*, January 2013; and BDHS 2011, p-65.

Table 3.4 reveals that, about 95% of the Bangladeshi woman starts their conjugal life within ages 20-24 years. The two surveys, BFS 1975 and CPS 1983 suggest that 70% and 66% women respectively started living with their husbands when they were aged 19. From the table, we may arrived at a conclusion that, the little improvement in age at marriage of the cohort 20-24 but reveal the risk of high teenage pregnancy. These investigations certify that fertility is turning about early ages and obviously for early teenage marriage. The investigation also proves that the lower age at marriage for older women than their younger.

**Figure 3.4: Percentage of never married women, by age groups, Bangladesh 1975-2011.**




## 3.4 Trends in Age at Marriage

Marriage indicates the onset of exposure to the risk of pregnancy for most women, and thus it is an important fertility indicator. The mean age at first marriage is a useful tool for summary measure to study the pattern of distributions of first marriages. Mean age at marriage (MAM) is a straightforward matter to compute directly the mean age or median age at first marriage, if data on age at first marriage are available. Table shows the trends of mean age at marriage by sex.

**Table 3.5: Trends of mean age at marriage by sex, Bangladesh 1982 to 2011.**

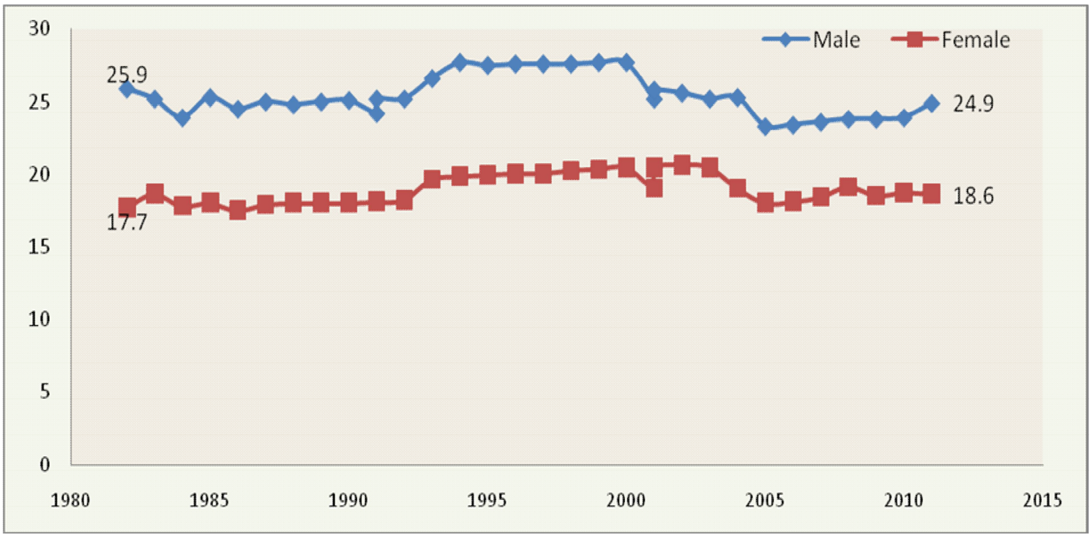
| Year | Source | Male | Female |
|---|---|---|---|
| **1982** | VRS | 25.9 | 17.7 |
| **1983** | VRS | 25.2 | 18.6 |
| **1984** | VRS | 23.9 | 17.8 |
| **1985** | VRS | 25.3 | 18.0 |
| **1986** | VRS | 24.5 | 17.5 |
| **1987** | VRS | 25.0 | 17.9 |
| **1988** | VRS | 24.8 | 18.0 |
| **1989** | VRS | 25.0 | 18.0 |
| **1990** | VRS | 25.1 | 18.0 |
| **1991** | SVR | 25.2 | 18.1 |
| **1992** | SVR | 25.2 | 18.2 |
| **1993** | SVR | 26.6 | 19.6 |
| **1994** | SVR | 27.7 | 19.8 |
| **1995** | SVR | 27.5 | 19.9 |
| **1996** | SVR | 27.6 | 20.0 |
| **1997** | SVR | 27.6 | 20.0 |
| **1998** | SVR | 27.6 | 20.2 |
| **1999** | SVRS | 27.7 | 20.3 |
| **2000** | SVRS | 27.7 | 20.4 |
| **2001** | SVRS | 25.8 | 20.4 |
| **2002** | SVRS | 25.6 | 20.6 |
| **2003** | SVRS | 25.2 | 20.4 |
| **2004** | SVRS | 25.3 | 19.0 |
| **2005** | SVRS | 23.3 | 18.0 |
| **2006** | SVRS | 23.4 | 18.1 |
| **2007** | SVRS | 23.6 | 18.4 |
| **2008** | SVRS | 23.8 | 19.1 |
| **2009** | SVRS | 23.8 | 18.5 |
| **2010** | SVRS | 23.9 | 18.7 |
| **2011** | SVRS | 24.9 | 18.6 |

**Source:** Statistical Pocketbook of Bangladesh, BBS, 2005; 2008, 2013 (April 2014); Population Census (PC), 1991, 2001.

Since the most frequently considered age groups are five years in span, the process of computing the MAM is described for data classified by such age groups. It is assumed that no first marriage occurs after age 50 or before age 15. The summary of the results on MAM at different time points is presented in Table 3.5 above.

The data in Table 3.5 include a decrease in the mean age at marriage from 1982 to 2011 for male. The MAM for males decreased from 25.9 years in 1982 to 24.9 years in 2011; again the MAM for females increased from 17.7 years in 1982 to 18.6 years in 2011.

**Figure 3.5: Trends of mean age at marriage by sex, Bangladesh 1982 to 2011.**




## 3.5 Period Fertility

The essential quality of period fertility analysis is that it looks at fertility cross-sectionally, that are at births occurring during a specified period of time, normally one year. Period analysis is generally simpler than co*h*ort analysis and is more frequently used.

Period fertility is measured by total fertility rate (TFR) based on the age specific fertility rates (ASFR's) of women for different age groups of the reproductive period (15-49 years of age) during a year. Period fertility is the current picture of the actual fertility performance in a recent time, generally the year preceding the census or survey, by women of different age groups in the reproductive period within a population.

### Trends in Fertility

Trends may be ascertained that fertility levels in Bangladesh have been relatively high and fluctuating within a relatively narrow range except in catastrophic situations such as war and famines.

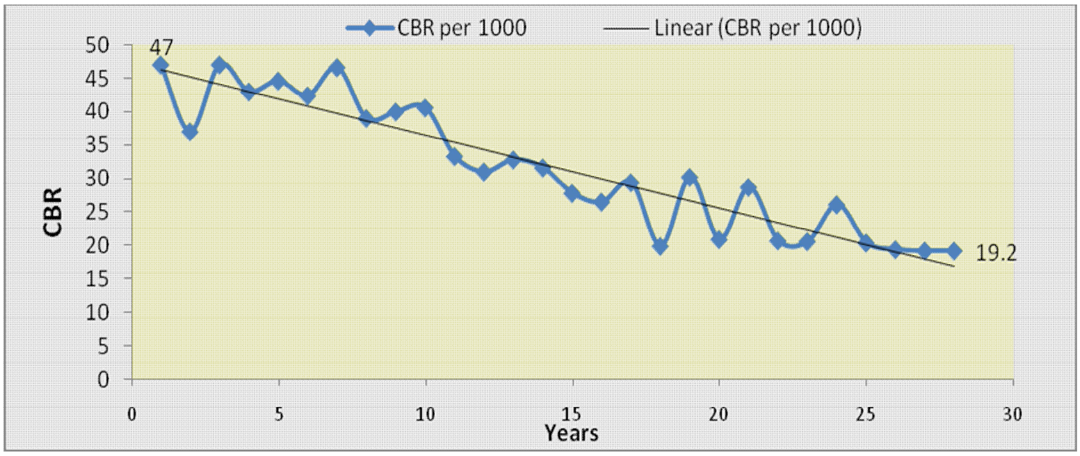
**Table 3.6: Crude birth rates: Bangladesh, 1975-2011.**

| Source | Year | CBR per 1000 |
|---|---|---|
| Bangladesh Fertility Survey (BFS) | 1975 | 47.0 |
| Pilot Survey | 1978 | 37.0 |
| ICDDR'B (Matlab) | 1979 | 47.0 |
| Planning Commission (GOB) | 1981 | 43.0 |
| ICDDR'B (Matlab) | 1982 | 44.6 |
| ICDDR'B (Matlab) | 1983 | 42.4 |
| ICDDR'B (Matlab) | 1984 | 46.6 |
| Planning Commission (GOB) | 1985 | 39.0 |
| ICDDR'B (Matlab) | 1986 | 40.0 |
| ICDDR'B (Matlab) | 1987 | 40.6 |
| Vital Registration Survey (VRS), BBS | 1988 | 33.3 |
| Bangladesh Fertility Survey (BFS) | 1989 | 31.0 |
| Vital Registration Survey (VRS), BBS | 1990 | 32.8 |
| Vital Registration Survey (VRS), BBS | 1991 | 31.6 |
| Sample Vital Reg. System (SVRS), BBS | 1994 | 27.8 |
| Sample Vital Reg. System (SVRS), BBS | 1995 | 26.5 |
| BDHS | 1996-`97 | 29.4 |
| Sample Vital Reg. System (SVRS), BBS | 1998 | 19.9 |
| BDHS | 1999-2000 | 30.2 |
| Sample Vital Reg. System (SVRS), BBS | 2003 | 20.9 |
| BDHS | 2004 | 28.7 |
| Sample Vital Reg. System (SVRS), BBS | 2005 | 20.7 |
| Sample Vital Reg. System (SVRS), BBS | 2006 | 20.6 |
| BDHS | 2007 | 26.1 |
| Sample Vital Reg. System (SVRS), BBS | 2008 | 20.4 |
| Sample Vital Reg. System (SVRS), BBS | 2009 | 19.4 |
| *Sample Vital Registration System (SVRS), BBS.* | 2010 | 19.2 |
| *Sample Vital Registration System (SVRS), BBS.* | 2011 | 19.2 |

The prospects for a dramatic decline in the birth rate do not appear to be bright given the age structure of the people, the early age at marriage, universality of marriage and the high traditional value given to childbearing and large families in the Islamic as well as Hindu cultures. The slow pace of mortality decline, particularly the persistence of infant and child mortality, does not provide a strong incentive for limitation either.

Table 3.6 represents the trend in the crude birth rates (CBR) from 1975 to 2011. The rates have been estimated from various sources and thus may be varying reliability. On the whole, after 1975, fertility has been declining moderately. The fluctuations in the birth rates at the high levels indicate forces operating that serve to compensate for the high mortality resulting from the recurrent epidemics, famines and the consequent worsening nutritional situation.

**Figure 3.6: Crude birth rates: Bangladesh, 1975-2011.**




The crude birth rate as a measure of fertility is limited by its inability to reflect the reproductive pattern of the population age and marital status. Shifts in the age structure, particularly in the proportion of women of childbearing ages, and change in the marriage pattern affecting proportions of married women at each age group may lead to change in the number of births and the crude birth rate even if underlying reproductive behavior of the population remains unchanged.

**Trends in Pregnancy Rate**

Table 3.7 shows the percentage of currently married women who reported that they were pregnant at the time of survey, according to age groups. Reports about current pregnancy are almost surly under estimates, since many women may be pregnant but not yet aware of their status. However, the data are useful, because, while fertility rates depend on some extent to accurate reporting of dates of events, the proportion pregnant is a current status indicator.

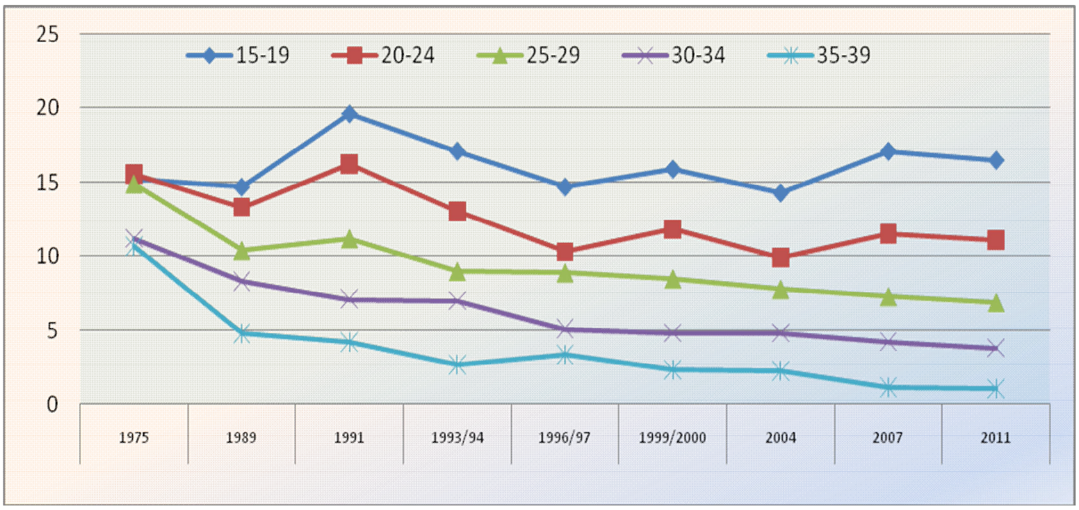
Change over time in the pregnant is an independent indicator of fertility change. In Bangladesh, the present pregnant have generally declined over time, from 13% in 1975 to 6% in 2011. During this period, the present pregnant declined in the late 1980s and early1990s, stalled around 8% for most of the 1990s, around 7% for 2004 to 2007 and it is 6% in 2011.

**Table 3.7: Percentages of currently married women by different age groups who were pregnant at the time of interview, Bangladesh 1975 to 2011.**

| Age group | BFS 1975 | BFS 1989 | CPS 1991 | BDHS 1993/94 | BDHS 1996/97 | BDHS 1999/2000 | BDHS 2004 | BDHS 2007 | BDHS 2011 |
|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 15.2 | 14.7 | 19.6 | 17.1 | 14.7 | 15.9 | 14.3 | 17.1 | 16.5 |
| 20-24 | 15.5 | 13.3 | 16.2 | 13.0 | 10.3 | 11.8 | 9.9 | 11.5 | 11.1 |
| 25-29 | 14.9 | 10.4 | 11.2 | 9.0 | 8.9 | 8.5 | 7.8 | 7.3 | 6.9 |
| 30-34 | 11.2 | 8.3 | 7.1 | 7.0 | 5.1 | 4.8 | 4.8 | 4.2 | 3.8 |
| 35-39 | 10.7 | 4.8 | 4.2 | 2.7 | 3.4 | 2.4 | 2.3 | 1.2 | 1.1 |
| 40-44 | u | u | 1.5 | 1.5 | 0.8 | 1.3 | 1.0 | 0.4 | 0.2 |
| 45-49 | u | u | 0.2 | 0.0 | 0.0 | 0.4 | 0.2 | 0.2 | 0.1 |
| Total | 12.5 | 9.3 | 10.7 | 8.7 | 7.7 | 7.8 | 6.6 | 6.5 | 6.0 |

**Source:** u= Unknown, 1975 BFS, (MHPC, 1978:49); 1983, 1985, 1989, and 1991 CPSs, (Mitra *et al.*, 1993:24); 1989 BFS (Huq and Cleland, 1990:43); 1993-1994 BDHS, (Mitra *et al,* 1994:72); 1996-1997 BDHS (Mitra *et al.*, 1997:82); 1999-2000 BDHS (NIPORT *et al.*, 2001:78); 2004 BDHS (NIPORT *et al.*, 2005: 93); 2007 BDHS (NIPORT *et al.*, 2009:77); NIPORT *et al.*, January 2013; and BDHS 2011.

**Figure 3.7: Percentage of currently married women who were pregnant at the time of interview by age groups, Bangladesh 1975 to 2011.**



**Trends in Age-Specific Fertility Rate (ASFR)**

Table 3.8 and Figure 3.8 summarize the characteristics of fertility patterns over the period of 1975 to 2011. The Table 3.8 reveals some interesting features of change in the age-specific fertility behavior of the women during the recent past. Most of the childbirths in recent years took place within a shorter span than in the past and the central tendency of fertility is shifting towards younger ages.

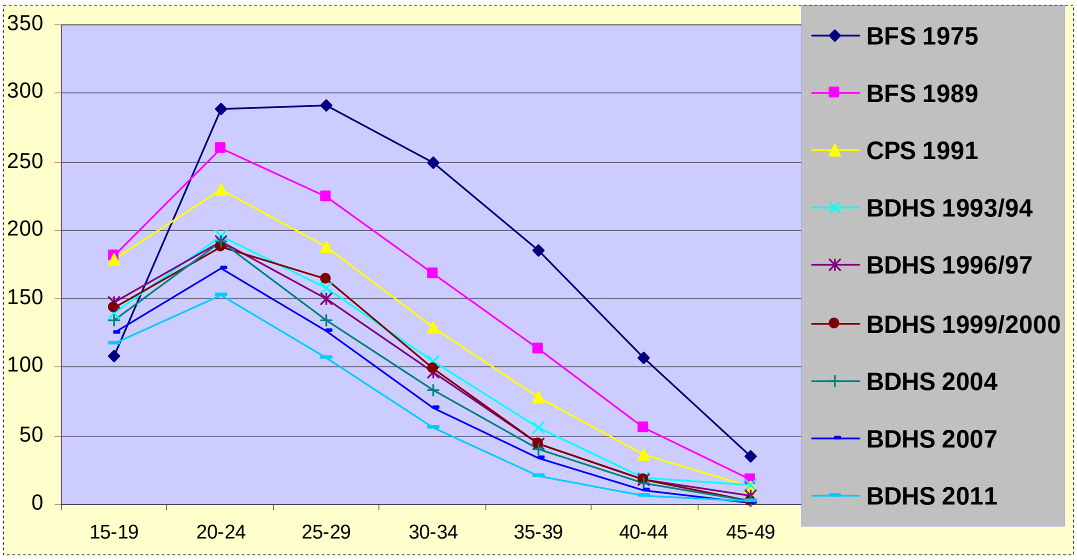
**Table 3.8 : ASFR's, per 1000 women of age 15-49, Bangladesh 1975-2011.**

| Age Group | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BFS 1975 | BFS 1989 | CPS 1991 | BDHS 1993/94 | 1996/97 | 1999/2000 | 2004 | 2007 | 2011 |
| 15-19 | 189 | 182 | 179 | 140 | 147 | 144 | 135 | 126 | 118 |
| 20-24 | 289 | 260 | 230 | 196 | 192 | 188 | 192 | 173 | 153 |
| 25-29 | 291 | 225 | 188 | 158 | 150 | 165 | 135 | 127 | 107 |
| 30-34 | 250 | 169 | 129 | 105 | 96 | 99 | 83 | 70 | 56 |
| 35-39 | 185 | 114 | 78 | 56 | 44 | 44 | 41 | 34 | 21 |
| 40-44 | 107 | 56 | 36 | 19 | 18 | 18 | 16 | 10 | 6 |
| 45-49 | 35 | 18 | 13 | 14 | 6 | 3 | 3 | 1 | 3 |
| TFR | 6.3 | 5.1 | 4.3 | 3.4 | 3.3 | 3.3 | 3.0 | 2.7 | 2.3 |

**Source:** 1975 BFS, and 1991 CPS, (Mitra *et al.*, 1993); 1989 BFS (Huq and Cleland, 1990); 1993-1994 BDHS, (Mitra *et al*, 1994); 1996-1997 BDHS (Mitra *et al.*, 1997); 1999-2000 BDHS (NIPORT *et al.*, 2001); 2004 BDHS (NIPORT *et al.*, 2005); 2007 BDHS (NIPORT *et al.*, 2009) and BDHS 2011( NIPORT *et al.*, January 2013).

Table 3.8 above also reveals that the level of fertility is still high in Bangladesh although ASFR has been decreasing over time in each age group. The peak age has shifted from 25-29 in 1975 to 20-24 in 1999-2000, in 2004, in 2007 and in 2011.

**Figure 3.8: ASFR's, per 1000 women of age 15-49, Bangladesh 1975-2011.**




Looking at figure 3.8 it is observed that the age pattern of fertility remains almost similar at different time points. The fertility curve is less skewed in the recent years than in the past.

Thus it may be concluded that the level of fertility is not high and seems to change little over time. It is observed that fertility increasing up to age 25 years then declines sharply. This implies that women who postpone their marriages to later ages try to recover the reproductive period already lost by producing on the average more children. But beyond age 25, the fertility performance slows down, which might be due to the fact that women who postpone their marriage up to that age might be mentally matured and motivated to reduce their fertility by using some modern contraceptive method and/ or might have become less fecund as the level of fecundity decreases with increasing age or might have been become sterile.

Trends in fertility in Bangladesh since the early 1970s can be examined by observing a time series estimates of TFR, produced from demographic surveys fielded over the last four decades, beginning with the 1975 Bangladesh fertility survey. The estimates shows in table 3.8 describe the ongoing Bangladeshi fertility change. Fertility has declined sharply from 6.3 in 1975 to 2.3 in 2011, which shown in figure 3.10. During this period, fertility declined rapidly in the late 1980s and early 1990s, and stalled at around 3.3 for most of the 1990s. The 2004 BDHS data indicate that after almost a decade-long stagnation the TFR declined slightly from 3.3 to 3.0 between 1997-1999 and 2004; the TFR declined after a decade from 2.7 to 2.3 between 2007 and 2011. The data show that fertility has dropped substantially among all age groups over the past two decades. Investigation of the age pattern of fertility shows no anomalous, the decline since the mid-1980s has been fairly uniform over all age groups of women.

## 3.6 Cohort Fertility

Cohort analysis looks at fertility longitudinally that is at all births occurring to a specific group of women, normally all those born or married during a particular year. Cohort analysis is complex than period analysis. A cohort approach to fertility is a comparatively new idea, having become widely used only in the last thirty years or so. It is used mainly for explaining fertility levels and trends, rather than forecasting, and it is consequently normally of more interest to academic researchers than to administrations and planners. The essential feature of cohort fertility analysis is that it is considers the experience of one group of people over time.

There are three big problems associated with cohort analysis. Cohort analysis-

(i) Requires data in the form of a fairly long, consistent time series, and such data are rare, even in highly developed societies.

(ii) Is the problem known technically as ‘censoring’- that one does not know what will happen in the future so the later experience of young or more recent cohorts is unknown.

(iii) Seems to be rather difficult to think about cohorts.

Cohort fertility computed for each age group reflects the actual cumulative fertility rate of the age cohorts, which for women age 45-49, may be assumed to be the completed family size. The completed family size in the case of cohort fertility will give the level of fertility of a particular cohort. Usually, cumulative fertility is expected to increase with age. However, accurate reporting of the number of children ever born is questionable, especially among older women. As such the completed family size may give an underestimate of the level of fertility of the cohort, which will mainly depend on the extent of under-reporting. If fertility did not change much over time and the reporting of the number of children never born is reasonably good, the completed fertility may be expected to give a closer approximation to the current level of fertility.

The information on reported mean number of children ever born is presented in Table 3.9 by age of ever-married women of age 15 years and over in different time periods. The mean number of live births per ever-married women's are calculated for each age group of women by dividing the total number of live births in each age group by the total number of ever-married women in the corresponding age group. The Table 3.9 indicates that the average number of children ever born per ever-married women tends to decline over time. This is slightly lower in recent years in each age group. Table 3.9 shows the mean number of children ever born to women in each five-year age group, an indicator of the momentum of childbearing. The mean number of children ever born for all women is 2.2 births on average. Allowing for mortality of children, Bangladeshi women have, on average, 2.0 living children. Currently married women have an average of 2.3 living children in 2011.

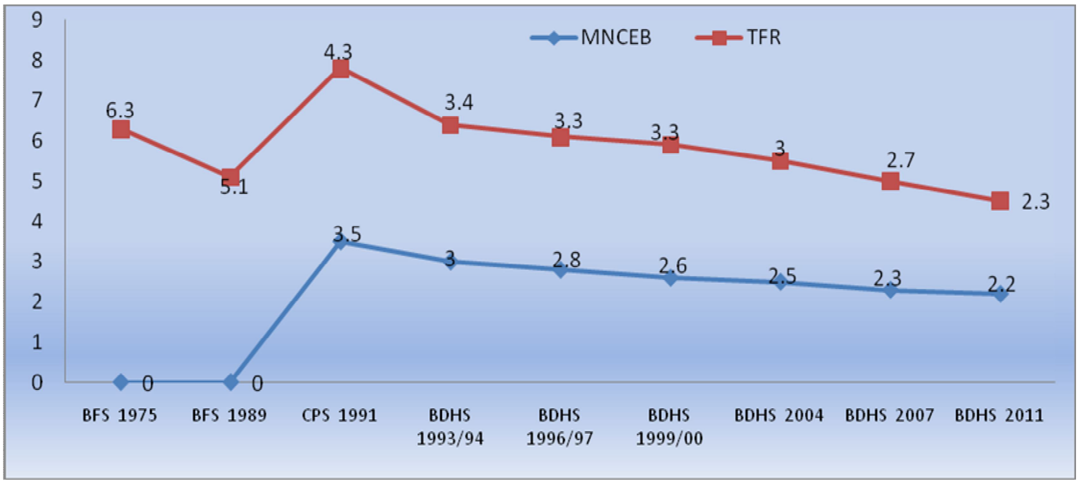
**Table 3.9: Mean number of children ever born (MNCEB) per ever-married women, Bangladesh 1975 to 2011.**

| Age Group | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BFS 1975 | BFS 1989 | CPS 1991 | BDHS 1993/94 | BDHS 1996/97 | BDHS 1999/2000 | BDHS 2004 | BDHS 2007 | BDHS 2011 |
| 15-19 | 0.6 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 |
| 20-24 | 2.3 | 1.7 | 1.7 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.2 |
| 25-29 | 4.2 | 3.1 | 3.2 | 2.9 | 2.8 | 2.6 | 2.6 | 2.3 | 2.2 |
| 30-34 | 5.7 | 4.7 | 4.5 | 4.1 | 3.9 | 3.6 | 3.4 | 3.2 | 2.9 |
| 35-39 | 6.7 | 5.9 | 5.7 | 5.2 | 4.8 | 4.3 | 4.1 | 3.8 | 3.4 |
| 40-44 | 7.1 | 6.6 | 6.7 | 6.4 | 5.6 | 5.1 | 4.7 | 4.3 | 3.9 |
| 45-49 | 6.7 | 7.3 | 7.4 | 6.9 | 6.4 | 6.1 | 5.6 | 4.9 | 4.5 |
| Total | u | u | 3.5 | 3.0 | 2.8 | 2.6 | 2.5 | 2.3 | 2.2 |

**Note:** u = Unknown (not applicable); **Source:** BFS 1975, 1989; CPS 1991; BDHS 1993-`94, 1996-`97, 1999-2000, 2004; Mitra and Associates, May 2005, 57; 2007 & 2011 BDHS, NIPORT *et al.*, January 2013, p-65.

Despite the fluctuations between surveys, the data generally show only modest declines until the late 1980s. Although this was followed by little change between 1989 and 1991, the mean number of children again declined considerably between 1991 and 1993-`94. The most recent data showed a decline in the mean number of children between 1999-2000 and 2004 among women age 30 and above. In Figure 3.9 it is seen that trend in CEB stalled since 1993/94, also TFR stalled in the same period.

**Figure 3.9: Mean numbers of children ever born and total fertility rate, 1975 to 2011.**



**Mean Age at Marriage and Total Fertility Rate**

There is a common belief that age at marriage (MAM) is inversely related to fertility, particularly in countries where no popular effective use of contraceptives. This means that delayed marriage increases the interval between generations and hence puts an independent barrier to long- range population growth by reducing the proportion of married female in the reproductive ages relative to the total population.

As a society may develops, desired family size declines, because of the influences of different socio-demographic and socio-economic determinants. The evidence for this view of the reproductive behavior includes the negative association (r= - 0.77) between the total fertility rate (TFR) and the mean age at marriage.

A simple regression of TFR on MAM in Bangladesh yielded the regression line given by-

TFR= 15.932- 0.644 X MAM ------------------------------------------------------ (1)

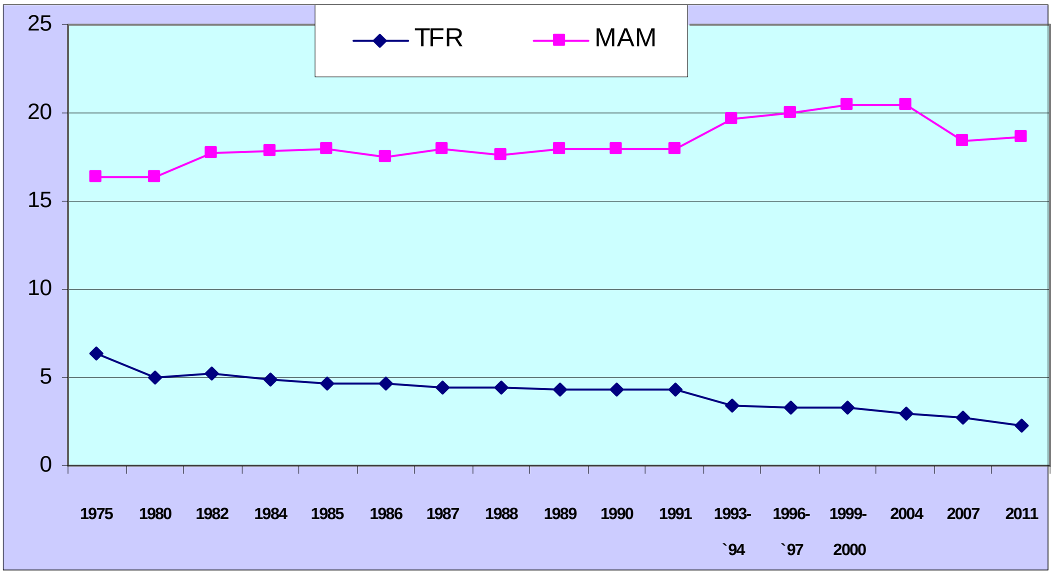
According to regression equation (1), the total fertility rate equal on average 16.0 births per women in the non-increasing of age at marriage and fertility declines at a rate of 6.4 births per women for each 10 percent in mean age at marriage. It also indicates that mean age at marriage explains about 60 percent ($R^2$= 0.59) of the variation in the total fertility rate. Deviations from the regression line are partly due to measurement errors and partly due to variations in other determinants. This is a statistical relationship, but in Bangladesh, the increase in contraceptive use, lactational infecundability might be other factors for declining fertility.

**Table 3.10: Female mean age' at marriage (MAM) and total fertility rate (TFR) for different time periods, Bangladesh 1975 to 2011.**

| Year | TFR | MAM |
|---|---|---|
| 1975 | 6.34 | 16.4 |
| 1980 | 4.99 | 16.4 |
| 1982 | 5.21 | 17.7 |
| 1984 | 4.83 | 17.8 |
| 1985 | 4.71 | 18.0 |
| 1986 | 4.70 | 17.5 |
| 1987 | 4.42 | 17.9 |
| 1988 | 4.39 | 17.6 |
| 1989 | 4.35 | 18.0 |
| 1990 | 4.33 | 18.0 |
| 1991 | 4.30 | 17.9 |
| 1993-`94 | 3.40 | 19.7 |
| 1996-`97 | 3.30 | 20.0 |
| 1999-2000 | 3.30 | 20.4 |
| 2004 | 3.0 | 20.5 |
| 2007 | 2.7 | 18.4 |
| 2011 | 2.3 | 18.6 |

**Source:** BBS 1991; VRS, BBS; SVR, BBS; SVRS, BBS; Statistical pocket book Bangladesh 2005 (Nov.2006), Statistical Pocketbook of Bangladesh, BBS, 2005; 2008, 2013 (April 2014), BDHS 1993/94-2011.

**Figure 3.10: Female mean age' at marriage (MAM) and total fertility rate (TFR) for different time periods, Bangladesh 1975 to 2011.**



**Trends in Current Use of Contraception**

Use of family planning method is one of the primary determinants of family size. Information on knowledge of family planning methods was collected by asking female respondents to name ways or methods by which a couple could delay or avoid pregnancy. Any spouse who dependent practice undertaken consciously to reduce the risk of conception is considered as contraception.

Use of contraception directly affects fertility level of a society to delay or limit the number of children to be born. Knowledge of family planning methods is widespread in Bangladesh. From a historical point of view, contraceptive use in our country had been very low, but substantial increases of contraception practices are now being well documented. In various surveys, use of contraception is defined as the proportion of currently married women who report that they are using a family planning method at the time of several surveys.

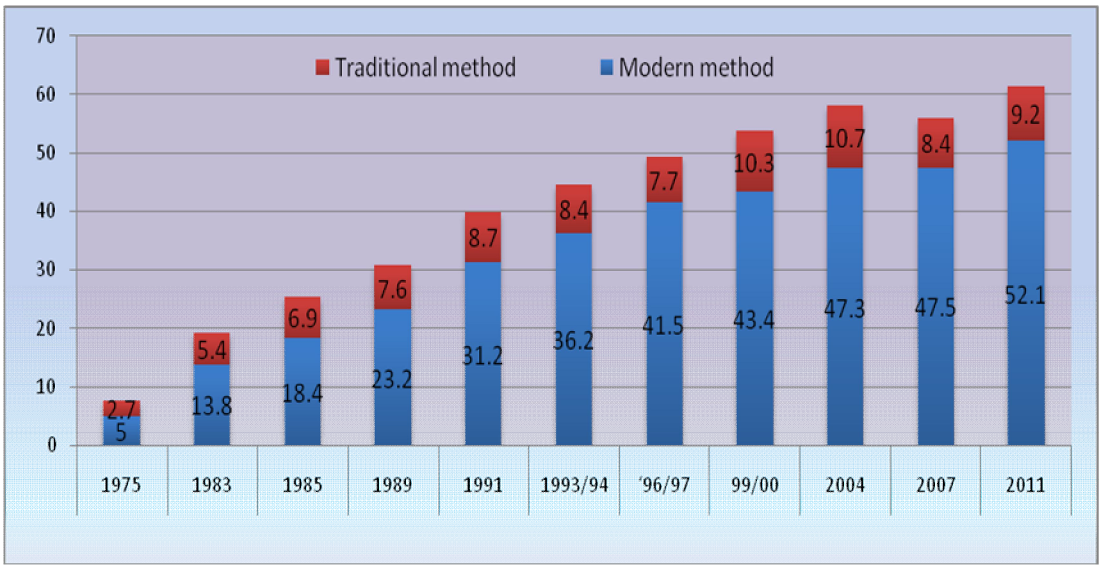
The family planning program in Bangladesh has been considered as an example of success story in fertility change in a country without a high-level of socio-economic development. Use of contraception among married women in Bangladesh has increased gradually, from 8 percent in 1975 to 61 percent in 2011, a greater than sevenfold increase in fewer than four decades. Over the past four years alone, contraceptive use has increased by five percentage points, from 56 percent in 2007 to 61 percent in 2011. The increase in the use of modern methods is even more dramatic, a more than tenfold increase from 5.0 percent to 52.1 percent in four decades.

**Table 3.11: Percentages of currently married women using family planning methods, selected sources, Bangladesh 1975-2011.**

| Methods | BFS 1975 | CPS 1983 | CPS 1985 | BFS 1989 | CPS 1991 | BDHS 93/94 | BDHS '96/97 | BDHS 99/00 | BDHS 2004 | BDHS 2007 | BDHS 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Modern method** | 5.0 | 13.8 | 18.4 | 23.2 | 31.2 | 36.2 | 41.5 | 43.4 | 47.3 | 47.5 | 52.1 |
| Pill | 2.7 | 3.3 | 5.1 | 9.6 | 13.9 | 17.4 | 20.8 | 23.0 | 26.2 | 28.5 | 27.2 |
| IUD | 0.5 | 1.0 | 1.4 | 1.4 | 1.8 | 2.2 | 1.8 | 1.2 | 0.6 | 0.9 | 0.7 |
| Injection | - | 0.2 | 0.5 | 0.6 | 2.6 | 4.5 | 6.2 | 7.2 | 9.7 | 7.0 | 11.2 |
| Condom | 0.7 | 1.5 | 1.8 | 1.8 | 2.5 | 3.0 | 3.9 | 4.3 | 4.2 | 4.5 | 5.5 |
| Female sterilization | 0.6 | 6.2 | 7.9 | 8.5 | 9.1 | 8.1 | 7.6 | 6.7 | 5.2 | 5.0 | 5.0 |
| Male sterilization | 0.5 | 1.2 | 1.5 | 1.2 | 1.2 | 1.1 | 1.1 | 0.5 | 0.6 | 0.7 | 1.2 |
| Implant | - | - | - | - | - | - | 0.1 | 0.5 | 0.8 | 0.7 | 1.1 |
| Vaginal Method | 0.0 | 0.3 | 0.2 | 0.1 | - | - | - | - | - | - | - |
| **Traditional method** | 2.7 | 5.4 | 6.9 | 7.6 | 8.7 | 8.4 | 7.7 | 10.3 | 10.7 | 8.4 | 9.2 |
| Periodic Abstinence | 0.9 | 2.4 | 3.8 | 4.0 | 4.7 | 4.8 | 5.0 | 5.4 | 6.5 | 4.9 | 6.9 |
| Withdrawal | 0.5 | 1.3 | 0.9 | 1.8 | 2.0 | 2.5 | 1.9 | 4.0 | 3.6 | 2.9 | 1.9 |
| Other Traditional Method | 1.3 | 1.8 | 2.2 | 1.8 | 2.0 | 1.1 | 0.8 | 0.9 | 0.6 | 0.6 | 0.4 |
| **All method** | 7.7 | 19.2 | 25.3 | 30.8 | 39.9 | 44.6 | 49.2 | 53.7 | 58.1 | 55.8 | 61.2 |

**Sources:** - = Not found, BFS 1975, 1989; CPS 1983, 1985, 1991; BDHS 1993/94, 1996/97, 1999/2000, 2004, 2007, 2011;

**Figure 3.11: Contraceptive uses among currently married women Bangladesh, 1975-2011.**



**Trends in the modern contraceptive prevalence rate**

Contraceptive use indicators—including the contraceptive prevalence rate (CPR), method mix, and unmet need—are showing encouraging progress in some censuses and surveys information for different time periods of Bangladeshi couples. Such changes are often precursors of fertility decline. The modern contraceptive prevalence rate—the proportion of a woman of reproductive age who are using a modern contraceptive method—varies widely across different time periods for different censuses and surveys.

The use of modern contraceptive methods show in Table 3.12 and in Figure 3.12 among married women in Bangladesh has increased gradually, from 5 percent in 1975 to 52 percent in 2011, a greater than tenfold increase in fewer than four decades. Over the past four years alone, modern CPR's has increased by nine percentage points, from 47.5 percent in 2007 to 52.1 percent in 2011.

**Table 3.12: Percentage of currently married using modern contraceptive methods, Bangladesh 1975-2011.**

| **Modern methods** | **BFS 1975** | **CPS 1983** | **CPS 1985** | **BFS 1989** | **CPS 1991** | **BDHS 1993/94** | **BDHS '96/97** | **BDHS 99/00** | **BDHS 2004** | **BDHS 2007** | **BDHS 2011** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pill | 2.7 | 3.3 | 5.1 | 9.6 | 13.9 | 17.4 | 20.8 | 23.0 | 26.2 | 28.5 | 27.2 |
| Condom | 0.7 | 1.5 | 1.8 | 1.8 | 2.5 | 3.0 | 3.9 | 4.3 | 4.2 | 4.5 | 5.5 |
| IUD | 0.5 | 1.0 | 1.4 | 1.4 | 1.8 | 2.2 | 1.8 | 1.2 | 0.6 | 0.9 | 0.7 |
| Male sterilization | 0.5 | 1.2 | 1.5 | 1.2 | 1.2 | 1.1 | 1.1 | 0.5 | 0.6 | 0.7 | 1.2 |
| Female sterilization | 0.6 | 6.2 | 7.9 | 8.5 | 9.1 | 8.1 | 7.6 | 6.7 | 5.2 | 5.0 | 5.0 |
| Injection | - | 0.2 | 0.5 | 0.6 | 2.6 | 4.5 | 6.2 | 7.2 | 9.7 | 7.0 | 11.2 |
| Vaginal Method | 0.0 | 0.3 | 0.2 | 0.1 | - | - | - | - | - | - | - |
| Implant/Norplant | - | - | - | - | - | - | 0.1 | 0.5 | 0.8 | 0.7 | 1.1 |
| **Modern CPR's** | 5.0 | 13.8 | 18.4 | 23.2 | 31.2 | 36.2 | 41.5 | 43.4 | 47.3 | 47.5 | 52.1 |

**Note:** - = Unknown; **Source:** BFS 1975, 1989; CPS 1991; BDHS 1993-`94, 1996-`97, 1999-2000, 2004; Mitra and Associates, May 2005, 57; 2007 NIPORT, March 2009 & 2011 BDHS, NIPORT., January 2013.

**Figure 3.12: Percentages of currently married women using modern contraceptive methods, Bangladesh 1975-2011.**

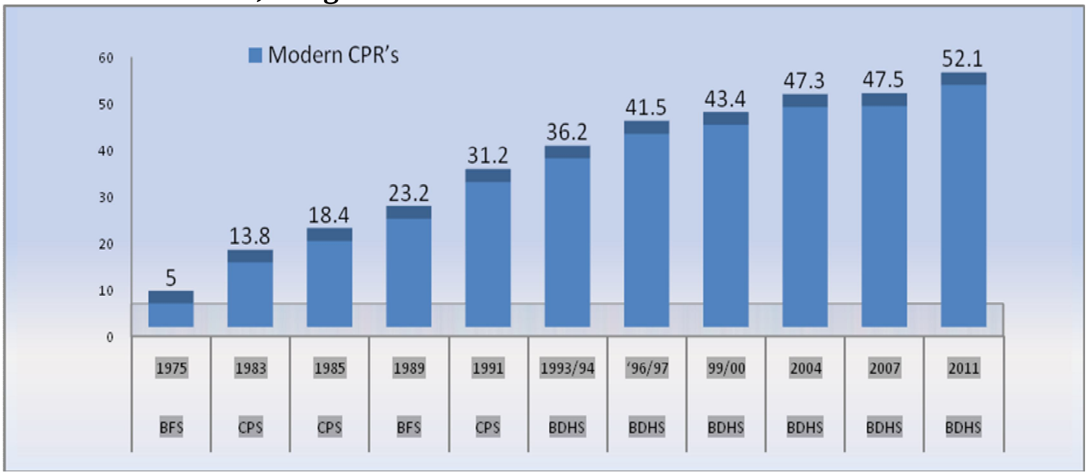



**Figure 3.12 (a): Trends in percentages of currently married women age 15-49 that are using pill as modern contraceptive methods, Bangladesh 1975-2011..**

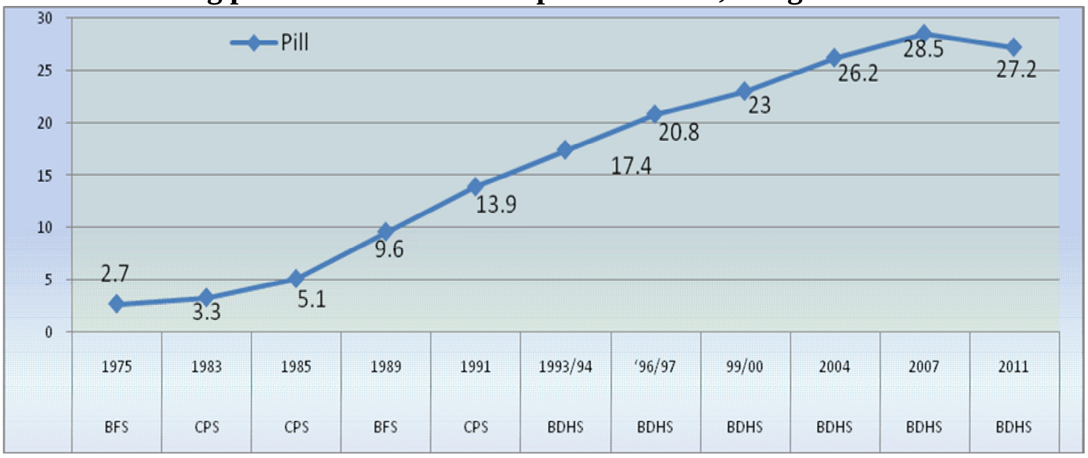
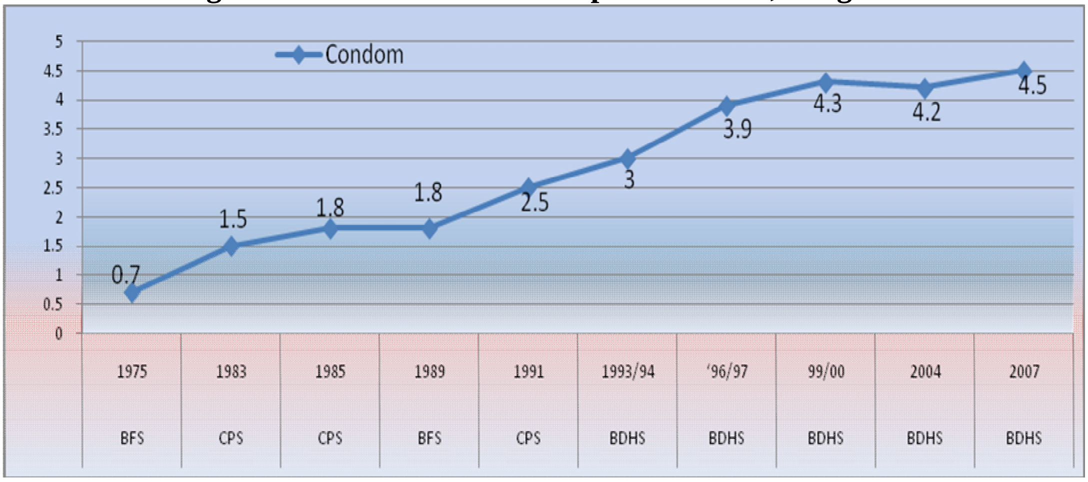



**Figure 3.12(b): Trends in percentages of currently married women age 15-49 that are using condom as modern contraceptive methods, Bangladesh 1975-2011.**



## 3.7 Conclusion

Age at marriage is one of the most important factors in demographic analysis as it is directly related to fertility. Such age has been established as one of the strongest determinants of fertility and it makes an important contribution on the rate of population growth through fertility especially in a society where contraception is not generally practical and where birth does not occur outside marriage. Clearly, a shift in proportions single of the magnitude should have had a measurable impact on the overall level of fertility, unless, as proves to be the case, fertility behavior within marriage has changed in a countervailing manner.

The data suggests that marriage pattern has changed over time. It can be observed that the proportion of single women particularly in the age group 15-19 and 20-24 years have increased to the highest degree, with time the age at marriage begins has tended to increase and also the tempo of marriage and hence the span of marriage and the maximum age beyond which first marriage is likely to take place have probably increased. Therefore, the indication is that the marriage pattern what has been expected to change over time is firstly established and thereby, causing changes in the marital fertility and hence overall fertility.

It is indicated from data on marriage and fertility has changed over time. The major increases MAM occur during the period 1993-1994 to 2004 and slightly decrease during the period 2007 to 2011. The impression is that in recent times the effect of marital reproductive behavior on reducing overall fertility is remarkable and the effect of change of marriage pattern is less than that of marital fertility.

To observe the trends in fertility of Bangladesh, it is evident that fertility is declining over the past 35 years. The trends in the crude birth rates from 1975 to 2011 indicates that the crude birth rates fluctuated around 45% per 1000 population throughout the period until 2007 then fertility has been declining moderately.

Total fertility rate has declined about 64% from 6.3 births per women in the period 1975 to 2.3 births for the period 2011. It is truly an exceptionally steep decline. Period fertility approach reveals that the level of fertility is still very high in Bangladesh although the age specific fertility rate has been decreasing over time in each age group.

The age has shifted from 25-29 in 1975 to 20-24 in 1999-2000 and 2004. Again the age has shifted from 20-24 to 15-19 in 2007 and 2011. Moreover, the completed family size in the case of cohort fertility will give the level of fertility of a particular cohort and it indicates that the mean number of children ever born per ever married women has been declining over time and it is slightly lower on recent years in each age group.

In Bangladesh, the norm of early and universal marriage still prevails. Most of the first marriages occur within a short span of life. The age patterns of marriage occur within a short span of life. The age patterns of marriage and the contraceptive use have changed in a positive direction, the negative impact of which has fallen on fertility.

Examination of the percent changes indicated at a various time segments that the change could be a recent phenomenon. Again, the effects of marriage pattern on the overall fertility and marital fertility on the overall fertility of the Bangladeshis analyses show higher influences of marriage pattern than marital fertility. The change in marital fertility that has taken place in the country overtime is contributed less by the change in marital fertility in comparison to the change in marriage pattern. Also, the effect of change of marriage pattern in reducing fertility level perhaps has increased over time.

# Chapter Four

## BIVARIATE ANALYSIS OF FERTILITY AND CONTRACEPTION

### 4.1 Introduction

Fertility is one of the most important components of demographic change. Fertility varies not only with age and duration of marriage, but also with area of residence that is rural or urban, type of marriage (monogamous or polygamous), level of educational attainment, occupation, religion and many other factors. The procedure involves classifying births and populations by age, year of birth, occupation, rural or urban residence, religion, education etc. In Bangladesh, the data for such **refined** analysis are normally obtained from different sample surveys or from censuses.

The study of the determinant of fertility in a population is a complex process. While every animal increase family. Human beings are not exception of it. To give birth of a child is a general characteristic of women. But the capacity of giving birth is not the same for all women. At the same time, this is seen in different region and within the same region is called the differential fertility. The focus on fertility differentials is due to its important role in determining population growth and its impact on economic development.

Human fertility is to be influenced by a multitude of socio-economic, socio-cultural, biological and demographic factors. Socio-economic and socio-cultural variables cannot directly influence fertility but must act on fertility through their effect on one or more of the proximate determinants. Socio-economic conditions of population and difference in them affect the level of fertility in a population and create differences among the sub-groups or sub-regions.

In this chapter, differentials of fertility are investigate by some selected background variables: Age at marriage, Region, Place of residence, Religion, Education, Currently working, Occupation of women, Women’s participation of NGO’s, Husband’s education, Husband's occupation, group family members (for living children), birth status of women and the use of contraception behavior in Bangladesh.

Here the average number of children ever born per ever-married women is used as a fertility measurement. The analysis is performed on the basis of means, standard deviations and co-efficient of variations where necessary, in order to look at the inherent pattern in the fertility analysis only mean (average) number of children ever born and mean number of living children are taken into account.

## 4.2 Age at first marriage

Age at first marriage is one of the important factors in demography as it is directly related to fertility in many societies. Marriage is the foremost social and demographic indicator of the exposure of women to the risk of pregnancy. Marriage in Bangladesh symbols the point in a woman's life when childbearing becomes socially acceptable. "Marriages of Bangladeshi population, like other Asian societies define onset of the socially acceptable way for childbearing (Ahmed Al Sabir *et al.*, May 2005)." Women who marry early will have, on average, a longer period of exposure to pregnancy, often leading to a higher number of children ever born.

Age at first marriage has an important effect on fertility, especially in a society where contraceptive method is not regularly practiced and where births do not occur outside marriage (Coale and Tey, 1961, p: 631). It is a common belief that marriage is inversely related to fertility. While early marriage of women has been conductive to high fertility, late marriage is argued to have a fertility reducing effect (Coale, 1975). Delayed marriage with other thing being equal, shortens the period between generations and hence puts an independent brake on long-range population growth (Davis and Blake, 1982).

In Mysore, it has been shown that a rise in the age at first marriage of women from less than 15 years to 15-19 years has raised fertility, but postponement of marriage to 20-24 years or past has produced an appreciable decline in fertility (UN, 1961). Agarwala (1967) estimated that an increase in average age at first marriage from the existing 15.6

years to 19 or 20 would lead to a decline of birth rate 29% in India. The potential impact of age at first marriage is especially high in countries where there is little voluntary control of fertility (Yaukey and Thorsen, 1972).

The proportion of women marrying by age 15 has declined by almost half over time, from 71 percent among women in the oldest cohort (that is 45-49) to 37 percent among women age 20-24 (Mitra and Associates, May 2005; 93); more than 50 percent of all women age 20-49 enter marriage before their 15$^{th}$ birthday. Compared of data from the six BDHS surveys since 1993 indicates that although the median age at first marriage for women 20-49 has increased over time, there was a decrease from a median of 15.0 years at the time of the 1999-2000 BDHS to 14.8 years in 2004 (NIPORT, Dhaka; May 2005); it is 14.1 years in 2007 (NIPORT *et al.*, March 2009).

A comparison of the 2011 BDHS survey results with findings from prior surveys confirms that the median age at first marriage for women in Bangladesh continues to increase. The median age at marriage among women age 20-49 has increased by one and a half years over the past decade, from 14.2 years in 1996-1997 (Mitra *et al.*, 1997) to the current figure of 15.8 years. On the other hand, comparing the results for men across surveys indicates that the median age at first marriage among men has remained relatively stable since 2004 when the median age at marriage for men age 25-59 was 24.2 years (NIPORT *et al.*, 2005).

The legal age of marriage in Bangladesh for women is 18 years, but a large proportion of marriages still take place before the legal age. The 2011 BDHS found that 65 percent of women age 20-24 were married before age 18. Over the past two decades, the proportion of women marrying before the legal age has decreased from 73 percent in 1989 to 65 percent in 2011 (NIPORT *et al.*, Jan 2013).

In this section the average numbers of children ever born per ever-married women are calculated by current age and age at first marriage, which are presented in Table 4.1 and Figure 4.1. The Table 4.1 reveals that when current age is held constant, the average number of children decreases with higher age at first marriage. It is experimental that fertility increase in age.

**Table 4.1: Average number of children ever born per ever-married women by current age and age at first marriage: Bangladesh.**

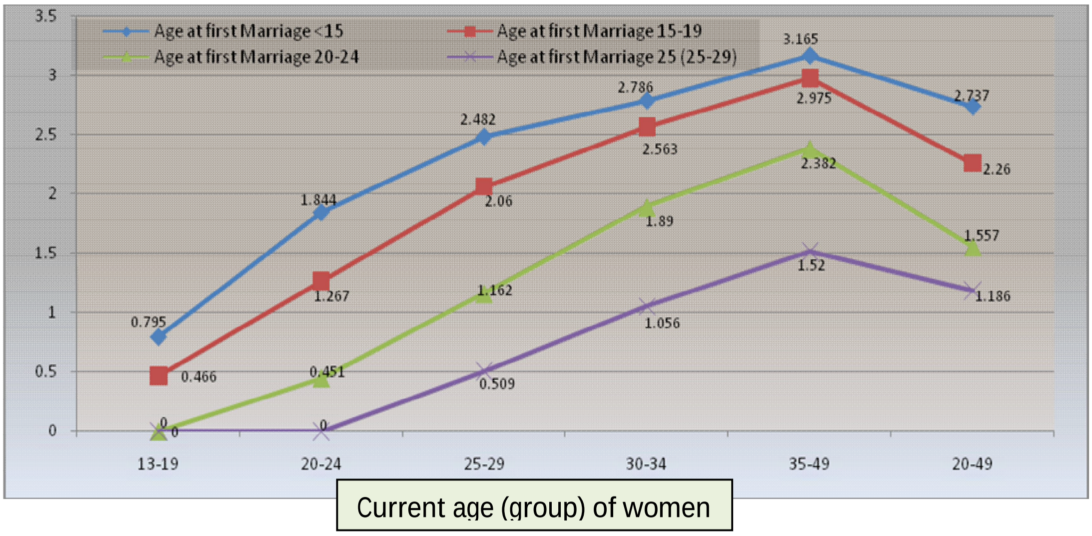
| Current age (of Women group) | Age at first Marriage | | | | Mean $\bar{x} = \frac{\sum x}{n}$ | S.D (σ) | $C.V = \frac{\sigma}{\bar{x}} \times 100$ |
|---|---|---|---|---|---|---|---|
| | **<15** | **15-19** | **20-24** | **$25^+$** | | | |
| 15-19 | 0.795 | 0.466 | - | - | 0.631 | 0.233 | 36.897 |
| 20-24 | 1.844 | 1.267 | 0.451 | - | 1.187 | 0.7 | 58.948 |
| 25-29 | 2.482 | 2.060 | 1.162 | 0.509 | 1.553 | 0.887 | 57.138 |
| 30-34 | 2.786 | 2.563 | 1.890 | 1.056 | 2.074 | 0.778 | 37.521 |
| 35-49 | 3.165 | 2.975 | 2.382 | 1.520 | 2.511 | 0.740 | 29.467 |
| 15-49 | 2.737 | 2.260 | 1.557 | 1.186 | 1.935 | 0.696 | 35.962 |

Note: - = Value not found

In table 4.1 represents that the women completing her childbearing period who was married at age <15 years have on average produced 3.165 children, while one who was married at age $25^+$ have produced on average 1.52 children which is about 52% less than those married at <15 years of age. The women completing childbearing period that was first married at age range 15-19 have on average approximately three children in her reproductive age.

The table 4.1 also shows age standardized mean number of births decline to educated women. Women's education shows a strong positive association with age at first marriage. It appears that fertility goes down when marriage takes place at a late phase it is well known fact that fertility rate is higher in countries where marriages take place at comparatively early ages, as compared with the people who marry at late period.

**Figure 4.1: Average number of children ever born per ever-married women by current age and age at first marriage: Using BDHS 2011 data, Bangladesh.**




## 4.3 Type of Place of Residence (PR) and De-facto PR

Urban-rural and de-facto differentials in fertility are the most widely studied areas in differential fertility. While higher fertility in rural areas than in the urban areas has almost consistently observed in the present developed countries, results from the developing countries do not show consistent differentials by urban-rural place of residence and de-facto place of residence. Thus urban fertility was found to be lower in Taiwan (Freedman *et al.*, 1972: 294) and Thailand (Gold, 1973: 225), than the rural one, while higher in urban than rural fertility has observed in Indonesia (University of Indonesia, 1974: 6) and Egypt (Omran, 1973: 100).

Data on urban-rural and small city, town, and countryside fertility for Bangladesh are presented in Table 4.2. Considering the mean number of births to currently married women age group $35^{+}$ (35-49) as completed fertility, it is observed that urban fertility is lower on the average by about 0.28 children than the rural one. The total average fertility all over Bangladesh is 2.983. The lower fertility for urban areas is also seen for all age groups.

**Table 4.2: Average Number of Children ever born for currently married women by age and urban-rural and de-facto place of residence: Bangladesh.**

| Usual type of place of residence | Current age of women (group) | | | | | Average number of CEB |
|---|---|---|---|---|---|---|
| | 15-19 | 20-24 | 25-29 | 30-34 | $35^+$ (35-49) | |
| Urban | 0.561 | 1.230 | 1.875 | 2.293 | 2.802 | 1.752 |
| Rural | 0.613 | 1.457 | 2.204 | 2.673 | 3.083 | 2.006 |
| De-facto place of residence | | | | | | |
| Small city | 0.568 | 1.184 | 1.831 | 2.170 | 2.707 | 1.692 |
| Town | 0.559 | 1.252 | 1.899 | 2.352 | 2.848 | 1.782 |
| Countryside | 0.613 | 1.457 | 2.204 | 2.673 | 3.033 | 1.996 |
| Total | 0.597 | 1.379 | 2.090 | 2.537 | 2.983 | 1.917 |

**Source:** BDHS 2011

Average number of CEB for age differences, higher fertility in rural areas is still apart, the overall average number of CEB being 2.006 in the rural areas and 1.752 in the urban areas (Table 4.2). This observed differential might be attributed to higher age at first marriage, higher level of real income per person, better health services, educational facilities, employment of women in the modern sector and other social amenities in the urban areas, which have the effect of reducing fertility. Furthermore, children might be considered as economic assists rather than burden in the rural areas, which cause higher fertility in the rural areas.

Rural community people, considered children are both as earners during childhood and as social security in old age. Similarly, we can describe different residential de-facto place of residence about CEB and currently married women.

The relative cost of bearing children and the lower economic value of children in the urban area, opportunity cost for mother's time might have played an important role in lowering the fertility of urban women through practice of the effective methods of birth control. Thus it is seen that the level of fertility is somewhat higher in the rural than urban areas.

## 4.4 Region

The identification of the factors underlying the regional differentials will help in formulating strategies and programs for reducing fertility. The study of regional differentials in fertility is of great importance because it will throw light on the regional variation, if any, in the childbearing patterns. It has been shown that the regional variation in the rate of growth of population in Bangladesh is mainly due to the variations in fertility (Sivamurthy and Ahmed, 1979).

Table 4.3 shows the number of children ever born per ever-married women by age group among different regions. It can be seen from the Table 4.3 that the variation is prominent in the age group 20-24 and diminishes with increasing age. The higher variation in the age groups may be attributed to variation in the proportion married in these age groups among the regions. The differentials in the level of urbanization, the level of education, and female participation in the labor force might have had varying influence in bringing about the observed variation in fertility. On the other hand, the variation in the higher age groups may be due to the extent of variation in widowhood, divorce and childlessness in addition to differential behavior towards fertility regulations or family planning practices among the regions, which are dependent on socio-cultural differences.

**Table 4.3: Average numbers of children ever born by different region and current age group of women: using BDHS 2011 data Bangladesh.**

| Different Regions | Current age of women (group) | | | | | Same region mean CEB | S.D ($s_{n-1}$) | $C.V = \frac{s_{n-1}}{\bar{x}} \times 100$ |
|---|---|---|---|---|---|---|---|---|
| | 15-19 | 20-24 | 25-29 | 30-34 | $35^{+}$ (35-49) | | | |
| Barisal | 0.547 | 1.317 | 2.113 | 2.241 | 3.077 | 1.859 | 0.963 | 51.799 |
| Chittagong | 0.696 | 1.419 | 2.213 | 2.795 | 3.259 | 2.076 | 1.033 | 49.767 |
| Dhaka | 0.559 | 1.350 | 2.062 | 2.451 | 2.921 | 1.869 | 0.931 | 49.831 |
| Khulna | 0.552 | 1.247 | 1.850 | 2.406 | 2.766 | 1.764 | 0.889 | 50.379 |
| Rajshahi | 0.483 | 1.352 | 1.998 | 2.354 | 2.806 | 1.799 | 0.907 | 50.449 |
| Rangpur | 0.718 | 1.442 | 2.118 | 2.497 | 2.968 | 1.949 | 0.886 | 45.466 |
| Sylhet | 0.623 | 1.525 | 2.294 | 2.737 | 3.163 | 2.068 | 1.010 | 48.831 |
| Bangladesh (Total) | 0.597 | 1.379 | 2.090 | 2.537 | 2.983 | 1.917 | 0.946 | 49.363 |

From table 4.3 above, it can be seen that average number of CEB in age group 15-19 is lower for Rajshahi, Khulna, Dhaka and Barisal division. Variation of the mean number of CEB is lowest in Khulna, Rajshahi, Dhaka and Rangpur.

When mean number of CEB by age groups (Table 4.3), it appears that fertility is higher stepwise in Chittagong, Sylhet, Barisal and Rangpur with average number of children ever born per women are 3.259, 3.163, 3.077 and 2.968 respectively. Fertility is lowest on average in Khulna 2.766; Rajshahi 2.806 and Dhaka 2.921 respectively. Dhaka and Rajshahi have intermediate levels of fertility. The following information of 2011 BDHS data by age group of women may be the effect of the regional variation of fertility in Bangladesh.

## 4.5 Education of women

Women's education is strongly associated with mean number of children ever born (CEB) or fertility. Education is one of the most important factors of mean number of CEB or as well as fertility. One of the consistent matters is finding the inverse relationship between education and mean number of CEB.

Education may affect fertility through raising age at first marriage, giving alternative source of new normative orientations and expansion of vision, increasing a woman's knowledge and use of birth control method as well as providing better opportunity for labor force participation if no physical harm might occurred.

Inspection of the Table 4.4 present average number of CEB per currently married women by women's education reveals that women who had no education (that is illiterate) show the highest completed fertility 3.129, the second highest completed fertility with incomplete primary; complete primary and primary respectively are 3.110, 3.054 and 3.115. The completed fertility for women with education levels secondary, incomplete secondary and complete secondary are respectively 2.710, 2.784 and 2.365. Also, for higher educated women the completed mean number of children born is 2.153.

**Table 4.4: Average number of CEB per woman by age group and women's education level: Using BDHS 2011 data, Bangladesh.**

| Women's education level | Current age of women (group) | | | | |
|---|---|---|---|---|---|
| | **15-19** | **20-24** | **25-29** | **30-34** | **$35^+$ (35-49)** |
| No education/illiterate | 0.793 | 1.823 | 2.476 | 2.300 | 3.129 |
| Primary | 0.662 | 1.628 | 2.348 | 2.734 | 3.110 |
| Incomplete primary | 0.662 | 1.682 | 2.440 | 2.751 | 3.115 |
| Complete primary | 0.661 | 1.565 | 2.215 | 2.702 | 3.054 |
| Secondary | 0.584 | 1.273 | 1.924 | 2.402 | 2.710 |
| Incomplete secondary | 0.594 | 1.305 | 1.983 | 2.439 | 2.784 |
| Complete secondary | 0.442 | 1.015 | 1.653 | 2.255 | 2.365 |
| Higher | 0.248 | 0.679 | 1.268 | 1.712 | 2.153 |
| Mean number of CEB | 0.597 | 1.379 | 2.090 | 2.537 | 2.983 |

The completed fertility for women who had completed primary education is 3.054, which are less than those with no formal education, although the difference is very little. It can be also seen from Table 4.4 that women with no education tended to have more children in first three age groups than those with primary, secondary and higher education level.

The higher mean number of CEB or fertility for women with uneducated (illiterate) than educated (literate) women may be due to the following reasons:

i. Women with no education are not aware of having a limited family size.
ii. By an age when there are more chances of having marriage and children born, the girls are in the college and university and thus do not get children, which during this period uneducated girl do.
iii. Uneducated women fell very hesitant to use contraceptive method to control family size and go on accepting even unnecessary motherhood responsibilities imposed on them.

iv. Duration of child producing time in the case of uneducated women is rapid, as compared with educated women.

v. Within a lot of cases, educated women get employed and with employment they cannot afford to have more children.

## 4.6 Wealth Index

Wealth is one of the important factors of mean number of children ever born (CEB). Total children ever born are negatively related with wealth; the disparity between women with poorest and richest wealth quintiles is 0.51 children per women for age group 35-49; 0.27, 0.68, 0.81 and 0.80 children per women respectively are for age groups 13-19, 20-24, 25-29 and 30-34. Women with poorest and poorer wealth quintile are not aware of having a limited family size. By an age when there are more chances of having marriage and more children born, the girls are of these quintile married. Those wealth quintiles, which do put any bar on the number of marriage and children ever born, are likely to have less CEB than the others, because more the number of wives for a male person have normally conscious about their child and family size.

**Table 4.5: Average number of CEB per woman by age group and women's wealth index: Bangladesh, using 2011 BDHS.**

| Women's wealth Index | Current age of women (group) | | | | |
|---|---|---|---|---|---|
| | 15-19 | 20-24 | 25-29 | 30-34 | $35^+$ (35-49) |
| Poorest | 0.757 | 1.762 | 2.480 | 2.904 | 3.082 |
| Poorer | 0.609 | 1.498 | 2.255 | 2.822 | 3.178 |
| Middle | 0.573 | 1.376 | 2.143 | 2.607 | 3.117 |
| Richer | 0.538 | 1.240 | 2.058 | 2.486 | 2.985 |
| Richest | 0.52. | 1.087 | 1.671 | 2.107 | 2.672 |

The Table 4.5 present average number of CEB per currently married women by women's with poorer wealth quintile reveals that women who had show the highest CEB 3.178 per women; women's with middle wealth, the second highest CEB 3.117 per women, poorest wealth quintile CEB 3.082 per women and richer, richest wealth quintile CEB are 2.985, 2.672 per women respectively.

## 4.7 Religion

Fertility or children ever born (CEB) is affected and influence by the preaching of religions. Those religions, which do not put any bar on the number of marriage and children, are likely to have more CEB than the others. Because more the number of wives for a male person have normally there are more children. Islam is the principal religion in Bangladesh with 90.0% Muslims, 9.5% Hinduism, 0.2% Buddhism, and 0.3% Christianity (BDHS 2011). Religious value systems, which influence individual values, are different between the Muslims and Non-Muslims.

The average numbers of children ever born by religions are presented in Table 4.6. The Table indicates that the Muslims have higher fertility than Non-Muslims in each age group. The Table also shows that average number of CEB for age differences, Muslims have the highest mean number of CEB 3.031 than Non-Muslims women 2.658; which mean that Muslims women have the 12.31% highest mean number of CEB than Non-Muslims women.

**Table 4.6: Average numbers of children ever born per currently married women by age group and religion: using 2011 BDHS Bangladesh.**

| Religion | Current age of women (group) | | | | |
|---|---|---|---|---|---|
| | 15-19 | 20-24 | 25-29 | 30-34 | $35^+$ |
| Muslim/Islam | 0.593 | 1.388 | 2.127 | 2.564 | 3.031 |
| Non-Muslim | 0.638 | 1.295 | 1.783 | 2.328 | 2.658 |
| Hinduism | 0.640 | 1.295 | 1.779 | 2.307 | 2.669 |
| Christianity | 0.500 | 1.500 | 1.917 | 2.414 | 3.0 |
| Buddhism | 0.667 | 1.200 | 1.714 | 2.533 | 3.0 |

From table only age group 15-19, the mean number of children for Muslim religion is 0.593 less than the same group Non-Muslim religion which is 0.638 CEB per women.

## 4.8 Working Status of Women

The 2011 BDHS asked respondents a number of questions regarding their working status, including whether they had worked in the 12 months before the survey. The results for women are presented in Tables 4.7. One in four working women are engaged in factory or blue collar services, 22 percent work as semi-skilled labor, and 13 percent each perform professional or technical services and home-based manufacturing work.

The relationship between women's occupation and age is mixed; younger women are more likely than older women to be engaged in factory work, blue collar services, semi-skilled labor services, and home-based manufacturing activities. In contrast, older women are more likely than younger women to work in business, in agriculture, or as domestic servants.

Studies concerning the impact of labor force participation on fertility suggest that working women have lower fertility than their non-working counterparts (Devanzo, 1972; UN, 1973). It also argued that labor-force participation would have a decreasing effect on fertility only if it is incompatible with childbearing (UN, 1973). The direction is of causality between labor force participation and fertility is not certain, because labor force participation may be a consequence as well as a cause of lower fertility. The average numbers of children ever born by work status and current age of women are presented in Table 4.7

**Table 4.7: Mean number of children ever born of currently married women by age group and women's current working status: using 2011 BDHS Bangladesh.**

| Women's working status | Current age of women (group) | | | | |
|---|---|---|---|---|---|
| | 15-19 | 20-24 | 25-29 | 30-34 | $35^+$ |
| Not working | 0.604 | 1.396 | 2.127 | 2.589 | 3.040 |
| Working | 0.486 | 1.249 | 1.876 | 2.272 | 2.649 |
| Mean number of CEB | 0.597 | 1.379 | 2.09 | 2.537 | 2.983 |

It appears that the mean number of children ever born is higher for non-working women than working women for each age group. In the case of average of live births same picture is apparent.

Women who are involved with a job are not dependent on men now and often. Both socially and mentally these have their own rights and absence of dependence, men cannot use women to forcibly increase their fertility number of CEB. This has also resulted in low fertility. Fertility depends on social status of the women. In societies where women are confined only to house jobs, these are considered suitable only for producing children and such those women who are held in high esteem.

## 4.9 Education of Husband

A basic background characteristic of the 3,997 ever-married men, age 13-54, was collected for 2011 BDHS. Twenty six percent of men are under age 30 and nearly all men that is 99 percent are currently married. The majority of respondents, 72 percent of men reside in the rural areas and rests are in urban areas.

Husband’s schooling has a significant effect on the children ever born to currently married women, because in our society almost everything depends on the opinion of a husband. Now a day’s higher educated persons are giving importance to the educated female for marriage; as a result a balance is prevailing upon the families, which play a negative role in fertility or total children ever born.

To observe the Table 4.8 present mean number of children ever born per currently married women by husband’s schooling. This Table also shows that husband with no education observed higher fertility than all other educational categories.

**Table 4.8: Mean number of children ever born per currently married women by age group and husband's education level: using 2011 BDHS, Bangladesh.**

| Husband's education level | Current age of women (group) | | | | |
|---|---|---|---|---|---|
| | 15-19 | 20-24 | 25-29 | 30-34 | $35^+$ |
| No education | 0.716 | 1.706 | 2.407 | 2.842 | 3.109 |
| Primary | 0.667 | 1.513 | 2.280 | 2.690 | 3.135 |
| Secondary | 0.540 | 1.255 | 1.935 | 2.416 | 2.927 |
| Higher | 0.392 | 0.933 | 1.485 | 1.972 | 2.476 |

The Table 4.8 reveals that women with husband's no education tended to have more children in all age groups than those with higher education. The completed fertility for women whose husband's with primary education is 3.135, which is greater than higher level that is 2.476 mean number of CEB per woman. When average number of live births is calculated the same picture is visible. That is, higher the education level, lower the number of children ever born.

The lower level of fertility for women who's that's education level is higher than those with secondary education may be due to the following reasons:

i. Generally educated men marry at late stage, educated women and so fewer children are produced but uneducated men marry at early age and less educated women, as a result they produce more children.
ii. Educated men always want to educate his children. As too much money is expanding to educate the children, so they want to keep their family size small. But illiterate men never think so.
iii. An educated man is more conscious about hygiene than an illiterate man and he does not take so many children considering the physical condition of his wife.

iv. Uneducated men are usually unorthodox about religion and they consider family planning as anti-religious and don't use any method. But educated men always think practically and they maintain different customs in a systematic way.

v. Educated men are commonly involved in different occupation and so they have to go different places and they want to maintain the high standard with other families. But too many children create hindrance to maintain it.

## 4.10 Husband's occupation and mean number of CEB of women

In developing countries like Bangladesh, the husband's occupation is closely related to children ever born (CEB) significantly. The various occupational categories included in 2011 BDHS data, for the sake of our analysis the categories are classified into two major groups' viz. manual, non-manual, Leader/ Imam or Religious leader, not working group and others categories. The classes of occupations included in the manual and non-manual categories are as follows: **Manua**l: - Land owner, farmer, agricultural worker, fisherman, poultry raising, cattle raising, home-made manufacturing, rickshaw puller, brick breaker, road builder or construction worker, domestic servant.

**Non-Manual**: Professional worker, Businessman, factory worker, carpenter, mason, bus/taxi driver, construction supervisor, tailor, policeman, armed services, dai, community services, doctor, lawyer, dentist, accountant, teacher, nurse, family wale fare visitor, mid and high level services(government and non-government), big businessman, small businessman/trader and housewife.

**Not working group**: Unemployed/student, retired, beggar.

**Others**: Silent about work, say don't know.

According to Professor Donald J Bogue's view fertility or CEB is influenced by the occupation of the head of the family. The people with good occupations are likely to check fertility, where as those with manual occupation are likely to have more children. He has related this to income also. According to him where income is low, fertility goes up, but income is not very high, then the fertility or CEB is the lowest, but when income considerably increases with that fertility goes up. He is of the opinion that it is wrong to think that when the family is reached the number of children will be less (Bogue, 1969).

**Table 4.9: Mean number of CEB per woman by age group and husband occupation, Bangladesh.**

| Husband's occupation | Current age of women (group) | | | | | |
|---|---|---|---|---|---|---|
| | 15-19 | 20-24 | 25-29 | 30-34 | 35-49 | 20-49 |
| Manual working group | 0.700 | 1.603 | 2.323 | 2.761 | 3.113 | 2.617 |
| Non-Manual working | 0.558 | 1.301 | 1.984 | 2.423 | 2.883 | 2.213 |
| Not working group | 0.327 | 0.786 | 1.913 | 2.095 | 3.035 | 2.538 |
| Others | 0.412 | 1.0 | 1.976 | 2.552 | 2.929 | 2.333 |

The mean number of children ever born by current age group of woman and husband's occupation is presented in Table 4.9. The Table indicates that the children ever born are higher in number for Manual occupations than all other occupation in each age group. Average number of CEB for age differences, higher fertility in Manual occupation 3.113 is apparent than all other occupation 2.883, 3.035, 2.929 respectively for non-manual, not working and other working groups. It is usually seen that those who are engaged in Manual work have less number of children which not have seen in the table, as compared with those who are occupied with of physical labor. Such as whose business is such that takes them to clubs and other places of interest and recreation have less number of children. Similar results we have found for age groups 20-49.

It is seen that Manual occupations have high fertility. It is primarily because husbands and wives always live together and has no other source of entertainment except that of sexual exposure. Moreover, it believed that every child, who is born, would after some time start earning something even at a very young age by doing unskilled jobs.

## 4.11 Mean number of CEB by age group and woman's current marital status

Marriage is the foremost social and demographic indicator of the exposure of women to the risk of pregnancy. Marriage in Bangladesh symbols the point in a woman's life when childbearing becomes socially acceptable. In Bangladesh, a substantially greater proportion of women age 15-49 have ever married. Eight in ten women that is, 80 percent are currently married.

Three percent of women and less than 1 percent of men age 15-49 are widowed. The proportion of women who are widowed increases sharply with age and are mostly limited to older age groups: 7 percent of women age 40-44 and 13 percent of women age 45-49 are widowed. Divorce and separation are uncommon in Bangladesh, with the proportion among women being slightly higher than among men. Two percent of women age 15-49 are either divorced or separated compared with less than 1 percent of men of the same age. The proportion divorced or separated does not vary markedly by age group among either woman. Table 4.10 shows the current marital status of women and mean number of CEB by age 15-49.

**Table 4.10: Mean number of CEB per woman and woman's current marital status: Using 2011 BDHS data, Bangladesh.**

| Woman's current marital status | Current age of women (group) | | | | |
|---|---|---|---|---|---|
| | 15-19 | 20-24 | 25-29 | 30-34 | 35-49 |
| Married | 0.606 | 1.396 | 2.108 | 2.575 | 3.030 |
| Widowed | 1.0 | 1.278 | 2.122 | 2.320 | 2.889 |
| Divorced | 0.269 | 0.636 | 0.788 | 0.931 | 1.319 |
| Separated | 0.136 | 1.060 | 1.667 | 1.702 | 2.165 |

There has seen that married except other current marital status have high fertility. It is primarily because husbands and wives always live together. The mean number of children ever born by current marital status of woman is presented in Table 4.10. The Table 4.10 indicates that the children ever born are higher in number for always married, completed CEB is 3.03 per woman by age period 15-49 than all other current marital status that is, who are widowed, divorced or separated completed CEB per woman are respectively 2.889, 1.319 and 2.165 by age period may or may not live together with husband 15-49 years.

## 4.12 Women's involvement in NGO's and means number of CEB

At present days NGO's memberships play a very important role in reducing have an effect on such a third world country like Bangladesh. In Bangladesh NGO's work are said to be the alternative institution to promote the national progress of the country. There are data on many NGO's in 2011 BDHS surveys such as Grameen Bank, BRAC, BRDB, ASHA, Proshika, Mothers club and others microcredit etc.

**Table 4.11: Mean number of CEB by current age group and women involvement in NGO's.**

| Woman's involvement on NGO's | | Current age of women (group) | | | | |
|---|---|---|---|---|---|---|
| | | 15-19 | 20-24 | 25-29 | 30-34 | 15-49 |
| BRAC | No | 0.587 | 1.363 | 2.077 | 2.516 | 2.971 |
| | Yes | 0.980 | 1.661 | 2.271 | 2.847 | 3.149 |
| BRDB | No | 0.594 | 1.377 | 2.087 | 2.534 | 2.984 |
| | Yes | 1.222 | 1.652 | 2.464 | 2.900 | 2.846 |
| ASHA | No | 0.574 | 1.348 | 2.053 | 2.518 | 2.958 |
| | Yes | 0.945 | 1.646 | 2.351 | 2.671 | 3.158 |
| Grameen Bank | No | 0.577 | 1.351 | 2.077 | 2.503 | 2.971 |
| | Yes | 0.962 | 1.605 | 2.173 | 2.722 | 3.050 |
| Proshika | No | 0.597 | 1.378 | 2.089 | 2.537 | 2.982 |
| | Yes | 0.600 | 1.750 | 2.167 | 2.750 | 3.067 |
| Mother's club | No | 0.597 | 1.379 | 2.098 | 2.537 | 2.983 |
| | Yes | - | 1.500 | 3.000 | - | 3.200 |
| Others microcredit | No | 0.573 | 1.355 | 2.076 | 2.523 | 2.971 |
| | Yes | 0.881 | 1.548 | 2.178 | 2.614 | 3.052 |

In Bangladesh, NGO's work is so diverse in nature and terms of activities that it is hard for anybody to find a single sphere where NGO's works are not involved directly or indirectly or individually. The NGO's three distinct categories are observable, these are: local, regional and national. At present there is a large number of local, regional and national NGO's are working all over the Bangladesh to change the socio-economic through demographic, socio-demographic and economic structure of the country. NGO's works play a vital role for human resources development. Human resource development in the pre-condition for economic development and economic conditions are directly linked with fertility or total children ever born. The mean number of children ever born by current age and women involvement of NGO's is presented in Table 4.11.

Table 4.11 indicates that the average number of children ever born is higher for women in all age groups, who have involved with BRAC, BRDB, ASHS, Grameen Bank, Proshika, Mother's club and others microcredit than others who are not connection with NGO's.

**The probable remedies to overcome these situations are as follows:**

(i) Considering to updating the standard of the lives of the people, NGO's might have taken lots of programs. They need to go to the rural and remotest area of the country and by their physical visit and they need to make the people understand about the benefit of building sound health and provide them a little bit idea of medical science that might reduce fertility.

(ii) Most of the villagers of our country are poor and illiterate; as a result, they cannot understand properly which work is economically profitable and which work is good for them. In those situation NGO's help the villagers by taking proper decision for their economical improvement, and that increases their consciousness as a result, there creates a tendency on them that family size should be small and population explosion should be checked, otherwise many economic and social problems are bound to arise.

(iii) Educational activities taken by the NGO's open a new chapter all over the country. NGO's might have taken various educational activities such as formal education, informal education, adult education, mass education, practical education and many other kinds of training etc. In those ways, a large number of villagers would have been conscious about themselves, about surrounding environment, about their practical life and about family planning system. NGO's might have needed to support various materials of family planning methods, which directly affect of reduction of fertility for villagers.

## 4.13 Regional Differentials of Mean Number of Children

Table 4.12 shows that the mean children ever born in all divisions for 2011 BDHS survey. It is seen that the mean CEB in Sylhet division (2.400 children per woman) is higher than other divisions; the second heist mean CEB in Chittagong (2.300 children per woman) and then Barisal, Rangpur, Dhaka, Rajshahi and Khulna respectively mean CEB 2.184, 2.154, 2.102, 2.063 and 2.021.

The mean number of living children (LC) in all the divisions for 2011 BDHS survey presented in table 4.12. The mean number of LC is highest in Sylhet which are 2.250 children per woman and the lowest in Khulna which is 1.903 children per woman. According to place of residence, for all urban regional divisions mean CEB per woman are less than their rural regional areas.

The mean number of CEB for urban areas is highest in Sylhet 2.225 children and lowest in Dhaka 1.897 children on the other hand the mean number of CEB for rural areas is highest in Sylhet 2.479 children and lowest in Khulna 2.071 children per woman. Hence it is clear that the mean number of CEB, mean number of living children and for urban-rural residence fertility is higher in Sylhet division in Bangladesh.

The mean ideal numbers of children have remained nearly same during the recent past. The mean ideal number of boys demand is higher than mean ideal number of girls for all regional areas which is approximately one boy and one girl. From above analysis, we might arrive at a conclusion that most families want to construct a two children family.

**Table 4.12: Regional Differentials of some selected characteristics using BDHS 2011.**

| Characteristics | | Barisal | Chittagong | Dhaka | Khulna | Rajshahi | Rangpur | Sylhet |
|---|---|---|---|---|---|---|---|---|
| Mean number of CEB | | 2.184 | 2.300 | 2.102 | 2.021 | 2.063 | 2.154 | 2.400 |
| Mean number of LC | | 2.058 | 2.185 | 1.981 | 1.903 | 1.924 | 2.018 | 2.250 |
| Place of residence mean number of CEB | Urban | 2.009 | 2.139 | 1.897 | 1.928 | 2.030 | 2.034 | 2.225 |
| | Rural | 2.268 | 2.391 | 2.260 | 2.071 | 2.078 | 2.201 | 2.479 |
| Mean ideal number of children | | 2.165 | 2.295 | 2.117 | 2.030 | 2.061 | 2.119 | 2.414 |
| Mean ideal number of boys | | 0.979 | 1.088 | 0.937 | 0.887 | 0.965 | 0.962 | 1.225 |
| Mean ideal number of girls | | 0.858 | 0.960 | 0.837 | 0.816 | 0.898 | 0.870 | 1.055 |

## 4.14 Percentages and Bivariate Analyses of contraception relative variables

Chi-square test is employed to determine the association of ever use contraception among the background characteristics of respondents (binary logistic regression analysis applied in chapter six).

### 4.14.1 Percentages and Bivariate Analyses of variables relative to ever use of contraception

Table 13 reveals the association of ever use of contraceptive methods among several selected variables. It is found that, there are 14 independent variables such as: de-facto place of residence, women current age, husband's current age, number of dead sons, women educational attainment, region/division, number of living children, spousal desire for children (SDC), husband's occupation, women currently working (WCW), husband's educational attainment, wealth index, women age at first birth and children ever born are associated with ever use contraception. Out of 17 independent variables, these 14 variables are highly statistically significant with $p<0.01$. Other 3 independent variables such as: currently breastfeeding, religion and women age at first marriage are not associated with ever use contraception that is statistically insignificant.

In de-facto place of residence, we found 65.4% lives in rural area, 11.2% in City Corporation and 23.4% in town (Table 13). Resident of City Corporation, town and rural women ever use contraceptive methods respectively 92%, 90% and about 86%. This indicates that there is very few difference between urban-rural users of the ever use contraceptive methods. The variable women current age: aged<20, 20-24, 25-29, 30-34 and 35-49 years are found in this study respectively 7.3%, 20.3%, 21.2%, 16.6% and 34.6%; husband current age: aged 15-24, 25-34, 35-44, 45-54 and $55^+$ years are 3.6%, 28.2%, 32.3%, 24.6% and 11.4% respectively.

The variable number of dead sons: about 88% is found never experienced the son mortality, 10% is found ever experienced single son mortality and about 2% is ever experienced two or more sons' mortality (Table 13). These percentages reflect the recent achievement in improving the child mortality level. Similarly, we could explain for lingering variables, which showed in Table 13.

**Table 4.13: Univariate and Bivariate analyses of variables relatives to ever use contraception using BDHS 2011, Bangladesh.**

| Background Characteristics | Ever use contraception | | Total cases | % | Pearson's $\chi 2$ | p-values |
|---|---|---|---|---|---|---|
| | No | Yes | | | | |
| **De-facto place of residence** | | | | | | |
| City | 122 | 1439 | 1561 | 11.2 | 71.208 | 0.000 |
| Town | 333 | 2934 | 3267 | 23.4 | | |
| Rural area | 1296 | 7827 | 9123 | 65.4 | | |
| **Women current age** | | | | | | |
| <20 | 163 | 860 | 1023 | 7.3 | | |
| 20-24 | 315 | 2519 | 2834 | 20.3 | 197.73 | 0.000 |
| 25-29 | 238 | 2717 | 2955 | 21.2 | | |
| 30-34 | 203 | 2113 | 2316 | 16.6 | | |
| 35-49 | 832 | 3991 | 4823 | 34.6 | | |
| **Husband's current age** | | | | | | |
| 15-24 | 74 | 423 | 497 | 3.6 | | |
| 25-34 | 411 | 3520 | 3931 | 28.2 | 322.074 | 0.000 |
| 35-44 | 424 | 4081 | 4505 | 32.3 | | |
| 45-54 | 429 | 3004 | 3433 | 24.6 | | |
| $55^{+}$ (55-96) | 413 | 1172 | 1585 | 11.4 | | |
| **Number of dead sons** | | | | | | |
| No son died | 1406 | 10841 | 12247 | 87.8 | 114.895 | 0.000 |
| =1 (one son died) | 276 | 1165 | 1441 | 10.3 | | |
| >1 (at least two sons died) | 69 | 194 | 263 | 1.9 | | |
| **Women educational attainment** | | | | | | |
| No education | 651 | 2816 | 3467 | 24.9 | | |
| Incomplete Primary | 311 | 2275 | 2586 | 18.5 | | |
| Complete Primary | 209 | 1497 | 1706 | 12.2 | | |
| Incomplete secondary | 439 | 3925 | 4364 | 31.3 | | |
| Complete. secondary | 65 | 669 | 734 | 5.3 | | |
| Higher | 76 | 1018 | 1094 | 7.8 | | |

**(Continued)**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Region/Division** | | | | | | |
| Barisal | 149 | 1525 | 1674 | 12 | | |
| Chittagong | 396 | 1897 | 2293 | 16.4 | | |
| Dhaka | 260 | 2109 | 2369 | 17 | 544.399 | 0.000 |
| Khulna | 179 | 1880 | 2059 | 14.8 | | |
| Rajshahi | 163 | 1887 | 2050 | 14.7 | | |
| Rangpur | 151 | 1763 | 1914 | 13.7 | | |
| Sylhet | 453 | 1139 | 1592 | 11.4 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Number of living children** | | | | | | |
| No living | 52 | 44 | 96 | 0.7 | | |
| 1 | 600 | 3048 | 3648 | 26.1 | 384.985 | 0.000 |
| 2 | 366 | 4109 | 4475 | 32.1 | | |
| (3-4) | 450 | 3923 | 4373 | 31.3 | | |
| (5-10) | 283 | 1076 | 1359 | 9.7 | | |
| **Currently breastfeeding** | | | | | | |
| No | 1204 | 8493 | 9697 | 69.5 | 0.527 | 0.468 |
| Yes | 547 | 3707 | 4254 | 30.5 | | |
| **Spousal desire for children (SDC)** | | | | | | |
| Both want same | 1341 | 9784 | 11125 | 79.7 | | |
| Husband wants more | 218 | 1274 | 1492 | 10.7 | 152.708 | 0.000 |
| Husband wants fewer | 86 | 934 | 1020 | 7.3 | | |
| Don’t know | 106 | 208 | 314 | 2.3 | | |
| **Husband’s occupation** | | | | | | |
| Agriculture | 448 | 3247 | 3695 | 26.5 | | |
| Non-agriculture | 755 | 4794 | 5549 | 39.8 | | |
| Service | 66 | 877 | 943 | 6.8 | | |
| Business | 311 | 2885 | 3196 | 22.9 | | |
| Others | 171 | 397 | 568 | 4.1 | | |
| **Women currently working** | | | | | | |
| Works as housewife | 1607 | 10731 | 12338 | 88.4 | 21.819 | 0.000 |
| Works outside home | 144 | 1469 | 1613 | 11.6 | | |

**(Continued)**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Husband's educational attainment** | | | | | | |
| No education | 594 | 3377 | 3971 | 28.5 | | |
| Incomplete Primary | 275 | 1968 | 2243 | 16.1 | 58.694 | 0.000 |
| Complete Primary | 228 | 1389 | 1617 | 11.6 | | |
| Incomplete secondary | 369 | 2753 | 3122 | 22.4 | | |
| Complete. secondary | 112 | 829 | 941 | 6.7 | | |
| Higher | 173 | 1884 | 2057 | 14.7 | | |
| **Religion** | | | | | | |
| Muslim | 1578 | 10828 | 12406 | 88.9 | 2.901 | 0.089 |
| Non-Muslim | 173 | 1372 | 1545 | 11.1 | | |
| **Wealth index** | | | | | | |
| Poorest | 369 | 1987 | 2356 | 16.9 | | |
| Poorer | 341 | 2252 | 2593 | 18.6 | 35.497 | 0.000 |
| Middle | 310 | 2398 | 2708 | 19.4 | | |
| Richer | 375 | 2581 | 2956 | 21.2 | | |
| Richest | 356 | 2982 | 3338 | 23.9 | | |
| **Women age at first marriage** | | | | | | |
| <20 | 682 | 4903 | 5585 | 40 | | |
| 20-24 | 897 | 6293 | 7190 | 51.5 | 5.302 | 0.151 |
| 25-29 | 143 | 842 | 985 | 7.1 | | |
| $30^+$ (30-45) | 29 | 162 | 191 | 1.4 | | |
| **Women age at first birth** | | | | | | |
| <20 | 1181 | 9280 | 10461 | 75 | | |
| 20-24 | 436 | 2414 | 2850 | 20.4 | 80.098 | 0.000 |
| 25-29 | 103 | 421 | 524 | 3.8 | | |
| $30^+$ (30-45) | 31 | 85 | 116 | 0.8 | | |
| **Children ever born** | | | | | | |
| 1 | 563 | 2839 | 3402 | 24.4 | | |
| 2 | 338 | 3756 | 4094 | 29.3 | 217.746 | 0.000 |
| (3-4) | 456 | 3936 | 4392 | 31.5 | | |
| $5^+$ | 394 | 1669 | 2063 | 14.8 | | |

## 4.15 Conclusion

All studies have shown that there are socio-economic variables like age at first marriage, place of residence, religion, education, member of NGO's, work status of women, husband's education and occupation have positive or negative effect on fertility. So, also in the case of Bangladesh as found in the preceding analysis; education and age at first marriage have been found to be a strong discrimination of fertility or mean CEB, increase of the age at first marriage and level of education may effectively reduce reproductive performance of the women in Bangladesh. The urban-rural and regional differentials of fertility show that the rural fertility is higher than urban. Besides these socio-economic variables that is women and men labor force participation and wealth index influence fertility or mean number of CEB and living children born negatively.

Again, it is usually seen that those who are engaged in mental work have less number of children, as compared with those who are in physical labor. Socio-cultural variables religion and others status of women prove that in our rural and superstitious society such variables help to increase fertility and those may be the result of education, occupation, religion, urbanization and economic condition of that area. Also the level of wanted fertility around the value of replacement level has increased recently. This is inductive of the fact that a slight reversal or offsetting effect has been taking place as the fertility or CEB is approaching replacement level. This can be viewed as a cause of stalling fertility change.

Although researchers and policymakers tipped the family planning programs as the most important contribution to the decline in fertility or CEB in the past, the BDHS data shows that about fifty percent of the users of contraception in all the regions discontinue within twelve months. In recent years, the discontinuation rates have increased slightly in most of the regions indicating a further decline in the efficiency of methods of contraception. In other words, the effective contraceptive prevalence rate has declined to small extent during the recent past in all regions. This decline in the effective contraceptive offsets the forthcoming impact of rising CPR, which contributed installing of fertility change.

# Chapter Five

# PROXIMATE DETERMINANTS OF FERTILITY

## 5.1 Introduction

The study of determinants of women's reproduction in a population is a very complex process. While women's reproductive behavior influences population growth, which have consequences towards pressure on resources, employment situations, health and other social facilities such as: savings and investment. Such consequence in turn great bearing on the demographic, socio-economic and cultural variables affect fertility behavior.

The level of fertility in a society is directly influenced by a set of variables called intermediate variables or proximate determinants. In general, the biological and behavioral factors through which demographic, economic, socio-economic, cultural and environmental variables affect fertility are called an intermediate fertility variable. The primary character of an intermediate fertility variable is its direct influence on fertility. Davis and Blake (1956) produce the first systematic classification of the proximate determinants of fertility through which economic, social and other factors must operate to control fertility.

Bongaarts (1978) revised the original classification and provide a simple analytical method accounting framework, which permits a quantitative assessment of the contribution of different proximate determinants to give fertility levels or change**.** Bongaarts (1982) demonstrated that most of the variation in fertility is due to four intermediate variables or proximate determinants. They are (i) marriage (ii) contraception (iii) abortion and (iv) lactational infecundability. If a proximate determinant such as contraceptive use changes, then fertility necessarily changes (also assume other proximate determinants remain constant), though this is not necessarily the case of socio-economic determinants. As a result, fertility differences among population and changes in fertility of a population over time can always be traced to variations in one or more of the proximate determinants (see Bongaarts 2001).

Historical and recent past studies about fertility alteration have shown that as societies being to undergo the change from natural to deliberately controlled fertility, significant changes in the overall levels of total natural fertility, total marital fertility and total fertility being occur (Bongaarts and Potter, 1983; J.B. Casterline and J.G. Cleland, 1985; Islam *et al.*, 1993; ). Such changes can be traced to one or more proximate determinants, such as, an increase in contraceptive use for stopping and spacing purposes; a rise in age at first marriage, a decline in the proportion married, prolonged breast feeding and increased fetal wastage (including induced abortion).

In Bangladesh, Islam *et al.* (1996; 2004) and some other researcher showed contraception was the most important fertility inhibiting factor from 1979 to 2007, followed by lactational infecundability, marriage and induced abortion. Due to data problem, the impact of induced abortion could not be estimated directly and an indirect estimation procedure used for estimating the effect of induced abortion. To improve our clear understanding of the fertility transition, we critically examine the effect of major proximate determinants: marriage, contraception, lactational infecundability on fertility and their changing effects.

This chapter attempts to identify the four intermediate variables namely proportion married among females, contraceptive use effectiveness, fetal wastage (also, induced abortion) and duration of lactational infecundability and investigates their impacts on change in the level of fertility for the period 1975 to 2011 in Bangladesh. During this period decomposing Original Bongaarts' model (OBM) and Revised Bongaarts model (RBM) assesses the individual contribution made by each of the four intermediate variables to change the fertility level. The study also examines how well these determinants predict fertility level in Bangladesh. This has been done by comparing observed total fertility rate as estimated by the model.

## 5.2 Marriage

For Muslim communities over the world and like in most Asian societies, child bearing without marriage is very rare. Thus, in Bangladesh, the age at which women marry and the proportions that remain single are potentially important factors influencing fertility levels. Marriage in Bangladesh marks the point in a woman's life when childbearing becomes socially acceptable. Age at first marriage has a major effect on childbearing because the risk of pregnancy depends primarily on the age at which women first marry. Women who marry early will have, on average, a longer period to exposure to pregnancy often leading to a higher number of children ever born. In our country, the legal age of marriage is 18 years for women. However, a large proportion of women marriages still take place before this legal age.

**Table 5.1: Percentages of women age 20-24 years who were first marriages before age18, Bangladesh 1989 to 2011.**

| Source | Year | Percentage |
|---|---|---|
| BFS | 1989 | 73.0 |
| BDHS | 1993-1994 | 73.0 |
| BDHS | 1996-1997 | 69.0 |
| BDHS | 1999-2000 | 65.0 |
| BDHS | 2004 | 68.0 |
| BDHS | 2007 | 66.0 |
| BDHS | 2011 | 65.0 |

**Source:** BFS 1989; NIOPRT *et al.*, 2005; BDHS 1993/94, 1996/97, 1999/2000, 2004, 2007, 2011, p-51;

Table 5.1 and Figure 5.1 show that in the 2011 BDHS, 65 percent of women age 20-24 years, were married before age 18. Here shows the trend in the percentage of women who were first marriage by age 18. The table 5.1 and figure 5.1 show that the tendency of first marriage at age 18 stalled during the period 1989-1994, after that period the percentage of women marriage before age at 18 year from 1996/97 to 1999/2000 reduced, after that period, in 2004, the age at first marriage before age 18 increased again. It also indicates that over the twenty six years, the proportion of women marrying before the legal age had been very slow declining; but in recent years, it has increased again.

**Figure 5.1: Percentages of women age 20-24 years who were first marriage before age 18 years, Bangladesh 1989 to 2011.**

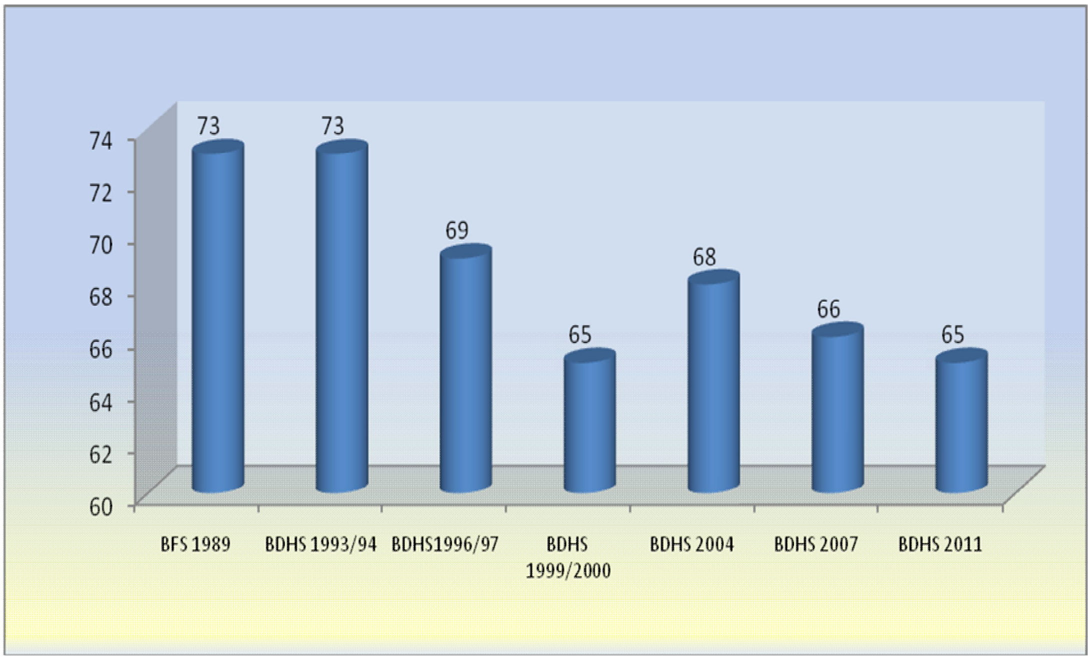


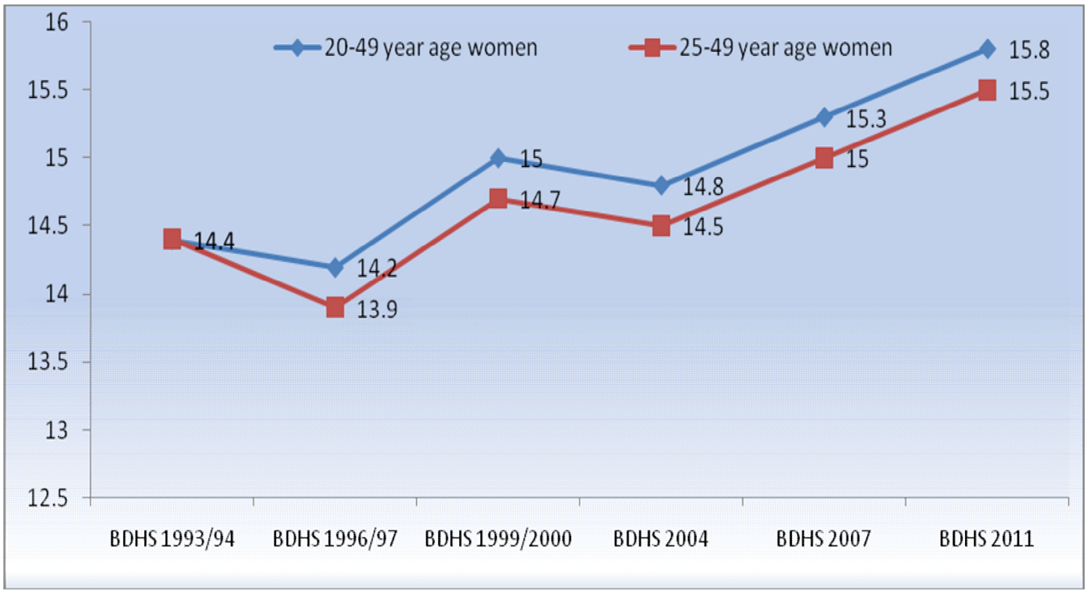

**Table 5.2: Median Age at First Marriage of Women Age 20-49 and 25-49, Bangladesh 1993/`94 -2011.**

| Source | Year | Women Age | |
|---|---|---|---|
| | | 20-49 | 25-49 |
| BDHS | 1993-1994 | 14.4 | 14.1 |
| BDHS | 1996-1997 | 14.2 | 13.9 |
| BDHS | 1999-2000 | 15.0 | 14.7 |
| BDHS | 2004 | 14.8 | 14.5 |
| BDHS | 2007 | 15.3 | 15.0 |
| BDHS | 2011 | 15.8 | 15.5 |

**Source:** BDHS 1993/94, 1996/97, 1999/2000, 2004; BDHS 2007, p-78; BDHS2011, p-51;

Note worthy that still more than fifty percent women age 20-49 years enter marriage before their 15th birthday. From Table 5.2, it is seen that the median age at first marriage for Bangladeshi women is still 14 to 16 years, though the median age at first marriage increased modestly over the last two decade. From the figure 5.2, it is also evident that women of both age 20-49 and 25-49; the age of first marriage had a modest increase from 14, which finally remained less than or equal to 16. Thus the modest increase or nearly unchanged pattern of first marriage before the legal age contributed installing of ongoing Bangladeshi fertility change.

**Figure 5.2: Percentages of median age at first marriage of women age 20-49 years and 25-49 years, Bangladesh from 1993/`94 -2011.**




## 5.3 Contraception

Use of family planning is one of the primary determinants of family size. Any spouse who dependent practice undertaken consciously to reduce the risk of conception is considered as contraception. Use of contraception directly affects fertility level of a society to delay or limit the number of children to be born. Knowledge of family planning methods is widespread in Bangladesh. From a historical point of view, contraceptive use in our country had been very low, but substantial increases of contraception practices are now being well documented.

All ever married women know of at least one modern method of family planning, and 80% women know of at least one traditional method. On average, a woman has heard of 8 methods of family planning. Knowledge was assessed for eight modern methods of family planning: the pill, IUD, injectables, Norplant/Implant, condoms, female sterilization, and male sterilization and vaginal method and three traditional methods of family planning: periodic abstinence and withdrawal and other method. There is virtually no difference in knowledge between ever-married and currently married women.

**Table 5.3: Use of contraceptive methods among currently married women for selected periods, Bangladesh.**

| Methods | BFS 1975 | CPS 1983 | CPS 1985 | BFS 1989 | CPS 1991 | BDHS 1993/94 | BDHS '96/97 | BDHS 99/00 | BDHS 2004 | BDHS 2007 | BDHS 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pill | 2.7 | 3.3 | 5.1 | 9.6 | 13.9 | 17.4 | 20.8 | 23.0 | 26.2 | 28.5 | 27.2 |
| IUD | 0.5 | 1.0 | 1.4 | 1.4 | 1.8 | 2.2 | 1.8 | 1.2 | 0.6 | 0.9 | 0.7 |
| Injection | u | 0.2 | 0.5 | 0.6 | 2.6 | 4.5 | 6.2 | 7.2 | 9.7 | 7.0 | 11.2 |
| Condom | 0.7 | 1.5 | 1.8 | 1.8 | 2.5 | 3.0 | 3.9 | 4.3 | 4.2 | 4.5 | 5.5 |
| Female sterilization | 0.6 | 6.2 | 7.9 | 8.5 | 9.1 | 8.1 | 7.6 | 6.7 | 5.2 | 5.0 | 5.0 |
| Male sterilization | 0.5 | 1.2 | 1.5 | 1.2 | 1.2 | 1.1 | 1.1 | 0.5 | 0.6 | 0.7 | 1.2 |
| Implant | u | u | u | u | u | u | 0.1 | 0.5 | 0.8 | 0.7 | 1.1 |
| Vaginal Method | 0.0 | 0.3 | 0.2 | 0.1 | u | u | u | u | u | u | u |
| Modern method (Total) | 5.0 | 13.8 | 18.4 | 23.2 | 31.2 | 36.2 | 41.5 | 43.4 | 47.3 | 47.5 | 52.1 |
| Periodic Abstinence | 0.9 | 2.4 | 3.8 | 4.0 | 4.7 | 4.8 | 5.0 | 5.4 | 6.5 | 4.9 | 6.9 |
| Withdrawal | 0.5 | 1.3 | 0.9 | 1.8 | 2.0 | 2.5 | 1.9 | 4.0 | 3.6 | 2.9 | 1.9 |
| Other Trad. Met | 1.3 | 1.8 | 2.2 | 1.8 | 2.0 | 1.1 | 0.8 | 0.9 | 0.6 | 0.6 | 0.4 |
| Traditional method (Total) | 2.7 | 5.4 | 6.9 | 7.6 | 8.7 | 8.4 | 7.7 | 10.3 | 10.7 | 8.4 | 9.2 |
| Observed total CPR | 7.7 | 19.1 | 25.3 | 30.8 | 39.9 | 44.6 | 49.2 | 53.7 | 58.1 | 55.8 | 61.2 |

**Sources:** BFS 1975, 1989; CPS 1983, 1985, 1991; BDHS 1993/94, 1996/97, 1999/2000, 2004, 2007, 2011;

The family planning program in Bangladesh has been considered as an example of success story in fertility change in a country without a high-level of socio-economic development. The contraceptive prevalence rate (CPR) in Bangladesh has increased from 7.7% in 1975 to 61.2% of currently married women in 2011, which showed in Table 5.3. This translates too more than an eight fold increase. The increase in the use of modern methods is even more dramatic, a more than tenfold increase from 5% to 52.1% in four decades.

Over the past four years alone, contraceptive use has increased by five percentage points, from 56% in 2007 to 61.2% in 2011. The use of oral pills declined slightly between 2007 and 2011, but the decline in injectables use seen in 2007 reversed in 2011, showing an increase from 7% to 11% of married women. It should be noted that the decline in injectables use, from 10% in 2004 to 7% in 2007, was due to a nationwide stock-out just before the survey.

The 2008 Utilization of Essential Service Delivery survey (UESD) found a return to 11% as soon as the stock out was resolved (Al-Sabir *et al*, 2009). While female sterilization has stalled, holding steady at about 5% of married women since 2004, there is a hint that use of male sterilization may have increased slightly since 2007. Use of traditional methods also declined, from 11% in 2004 to 8% in 2007, but then usage increased slightly to 9% in 2011.

Between two decades from, 1991 and 2011 use of female sterilization among currently married women declined from 9% to 5%; at the same time, two methods gained popularity; the pill is being used by 27% of women, almost double the level in 1991 BDHS was 14%. Use of injectables increased from 3% in 1991 to 11% in 2011, nearly fourfold increase. However, the usage rate of injectables has stagnated at around 11% since 2008, a matter that may need further attention by program planners and policy makers.

The method mix has also changed over the past two decades. Currently only 8% of married couples use a long-acting or permanent method (LAPM), namely sterilization, IUD, and implants, which account for 13% of all contraceptive use. Use of LAPM was

12% in 1991, accounting for 30% of contraceptive use. Use of LAPM started to decline in the early 1990s, stabilized in 2007, and hints at a slight increase in 2011. Since 2004 there has been a slow increase in the use of male sterilization and implants, although the usage rate of these methods remains very low. The plateauing of LAP methods should be of concern, as fertility is now so low that most childbearing is completed by the mid- to late-twenties, and women face two subsequent decades of reproductive life during which they must protect themselves from unwanted pregnancies.

The HPNSDP, Bangladesh aims to increase overall use of contraception to 72% by 2016. This means the increase of 10.8% points would need to occur in the next 5 (only one year in hand) years, or an average of a 2.2% point increase per year. During 2004-2011, all-method contraceptive use increased from 58 to 61.2%, a 3.2% point increase in seven years.

## 5.4 Estimation of the Effect of Contraception on Reduction of Fertility

The exact effect of contraception on fertility is difficult to estimate. By using the Bongaarts' formula, the approximate effect of use of contraception on fertility may be calculated. The formula defines the proportionate reduction in fertility caused by non-contraception. The index $C_c$ can be written as:

$$C_{\mathbf{c}} = 1 - 1.08 \times u \times e$$

Where u is the proportion of currently married women using contraception among married women of reproductive age i.e. average of age specific use rate and e is the average contraceptive use-effectiveness of methods used. A value for s = 1.08 (Sterility correction factor obtained by Henry in 1961).

In 2011 BDHS survey, 'u' is 0.612. From the results of the study of Islam and Islam, 2002, the average use-effectiveness of the contraceptive methods is 0.87 (that is, e = 0.87). Bairagi *et al,* (1996), M Kamal *et al,* (2005), argued that the use-effectiveness that had been observed in Matlab was probably the true value of use-effectiveness of the contraceptive methods in Bangladesh. In the later analysis, we will utilize this figure for estimating the fertility inhibiting effect of contraception, under the assumption that the use-effectiveness of the contraceptive methods is constant for a population. Therefore, proportionate reduction in fertility due to non-contraception is:

$$C_c = 1 - 1.08 \times u \times e$$
$$= 1 - 1.08 \times 0.612 \times 0.87$$
$$= 0.425$$

That is, contraception reduces 58 percent of fertility in Bangladesh and this effect is increasing steadily.

## 5.5 Breastfeeding and Postpartum Infecundability

Feeding practices play a pivotal role in determining the optimal development of infants. Poor breastfeeding and infant feeding practices have adverse consequences for the health and nutritional status of children, which in turn have consequences on the mental and physical development of the child. Breastfeeding affects mothers through the physiological suppression of the return to fertile status, thereby affecting the length of interval between pregnancies.

Breastfeeding is the focus of rapidly growing interest in developing countries like Bangladesh, because of its important implications not only for health of children, who are breastfeed, but also on the fertility levels. For optimal growth, it is recommended that infants should be exclusively breastfeed for the first six months of life and that children be given solid or semi-solid complimentary food beginning with the $7^{th}$ month of life.

The standard indicator of exclusive breastfeeding is the percentage of children less than six months of age who are exclusively breastfeeding. The standard indicator of timely complementary feeding is the percentage of children age 6-9 months who are breastfeeding and receiving complementary foods. Exclusive breastfeeding in the early months of life is correlated strongly with increased child survival and reduced risk of morbidity. Table 5.4 and Figure 5.4 show breastfeeding situation of children up to three years of age.

**Table 5.4: Percentage of Exclusive Breastfeeding<6Months, Complementary feeding for Children 6-9 Months and Median Duration of Breastfeeding, Bangladesh 1993 to 2011.**

| Year | Percentage of exclusive Breastfeeding, children <6 months | Percentage of complimentary feeding for children 6-9 months | Median duration of Breastfeeding in months |
|---|---|---|---|
| 1993/94 | 46 | 29 | 36 |
| 1996/97 | 45 | 28 | 33 |
| 1999/2000 | 46 | 59 | 30.5 |
| 2004 | 42 | 62 | 32.4 |
| 2007 | 43 | 74 | 32.8 |
| 2011 | 64 | 67 | 31.2 |

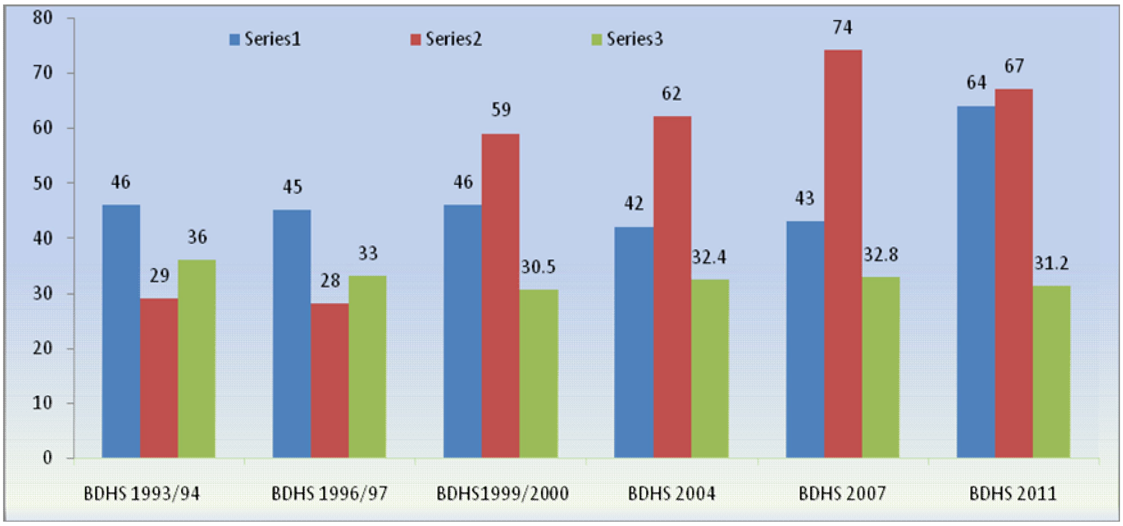
**Source:** BDHS 1993-1994, 1996-1997, 1999-2000, 2004, 2007, 2011.

The median duration of any breastfeeding among Bangladeshi children in 2011 is 31.2 months which is 1.6 months shorter from 2007. After remaining stagnant at around 40 percent for almost a decade, the rate of exclusive breastfeeding during the first 6 months of life increased by 21 percentage points, from 43 percent in the 2007 to 64 percent in the 2011.

The standard indicator of exclusive breastfeeding is the percentage of children under age 6 months who are exclusively breastfeeding. UNICEF and WHO recommend that children be exclusively breastfed that is, given no other liquid or solid food or plain water for the first six months of life and those children be given solid or semisolid complementary foods beginning in the seventh month of life. The standard indicator of timely complementary feeding is the percentage of children age 6-8 months who receive solid, semisolid, or soft foods. WHO recommends that breastfeeding continue through the second year of life. Use of bottles with nipples is not recommended for feeding at any age (WHO, 2008).

Complementary food taker children in 1993/’94 is 29%; 1% children was less in 1996/’97; 30% in 1999/2000; 33% in 2004 from 1993/’94; 45% in 2007 which was highest complementary food taking period in the last two decade and 38% in 2011 from 1993/’94 which was 7% less from 2007 BDHS time period.

**Figure 5.4: Series-1, Exclusive Breastfeeding<6 Months; Series-2, Complementary feeding for Children 6-9 Months and Series-3, Median Duration of Breastfeeding in Bangladesh.**




## 5.6 Statistical Relation between Breastfeeding and Amenorrhea

Demographers often face problems in estimating the length of amenorrhea when its direct measurement is lacking. However, it might be estimated from breastfeeding duration. Different authors have observed different types of interrelationships between breastfeeding and amenorrhea. Among them, the most widely used one is the equation proposed by Bongaarts’ and potter (1983). Analyzing data on average duration of breastfeeding and amenorrhea from twenty-one developed and developing countries, they suggested that breastfeeding and amenorrhea are related through an exponential function given by-

$i = 0.1753 \times \exp [0.1396B - 0.0001872B^2]$; $R^2 = 0.96$

Where i, and B stand for average duration of amenorrhea period and breastfeeding period respectively.

According to these relationships between the breastfeeding and amenorrhea, the average duration of amenorrhea period is-

$$i = 0.1753 \times \exp [0.1396B - 0.0001872B^2]$$

$$= 0.1753 \times 64.92884851$$

$$\text{So, } i = 11.382$$

$$= 11.4$$

Where B=31.20 months, the median duration of breastfeeding for 2011BDHS. Hence, the average duration of amenorrhea period (estimated) for 2011 BDHS is 11.4 months.

## 5.7 Estimation of the Effect of Amenorrhea on Fertility Decline

It is quite difficult to estimate the exact effect of amenorrhea on fertility. However, the approximate effect of postpartum amenorrhea can be estimated by using the formula of Bongaarts:

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

=0.66889, Where i = 11.4 (estimated).

= 0.67 (estimated).

Where $C_i$ is the index of amenorrhea and i is the mean duration of amenorrhea. $C_i$ represents the proportionate increase in the average length of birth intervals caused by lactational amenorrhea. It is assumed implicitly that there is no overlap between contraception and amenorrhea and this is a reasonable assumption for Bangladesh.

In the 2011 BDHS, direct estimation of the mean duration of amenorrhea is 7.1 months (our estimated value from indirect method is 11.4, by using Bongaarts' and Potter Proposed function). The value of $C_i$, derived from the direct estimates of amenorrhea is 0.7813; implying a 21.87 percent reduction of fertility in Bangladesh (our estimated value of amenorrhea is 0.66889, which implies that a 33.11 percent reduction in fertility) and this effect is reducing over years, since duration of breastfeeding is non-decreasing from 1999-2000 time period.

## 5.8 Estimation of Factors Using Revised Bongaarts Model

In original Bongaarts model we replace only the index "all fetal wastage" (combination of miscarriage, abortion and stillbirth) instead of the index "induced abortion" which is one of the proximate determinants of fertility. Other indices have remained same as proposed by Bongaarts original model. In the revised Bongaarts model (Md. Nurul Islam *et al.*, 2014, Fertility Analysis of Bangladesh Population Using the Revised Bongaarts Model, Journal of Advances in Life Sciences 4(2): 44-51) they considered all miscarriage or all fetal wastages together instead of only the index induced abortion in computed in the index, then the index might be termed as the index of fetal wastage and it indicated by $C_{fw}$. Then the proposed model becomes

$$TFR = C_m \times C_c \times C_{fw} \times C_i \times TF \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

Where, the index of fetal wastage is defined as the ratio of the observed total fertility rate to the estimated total fertility rate with all fetal wastage which is (TFR+AFW), that is

$$C_{fw} = \frac{TFR}{(TFR + AFW)}$$

Where AFW equals the average number of birth averted per woman by the end of the reproductive years for all fetal wastage and which is estimated by

$$AFW = 0.4 \times (1 + u) \times TFW$$

$= 0.4 \times (1 + 0.612) \times 0.669$

$= 0.431$

Here, TFW is the total fetal wastage rate and AFW is average number of all fetal wastage per woman at the end of the reproductive years.

### 5.8.1 Estimated Proximate Variables and Implications

On the basis of original Bongaarts model given in equation (1), the estimated values of the measures and indices for different time points are presented in table 5.5 below:

The complement of the indices represents the proportionate reduction in fertility attributed to the fertility determinant. The lower the estimated value of the indices, the larger the fertility reducing effect. Thus, we have the value of $C_m$ in 1975 is 0.859, indicating that the proportion of women married reduces fertility by 14.1%, while the value of $C_m$ in 1989 is 0.785, in 1996-1997 is 0.781, in 19999-2000 is 0.776, in 2004 is 0.731, in 2007 is 0.7474 and in 2011 is 0.8142 indicating that the proportion of women married reduces fertility by 21.50%, 21.90%, 22.34%, 26.90%, 25.26% and 18.58% respectively. The value of $C_c$ in 1975 is 0.932 indicating that the index of contraception reduces fertility by 6.80%, while the value of $C_c$ in 1989 is 0.718, in 1996-1997 is 0.548, in 1999-2000 is 0.5294, in 2004 is 0.4537, in 2007 is 0.4757 and in 2011 is 0.4250 indicating that the index of contraception reduces fertility by 28.20%, 45.20%, 47.06%, 54.61%, 52.43% and 57.5% respectively.

The impact of contraception on reducing fertility varies from one time point to other, because of increase in use effectiveness of methods. In recent years, the use of contraception increased and as a result the average fertility reducing impact of contraception also increased. It is clear from table 5.5 that there is a downward trend in $C_{\mathbf{m}}$ and $C_{\mathbf{c}}$, and $C_i$ which shows reduction of fertility, the effect of proportion married, contraception and lactational infecundability are increasing.

**Table 5.5: Estimates of different reproductive measures and indices of fertility, Bangladesh 1975-2011.**

| Measures and indices | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 1983 | 1985 | 1989 | 1991 | 1993/ 1994 | 1996/ 1997 | 1999/ 2000 | 2004 | 2007 | 2011 |
| TFR(obs.) | 6.329 | 5.042 | 4.502 | 4.895 | 4.350 | 3.440 | 3.265 | 3.310 | 3.0 | 2.705 | 2.30 |
| CBR(obs.) | 47.0 | 43.0 | 39.0 | 31.0 | 31.6 | 29.1 | 29.4 | 30.2 | 28.7 | 26.1 | 22.6 |
| TM | 7.368 | 6.017 | 5.558 | 6.236 | 6.400 | 4.547 | 4.181 | 4.262 | 4.1 | 3.771 | 5.613 |
| TNM | 7.906 | 7.206 | 7.284 | 8.685 | 10.09 | 8.434 | 7.631 | 8.051 | 7.509 | 5.530 | 7.49 |
| TF (obs.) | 15.087 | 13.75 | 13.641 | 13.20 | 15.30 | 15.30 | 15.197 | 16.10 | 15.30 | 15.30 | 15.30 |
| $C_m$ | 0.859 | 0.838 | 0.810 | 0.785 | 0.680 | 0.756 | 0.781 | 0.7766 | 0.732 | 0.7474 | 0.814 |
| $C_c$ | 0.932 | 0.835 | 0.763 | 0.718 | 0.634 | 0.573 | 0.548 | 0.5294 | 0.4539 | 0.4757 | 0.4250 |
| $C_i$ | 0.524 | 0.524 | 0.534 | 0.66 | 0.660 | 0.66 | 0.502 | 0.500 | 0.735 | 0.616 | 0.6689 |
| $C_a$ | 1.000 | 1.000 | 1.000 | 0.983 | 0.960 | 0.976 | 0.967 | 0.950 | 0.925 | 0.910 | 0.881 |
| $C_{fw}$ | NA | NA | NA | 0.850 | 0.840 | 0.844 | 0.840 | 0.857 | 0.834 | 0.835 | 0.842 |
| TFR (OBM); $R^2$ =84% | 6.594 | 5.042 | 4.502 | 4.827 | 4.178 | 4.269 | 3.157 | 3.144 | 3.456 | 3.05 | 3.12 |
| TFR (RBM); $R^2$ =98% | NA | NA | NA | 4.174 | 3.657 | 3.692 | 2.743 | 2.836 | 3.116 | 2.797 | 2.981 |
| TF (OBM) | 14.483 | 13.738 | 13.642 | 13.411 | 15.934 | 12.33 | 15.697 | 16.97 | 13.274 | 13.593 | 11.274 |
| TF (RBM) | NA | NA | NA | 15.490 | 17.201 | 14.274 | 16.14 | 17.81 | 14.710 | 14.781 | 11.795 |
| Average use effectiveness | 0.817 | 0.800 | 0.867 | 0.848 | 0.849 | 0.886 | 0.851 | 0.811 | 0.870 | 0.870 | 0.870 |
| CBR | 49.0 | 43.0 | 39.0 | 30.5 | 30.3 | 36.1 | 28.5 | 28.6 | 29.9 | 26.4 | 27.5 |

**Sources**: BFS 1975, 1989; CPS 1981, 1991; Planning com., GOB 1981, 1985; VRS, BBS 1991;BDHS 1993-1994, 1996-1997, 1999-2000, 2004, 2007, 2011.Other than observed indicate author's calculation based on the above sources. Note- (NA: Not available).

Again the index lactational amenorrhea, $C_i$ in 2011 is 0.6689, indicates that the average estimated effect is stronger for the reduction in fertility 33.11%, compared with the value of the index $C_i$ in 2004 which is 0.7432 indicates that the average estimated effect is strong for the reduction in fertility 25.68% and the value of the index, $C_i$ in 2007 is 0.6161 indicates that the average estimated effect is more strong for the reduction in fertility 38.39% during the last decade.

The results presented in the above table 5.5 recommended that fetal wastage is also playing a positive role in fertility reduction from 1989 to till 2011. In the last twenty three years, it reduces about 16% fertility, which confirms the increase of fetal wastage in Bangladesh.

### 5.8.2 Estimation of Fertility Inhibiting Effect of Proximate Determinant

Table 5.6 exhibits the trend in the magnitude of the fertility-inhibiting effect being accounted for by each proximate variable of fertility for the period 1975-2011. Each estimated value of the columns expresses the inhibiting capacity of the corresponding determinant of fertility for that period. The results indicate that a total of 8.493 births in 1975 being inhibited: 1.487 births are due to effect of marriage variable; 0.685 is due to contraception and 6.321 are due to postpartum infecundability and there is no effect of fetal wastage. A total of 12.319 births in 2011 being inhibited; 1.55 births are due to effect of marriage variable; 6.445 births are due to contraception; 3.029 births are due to postpartum infecundability and 1.295 birth is due to fetal wastage.

**Table 5.6: Trends of Fertility Inhibiting Effect for proximate variable, Bangladesh 1975-2011.**

| Proximate Variables | Fertility Inhibiting Effect | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Births per women | | | | | | | |
| | BFS 1975 | CPS 1991 | BDHS 1993/'94 | BDHS 1996-1997 | BDHS 1999-2000 | BDHS 2004 | BDHS 2007 | BDHS 2011 |
| Marriage | 1.487 | 3.137 | 2.284 | 1.798 | 1.931 | 2.389 | 2.143 | 1.550 |
| Contraception | 0.685 | 3.707 | 4.547 | 4.375 | 4.859 | 6.048 | 5.467 | 6.445 |
| Postpartum Infecundability | 6.321 | 3.380 | 3.393 | 5.013 | 5.295 | 2.357 | 3.566 | 3.029 |
| Fetal wastage | 0.0 | 1.419 | 1.385 | 1.268 | 1.179 | 1.390 | 1.327 | 1.295 |
| [TF-TFR(esti.)] | 8.493 | 11.643 | 11.608 | 12.454 | 13.264 | 12.184 | 12.503 | 12.319 |

**Source:** Authors calculation based on tables 5.1 to 5.5;

Table 5.6 depicts that the contribution of marriage in reducing fertility increased to 2.389 births per-women in 2004 to decreased 0.839 births per-women in 2011, from a level of 1.487 births per-women in 1975. Also, the effect of contraceptive use increased to 6.048 births per-women in 2004 and increased to 6.445 births per-women in 2011, from a level of 0.685 births per-women in 1975. Oppositely, the effect of postpartum infecundability decreased during three and a half decades but perfectly we could not draw any clear conclusion about lactational infecundability during this period. Same directional results we have found between the period 2007 and 2011, except the effect of fetal wastage.

**Figure 5.6: Trends of Fertility Inhibiting Effect of four proximate variables, Bangladesh 1975-2011.**

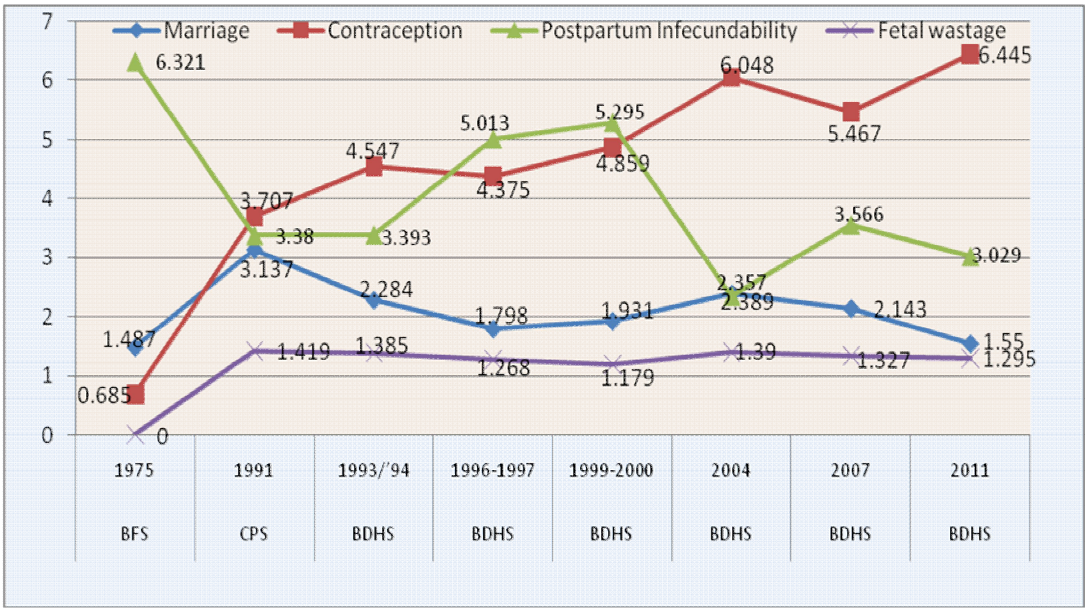


**Table 5.7: Distribution of Percentage Trends in the Magnitude of the Total Fertility Inhibiting Effect for each proximate variable, Bangladesh 1975-2011.**

| Proximate Variables | Percentage distribution of Fertility Inhibiting Effect | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BFS 1975 | CPS 1991 | BDHS 1993/'94 | BDHS 1996-1997 | BDHS 1999-2000 | BDHS 2004 | BDHS 2007 | BDHS 2011 |
| Marriage | 17.509 | 26.943 | 19.676 | 14.437 | 14.558 | 19.608 | 17.140 | 12.582 |
| Contraception | 8.065 | 31.839 | 39.171 | 35.129 | 36.633 | 49.639 | 43.726 | 52.318 |
| Postpartum Infecundability | 74.426 | 29.030 | 29.230 | 40.252 | 39.920 | 19.345 | 28.521 | 24.588 |
| Fetal wastage | 0.0 | 12.188 | 11.931 | 10.181 | 8.889 | 11.408 | 10.613 | 10.512 |
| [TF-TFR(esti.)] | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

**Source:** Authors calculation based on table 5.6

Table 5.7 suggests that, of a total 100% births have been constrained in the period 1975 due to four major proximate determinants. Marriage pattern inhibited 17.509% births, contraception 8.065%, lactational/postpartum infecundability 74.426% and no inhibition of fetal wastage births. In 1991, marriage pattern, contraception, lactational infecundability and fetal wastage inhibited 26.943%, 31.839%, 29.03% and 12.2% births respectively. Similarly, in 2011, a total of 100% births: marriage pattern, contraception, lactational infecundability and fetal wastage inhibited 12.582%, 52.318%, 24.588% and 10.512% births respectively.

The analyses suggest that lactational infecundability have played a significant role in reducing fertility before the period 2004. From 1991, family planning methods occupied its sovereignty and have been emerged as a key factor of fertility change in Bangladesh. The results also indicate that, due to successive reduction of postpartum amenorrhea, the fertility reducing effect of lactational infecundability constantly decreasing, it is hopeful that the value of lactational infecundability increased in 2007 and after it is decreased 4% in 2011. The effect of marriage pattern is almost constant meanwhile fetal wastage showing better performance (not culturally, because it might break down family formation and it is harmful for women's ovulatory function) in reducing fertility.

### 5.8.3 Decomposition of Changes in Fertility and Contraception of Proximate Variables

Revised Bongaarts' model (RBM) given by the equation (11) of 5.2, can easily be turned to a decomposition equation that allows the quantification of the contribution made by each of the four intermediate fertility variables to an observed change in fertility between two time points 0 and t, the basic equation is as follows:

$$\frac{TFR(t)}{TFR(0)} = \frac{C_m(t)}{C_m(0)} \times \frac{C_c(t)}{C_c(0)} \times \frac{C_{fw}(t)}{C_{fw}(0)} \times \frac{C_i(t)}{C_i(0)} \times \frac{TF(t)}{TF(0)} \quad \text{------------------------} \quad \textbf{(12)}$$

If the two points of times are 1975 and 2011, using equation (12) for two times 1975 and 2011, we can show that:

$$\frac{TFR(2011)}{TFR(1975)} = \frac{C_m(2011)}{C_m(1975)} \times \frac{C_c(2011)}{C_c(1975)} \times \frac{C_{fw}(2011)}{C_{fw}(1975)} \times \frac{C_i(2011)}{C_i(1975)} \times \frac{TF(2011)}{TF(1975)} \quad \text{----} \quad (13)$$

Defining again,

$$P_f = \frac{TFR(2011)}{TFR(1975)} - 1$$

= Proportional change in TFR between 1975 and 2011.

$$P_m = \frac{C_m(2011)}{C_m(1975)} - 1$$

= Proportional change in TFR due to a change in the index of marriage.

$$P_c = \frac{C_c(2011)}{C_c(1975)} - 1$$

= Proportional change in TFR due to a change in the index of contraception.

$$P_{fw} = \frac{C_{fw}(2011)}{C_{fw}(1975)} - 1$$

= Proportional change in TFR due to a change in the index of fetal wastage.

$$P_i = \frac{C_i(2011)}{C_i(1975)} - 1$$

= Proportional change in TFR due to a change in the lactational infecundability.

$$P_r = \frac{TF(2011)}{TF(1975)} - 1$$

= Proportional change in TFR due to a change in the remaining proximate determinants: natural fecundability, spontaneous intrauterine mortality and permanent sterility.

Equation (1) can be rearranged as –

$P_f = P_m + P_c + P_{fw} + P_i + P_r + I$ ------------------------------------------------------ (14)

Here, I represent an interaction factor. This equation simply states that a given proportional change in the TFR between 1975 and 2011equal to the sum of the proportional fertility changes due to the different intermediate fertility variables plus an interaction term. It is simply estimated by substituting the sum of $P_m$, $P_c$, $P_{fw}$, $P_i$ and $P_r$ from $P_f$. Equation (14) can now easily be turned into a decomposition equation for the absolute decline in TFR (2011) viz. TFR (2011)- TFR (1975) multiplying TFR (1975). The decomposition procedure for the TFR can easily be extended also to allow the decompositions of a change in the crude birth rate (CBR). The CBR is linked to its proximate determinants by the following equation-

CBR = S × $C_m$× $C_c$× $C_{fw}$× $C_i$× TF --------------------------------------------------- (15)

Where S is an age-sex composition term calculated by –

$$S = \frac{CBR}{TFR} - 1$$

Defining again,

$$P_b = \frac{CBR(2011)}{CBR(1975)} - 1$$

= Proportional change in the CBR between 1975 and 2011.

$$P_s = \frac{S(2011)}{S(1975)} - 1$$

= Proportional change in the CBR due to a change in the age-sex composition.

Then it becomes

$$P_b = P_s + P_m + P_c + P_{fw} + P_i + P_r + I \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (16)$$

Where $P_m$, $P_c$, $P_{fw}$, $P_i$, and $P_r$ are the values obtained earlier.

Table 5.8 in the next page represents the measures of the contribution performed by each of the proximate factor to the observed change in fertility among 1975-2011 at different point in time.

Table 5.8 represents the decomposition of change of all indices in TFR between 1975, 2004; 1975, 2007 and 1975, 2011. It indicates that TFR has declined about 52.59% or absolutely 3.33 births from 6.329 births in 1975 to 3 births in 2004; 57.34% or absolutely 3.63 births from 6.329 births in 1975 to 2.7 births in 2007 and 63.83% or absolutely 4.03 births from 6.329 births in 1975 to 2.3 births in 2011.

It also indicates that the decomposition of this decline in TFR between 1975 to 2004 has nearly 15% decline due to increase in the proportion of women married, about 48.68% decline due to an increase in contraceptive use and effectiveness but a dramatically change about approximately 42% increase due to decrease of the duration of lactational infecundability, 7.55% decline due to increase the use of fetal wastage. The remaining proximate determinants together contribute about 1.41% increases and by interaction factor decrease 24.75% in TFR.

Again, the decomposition of this decline in TFR between 1975, 2007 has been nearly 13% decline due to decrease in the proportion of women married, about 48.96% decline due to an increase in contraceptive use and effectiveness, a change about 17.58% increase due to decrease of the duration of lactational infecundability. The remaining proximate determinants together contribute about 1.41% increases and by interaction factors decreases 5.38% in TFR.

And the decomposition of this decline in TFR between 1975, 2011 has been nearly 5.22% decline due to decrease in the proportion of women married, about 38.30% decline due to an increase in contraceptive use and effectiveness, a change about 27.65% increase due to decrease of the duration of lactational infecundability. The remaining proximate determinants together contribute about 1.41% increases and by interaction factors decreases 21.37% in TFR.

**Table 5.8: Decomposition of the change in TFR in Bangladesh: 1975 to 2011.**

| Changing Indices | Percentage of change in TFR | | | Distribution of percentage change in TFR | | | Absolute change in TFR | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1975 to 2004 | 1975 to 2007 | 1975 to 2011 | 1975 to 2004 | 1975 to 2007 | 1975 to 2011 | 1975 to 2004 | 1975 to 2007 | 1975 to 2011 |
| $P_m$ | -14.85 | -12.99 | -5.22 | -28.24 | -22.65 | -8.18 | -0.94 | -0.82 | -0.33 |
| $P_c$ | -48.68 | -48.96 | -54.40 | -92.57 | -85.39 | -85.23 | -3.08 | -3.10 | -3.44 |
| $P_i$ | 41.83 | 17.58 | 27.65 | 79.54 | 30.66 | 43.32 | 2.65 | 1.11 | 1.75 |
| $P_{fw}$ | -7.55 | -9.00 | -11.90 | -14.36 | -15.70 | -18.64 | -0.48 | -0.57 | -0.75 |
| $P_r$ | 1.41 | 1.41 | 1.41 | 2.68 | 2.46 | 2.21 | 0.09 | 0.09 | 0.09 |
| I | -24.75 | -5.38 | -21.37 | -47.06 | -9.38 | -33.50 | -1.57 | -0.34 | -1.35 |
| $P_f$ | -52.59 | -57.34 | -63.83 | -100 | -100 | -100 | -3.33 | -3.63 | -4.03 |

**Source:** Authors calculation based on table 5.5 and using equation (14).

The decomposition results are standardized to add to 100%. Furthermore table 5.8, indicates that during 1975 to 2004, it has declined by 3.33 births per-women of which 0.94 birth declined by proportion married, 3.08 births declined due to contraceptive use, 2.65 births increased due to decreased of lactational infecundability, 0.48 birth decreased by increase use of fetal wastage, and the interaction factor has decreased 1.57 births per-women.

Again during 1975 to 2007, it has declined by 3.63 births per-women of which 0.82 birth has declined by proportion married, 3.10 births decline due to contraceptive use, 1.11

birth increased due to lactational infecundability which indicate that a negative change to lactation within 3 years period; that is women reduces to lactate their children recently, it negatively affect to reduce fertility; 0.57 birth decreased by increase use of fetal wastage, 0.09 births increased by other proximate determinants, which is negligible; and 0.34 birth declined by the interaction factor.

And during 1975 to 2011, it has declined by 4.03 births per-women of which 0.33 birth has declined by proportion married, 3.44 births decline due to contraceptive use, 1.75 births increased due to lactational infecundability which indicate that a negative change to lactation within 4 years period; that is women reduces to lactate their children recently, it negatively affect to reduce fertility; 0.75 birth decreased by increase use of fetal wastage, 0.09 births increased by other proximate determinants, which is negligible; and 1.35 births declined by the interaction factor.

It is clear from Table 5.8 that a decline in fertility by proportion married made significant contribution to the overall fertility reduction, and that the contraception use has the highest impact on reducing fertility of total reduction which may be attributed to the increase use of contraception from 7.7% in 1975 to 58.1% in 2004, 55.8% in 2007 and 61.2% in 2011. It is notable that the contribution of fetal wastage in fertility decline has increased gradually and the contribution of marriage pattern decreasing gradually; meanwhile lactational infecundability is playing a negative role in fertility reduction after the year 1989, it is probably due to out of several reasons. A major's reason is countless women engaged as out of house workforce.

It is clear from table 5.9, that the change in CBR a total 38.94% (or absolutely 18.30 births) decline from 47 births on in 1975 to 28.7 births in 2004 by different intermediate fertility variables and age-sex composition has 33.31% (absolutely 15.65 births) positive contribution that in decreasing of CBR, by the proportion of women married about 14.85% (6.98 births) decrease due to increase in the proportion of women married, 48.68% (absolutely 22.88 births) decline due to an increase in contraceptive use and effectiveness but a dramatically change 41.83% (absolutely 19.66 births) increase due to decrease of the duration of lactational infecundability in this period, 7.55% (absolutely 3.55 births) decline due to increase the use of fetal wastage. The remaining proximate determinants together contribute about 1.41% (absolutely very poor contribution 0.66 birth) increases and by interaction factor decrease 44.40% (absolutely 20.87 births) in CBR.

Again the change in CBR a total 44.50% (or absolutely 20.9 births) decline from 47 births in 1975 to 26.1 births in 2007 by different intermediate fertility variables and age-sex composition has 34.86% (absolutely 16.37 births) positive contribution that in decreasing of CBR, by the proportion of women married about 12.99% ( absolutely 6.1 births) decrease due to increase in the proportion of women married, 48.96% (absolutely 23.05 births) decline due to an increase in contraceptive use and effectiveness but a change 17.58% (absolutely 8.26 births) increase due to decrease of the duration of lactational infecundability, 9% (absolutely 4.23 births) decline due to increase the use of fetal wastage and by interaction factor decrease 27.4% (absolutely 12.9 births) in CBR.

**Table 5.9: Decomposition of percentage changes in CBR by different measures and indices, Bangladesh 1975 to 2011.**

| Changing Indices | Percentage of change in CBR | | | Distribution of percentage change in CBR | | | Absolute change in CBR | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1975 to 2004 | 1975 to 2007 | 1975 to 2011 | 1975 to 2004 | 1975 to 2007 | 1975 to 2011 | 1975 to 2004 | 1975 to 2007 | 1975 to 2011 |
| $P_s$ | 33.31 | 34.86 | 37.35 | 85.54 | 78.34 | 71.95 | 15.65 | 16.37 | 17.56 |
| $P_m$ | -14.85 | -12.99 | -5.22 | -38.14 | -29.19 | -10.07 | -6.98 | -6.10 | -2.46 |
| $P_c$ | -48.68 | -48.96 | -54.40 | -125.01 | -110.27 | -104.80 | -22.88 | -23.05 | -25.57 |
| $P_i$ | 41.83 | 17.58 | 27.65 | 107.42 | 39.51 | 53.27 | 19.67 | 8.26 | 13.0 |
| $P_{fw}$ | -7.55 | -9.00 | -11.90 | -19.39 | -20.22 | -22.92 | -3.55 | -4.23 | -5.59 |
| $P_r$ | 1.41 | 1.41 | 1.41 | 3.62 | 3.17 | 2.72 | 0.66 | 0.66 | 0.66 |
| I | -44.40 | -27.40 | -46.80 | -114.02 | -61.71 | -90.16 | -20.87 | -12.90 | -21.99 |
| $P_b$ | -38.94 | -44.50 | -51.91 | -100 | -100 | -100 | -18.30 | -20.90 | -24.40 |

Source: Authors calculation based on table 5.5 and using equation (16)

**Note that, all births are per 1000 population for crude birth rate (CBR).**

Similarly, the change in CBR a total 51.91% (or absolutely 24.4 births) decline from 47 births in 1975 to 22.6 births in 2011 by different intermediate fertility variables and age-sex composition has 37.35% (absolutely 17.56 births) positive contribution that in decreasing of CBR, by the proportion of women married about 5.22% (2.46 births) decrease due to increase in the proportion of women married, 54.4% (absolutely 25.57 births) decline due to an increase in contraceptive use and effectiveness but upward change 27.65% (absolutely 13 births) increase due to decrease of the duration of lactational infecundability, 11.9% (absolutely 5.6 births) decline due to increase the use of fetal wastage and by interaction factor decrease 46.80% (absolutely 21.99 births) in CBR.

In fertility alteration in Bangladesh, the roles of other intermediate variables are not obviously negligible. The second broad column of table 5.8 and table 5.9 indicates as well as the standardization of adding up to 100%. From above analyses, it is clear that fertility decline witnessed in our country is mainly for the momentous increases of contraceptive uses.

### 5.8.4 Inhibiting Effect of Marriage on Fertility

The approximate effect of marriage pattern on fertility can be measured by adopting Bongaarts model (Bongaarts, 1982). The model assumes that women who are not currently married would experience the same fertility as their married counterparts, if they themselves were married as shown in Table 5.10, which include the relevant data for 1975, 1981, 1989, 1991, 1996-1997, 1999-2000, 2004, 2007 and 2011. Column indicated by (1), gives the all women age-specific fertility rates (ASFR), averaged for the five-year period prior to the survey from 1975-1991 and for the three-year period preceding the survey from 1996-2011. By multiplying these rates by the reciprocal of the proportions ever-married at the time of survey, an estimate is formed of hypothetical fertility in the absence of any postponement of marriage beyond age 15, which is shown in column (3). Column (4) shows the proportion that is currently married among those who ever-married. The reciprocal of these proportions multiplied by the rates in column (3) gives an estimate of hypothetical fertility in the absence of any postponement of marriage beyond age 15 and the absence of divorced and widowed shown in column (5). In column (6), the reduction in fertility by marriage has shown.

**Table 5.10: Estimation of the effect of marriage pattern on fertility.**

| Age | ASFR (1) | Proportion ever married (2) | ASEMFR $(3)=\frac{(1)}{(2)}$ | Prop. Currently married among ever married (4) | ASMFR $(5)=\frac{(3)}{(4)}$ | $(6)=1.0-\frac{(1)}{(5)}$ |
|---|---|---|---|---|---|---|
| | | | 1975 | | | |
| 15-19 | .1090 | .7020 | .1553 | .9231 | .1682 | .3520 |
| 20-24 | .2886 | .9540 | .3025 | .9466 | .3196 | .0970 |
| 25-29 | .2911 | .9900 | .2940 | .9303 | .3160 | .0788 |
| 30-34 | .2502 | .9980 | .2507 | .9097 | .2756 | .0922 |
| 35-39 | .1848 | .9960 | .1855 | .8468 | .2191 | .1565 |
| 40-44 | .1074 | .9980 | .1076 | .7888 | .1364 | .2126 |
| 45-49 | .0347 | 1.0000 | .0347 | .7105 | .0488 | .2889 |
| Total | 1.2658 | | 1.3304 | | 1.4837 | .1469 |
| 5×Total | 6.3290 | | 6.6515 | | 7.4185 | |
| Effect | | | .3225 | | .7670 | |
| | | | 1981 | | | |
| 15-19 | .1330 | .6870 | .1936 | .9518 | .2034 | .3461 |
| 20-24 | .2755 | .9490 | .2903 | .9577 | .3031 | .0911 |
| 25-29 | .2384 | .9870 | .2415 | .9560 | .2526 | .0562 |
| 30-34 | .1667 | .9900 | .1684 | .9379 | .1796 | .0718 |
| 35-39 | .1296 | .9960 | .1301 | .9015 | .1443 | .1013 |
| 40-44 | .0465 | .9930 | .0468 | .8245 | .0568 | .1813 |
| 45-49 | .0185 | .9970 | .0186 | .7471 | .0249 | .2570 |
| Total | 1.0082 | | 1.0893 | | 1.1647 | .1344 |
| 5×Total | 5.0410 | | 5.4465 | | 5.8235 | |
| Effect | | | .4055 | | .3770 | |
| | | | 1989 | | | |
| 15-19 | .1422 | .5095 | .2791 | .9439 | .2957 | .5191 |
| 20-24 | .2599 | .8797 | .2954 | .9415 | .3138 | .1718 |
| 25-29 | .2254 | .9771 | .2307 | .9362 | .2464 | .0852 |
| 30-34 | .1642 | .9968 | .1647. | .9319 | .1767 | .0707 |
| 35-39 | .1141 | .9985 | .1143 | .9002 | .1270 | .1016 |
| 40-44 | .0555 | .9882 | .0556 | .8428 | .0660 | .1591 |
| 45-49 | .0176 | .9989 | .0176 | .8070 | .0218 | .1927 |
| Total | .9789 | | 1.1574 | | 1.2474 | .2152 |
| 5×Total | 4.8945 | | 5.7870 | | 6.2370 | |
| Effect | | | .8925 | | .4500 | |

**Table 5.11: Estimation of the effect of marriage pattern on fertility.**

| Age | ASFR (1) | Proportion ever married (2) | ASEMFR $(3)=\frac{(1)}{(2)}$ | Prop. Currently married among ever married (4) | ASMFR $(5)=\frac{(3)}{(4)}$ | $(6)=1.0-\frac{(1)}{(5)}$ |
|---|---|---|---|---|---|---|
| | | | 1991 | | | |
| 15-19 | .1910 | .5330 | .3583 | .9586 | .3738 | .4890 |
| 20-24 | .2350 | .8770 | .2680 | .9422 | .2844 | .1737 |
| 25-29 | .2030 | .9720 | .2088 | .9489 | .2200 | .0773 |
| 30-34 | .1500 | .9950 | .1508 | .9343 | .1614 | .0706 |
| 35-39 | .0890 | .9990 | .0891 | .9048 | .0985 | .0965 |
| 40-44 | .0500 | .9970 | .0502 | .8581 | .0585 | .1453 |
| 45-49 | .0100 | 1.0000 | .0100 | .7746 | .0129 | .2248 |
| Total | .9280 | | 1.1352 | | 1.2095 | .2327 |
| 5×Total | 4.6400 | | 5.6760 | | 6.0475 | |
| Effect | | | 1.0360 | | .3715 | |
| | | | 1996-1997 | | | |
| 15-19 | .1470 | .5020 | .2930 | .9620 | .3050 | .5180 |
| 20-24 | .1920 | .8280 | .2320 | .9580 | .2420 | .2070 |
| 25-29 | .1500 | .9650 | .1550 | .9520 | .1630 | .0790 |
| 30-34 | .0960 | .9950 | .0960 | .9250 | .1040 | .0760 |
| 35-39 | .0440 | .9990 | .0440 | .9140 | .0480 | .0830 |
| 40-44 | .0180 | 1.0000 | .0180 | .8600 | .0210 | .1430 |
| 45-49 | .0060 | 1.0000 | .0060 | .7900 | .0080 | .2500 |
| Total | .6530 | | .8440 | | .8910 | .2670 |
| 5×Total | 3.2650 | | 4.2200 | | 4.4550 | |
| Effect | | | .9550 | | .2350 | |
| | | | 1999-2000 | | | |
| 15-19 | .1440 | .4810 | .2994 | .9688 | .3090 | .5340 |
| 20-24 | .1880 | .8150 | .2307 | .9546 | .2417 | .2222 |
| 25-29 | .1650 | .9580 | .1722 | .9509 | .1811 | .0889 |
| 30-34 | .0990 | .9990 | .0991 | .9399 | .1054 | .0208 |
| 35-39 | .0440 | .9980 | .0441 | .8788 | .0502 | .1235 |
| 40-44 | .0180 | .9990 | .0182 | .8428 | .0216 | .1667 |
| 45-49 | .0030 | 1.0000 | .0030 | .8230 | .0036 | .1667 |
| Total | .6610 | | .8667 | | .9128 | .2758 |
| 5×Total | 3.3050 | | 4.3335 | | 4.5638 | |
| Effect | | | 1.0285 | | .2303 | |

**Table 5.12: Estimation of the effect of marriage pattern on fertility.**

| Age | ASFR (1) | Proportion ever married (2) | ASEMFR $(3)=\frac{(1)}{(2)}$ | Prop. Currently married among ever married (4) | ASMFR $(5)=\frac{(3)}{(4)}$ | $(6)=1.0-\frac{(1)}{(5)}$ |
|---|---|---|---|---|---|---|
| 2004 | | | | | | |
| 15-19 | .1350 | .4790 | .2810 | .4600 | .6100 | .7787 |
| 20-24 | .1920 | .8480 | 2270 | .8170 | .2787 | .3111 |
| 25-29 | .1350 | .9580 | .1410 | .9210 | .1530 | .1176 |
| 30-34 | .0830 | .9880 | .0840 | .9270 | .0900 | .0778 |
| 35-39 | .0410 | .9960 | .0410 | .8940 | .0450 | .0889 |
| 40-44 | .0160 | .9970 | .0160 | .8440 | .0180 | .1111 |
| 45-49 | .0030 | 1.0000 | .0030 | .8160 | .0043 | .2500 |
| Total | .6050 | | .7930 | | 1.199 | .4954 |
| 5×Total | 3.0250 | | 3.9650 | | 5.9950 | |
| Effect | | | .9400 | | 2.0300 | |
| 2007 | | | | | | |
| 15-19 | 0.1260 | 0.5435 | 0.2318 | 0.4557 | 0.5086 | 0.7523 |
| 20-24 | 0.1730 | 0.7335 | 0.2358 | 0.8254 | 0.2856 | 0.3942 |
| 25-29 | 0.1270 | 0.8193 | 0.1550 | 0.9212 | 0.1682 | 0.2449 |
| 30-34 | 0.0700 | 0.8545 | 0.0819 | 0.9287 | 0.0882 | 0.2063 |
| 35-39 | 0.0340 | 0.8989 | 0.0378 | 0.9135 | 0.0414 | 0.1787 |
| 40-44 | 0.0100 | 0.9205 | 0.0109 | 0.8552 | 0.0123 | 0.2156 |
| 45-49 | 0.0010 | 1.0000 | 0.0010 | 0.8044 | 0.0012 | 0.1667 |
| Total | 0.5410 | | 0.7542 | | 1.1060 | 0.5110 |
| 5×Total | 2.7050 | | 3.7710 | | 5.5300 | |
| Effect | | | 1.0660 | | 1.7590 | |
| 2011 | | | | | | |
| 15-19 | 0.1180 | 0.5148 | 0.2292 | 0.4471 | 0.5126 | 0.7698 |
| 20-24 | 0.1530 | 0.7049 | 0.2171 | 0.8368 | 0.2594 | 0.4102 |
| 25-29 | 0.1070 | 0.8154 | 0.5771 | 0.9317 | 0.6194 | 0.8273 |
| 30-34 | 0.0570 | 0.8654 | 0.0659 | 0.9427 | 0.0699 | 0.1845 |
| 35-39 | 0.0210 | 0.8863 | 0.0237 | 0.9192 | 0.0258 | 0.1860 |
| 40-44 | 0.0060 | 0.9123 | 0.0066 | 0.8976 | 0.0074 | 0.1892 |
| 45-49 | 0.0030 | 1.0000 | 0.0030 | 0.8229 | 0.0036 | 0.1667 |
| Total | 0.4650 | | 1.1226 | | 1.4981 | 0.6896 |
| 5×Total | 2.325 | | 5.6130 | | 7.4905 | |
| Effect | | | 3.2880 | | 1.8775 | |

**Source:** BFS 1975, 1989; BCPS 1981, 1991; BDHS 1996-1997, 1999-2000, 2004, 2007, 2011

In absolute terms, postponement of marriage in 1975, 1981, 1989 and 1991, 1996-1997, 1999-2000, 2004, 2007 and 2011 is estimated to reduce fertility by .3225, .4055, .8925, 1.036, .9550, 1.0285, .9400, 1.066 and 3.288 births respectively. Again widowed and divorced further reduce fertility by .7670, .3770, .45, .3715, .235, .2303, 2.03, 1.759 and 1.8775 births respectively in these years. The table 5.10 also shows the effect of postponement of marriage on fertility by age. At the age 15-19, the reduction of fertility by postponement of marriage is being .352, 3461, .5191, .489, .518, .534, 0.7787, 0.7523 and 0.7698 births in 1975, 1981, 1989, 1991, 1996-1997, 1999-2000, 2004, 2007 and 2011 respectively. After the age 15-19, the rate has been decreasing up to the age 25-29 in 1975, up to the ages 25-29 in 1981, up to the ages 30-34 in 1989, up to the ages 30-34 in 1991, up to the ages 30-34 in 1996-1997, up to the ages 30-34 in 1999-2000, 2004, 2007 and up to the ages 20-24 in 2011 and sudden increase up to ages 25-29 only for the year 2011. After that the rates are found to be gradually increased up to the marriageable ages.

The effect of postponement of marriage on fertility in 2004 is 0.4954, in 2007 is 0.511 and in 2011 is 0.6896. The effect of postponement of marriage on fertility in 2011 is higher than any other point of time. It simply implies that the age at marriage is higher and also the fertility is lower in 2011, than in the other study periods. This also indicates that the effect of marriage on fertility is higher in recent times.

Again divorced and widowhood have a major contribution on fertility reduction. This indicates that the contribution has been decreasing from 1989 to 1999-2000 but increasing clearly in recent periods. This implies that the amount of divorced and widowhood has increased in recent times.

The Table 5.10 also indicates the reduction in fertility due to the effect of marriage pattern by 14.69%, 13.44%, 21.52%, 23.27%, 26.70%, 27.58%, 49.54%, 51.1% and 68.96% respectively in the years of 1975, 1981, 1989, 1991, 1996-1997, 1999-2000, 2004, 2007 and 2011. Thus the fertility reducing effect of marriage pattern has increased over time. This is because the impact of changing marriage patterns 1975 to 2011 might have caused fertility to decrease. For example the mean age at marriage (MAM) for females in 1975 was 16.4 years, while in 2004, the MAM is 20.4 years. During the period 1975 to 2004, the MAM have increased about four years for females.

A comparison of the 2011 results with findings from prior surveys confirms that the median age at first marriage for women in Bangladesh continues to increase. The median age at marriage among women age 20-49 has increased by one and a half years over the past decade, from 14.2 years in 1996-1997 (Mitra *et al.*, 1997) to the current figure of 15.8 years. On the other hand, comparing the results for men across surveys indicates that the median age at marriage among men has remained relatively stable since 2004 when the median age at marriage for men age 25-59 was 24.2 years (NIPORT *et al.*, 2005).

The legal age of marriage in Bangladesh for women is 18 years, but a large proportion of marriages still take place before the legal age. The 2011found that 65% of women age 20-24 were married before age 18. Over the past two decades, the proportion of women marrying before the legal age has decreased from 73% in 1989 to 65% in 2011.

Whatever be the causes of changing marriage patterns, their net effect have not been large except widowed and divorced. The Table 5.10 shows that a downward effect on fertility at younger ages caused by rising age at marriage have been balanced by an upwards effect at older ages caused by decreasing widowhood and divorce except the time period 1999-2000 to 2011, since in these period widowhood and divorce increased clearly before the past two and a half decades.

## 5.9 Conclusion

Application of Revised Bongaarts model (RBM) clearly indicates that there is a downward trend in all the proximate indices. Between 1975 and 1999-2000, the amount of decrement of total fertility rate (TFR) is about 48% and it is about 53% between 1975 and 2004 and the amount of decrement of total fertility is more than 60% between 1975 and 2011. This is primarily caused by an increase in the use and effectiveness of the contraceptive methods.

The inconsistencies, which have been observed, are owing to mainly the lack of exact information about fetal wastage. Several other factors may have been associated with these inconsistencies. One of the important specification errors for use of the model is the consideration of the total fecundity (TF), which have been assumed as 15.30 as suggested by Bongaarts (1978) on the basis of mainly the historical European experiences (Islam and others, 2004). Bangladesh is a developing country having poor nourishment, low life standard, poor health status, recurrent spousal separation, socio-cultural and religious lack of knowledge's on sex freedom and climate hazards etc. Hence, it is considerable that the value of TF might be lower than 15.3 in Bangladesh. So, due to low average value of fecundity for Bangladeshi female, this ultimately affects the TF value.

The analysis suggests that, though fertility conversion in Bangladesh sharply declined up to the period 1991; but thereafter TFR did not change as we might expect. This investigation is evidently supported by the estimated values of each of the index of the model. Thus, the credit of such decline ultimately goes firstly to the extended uses of contraception. The contraception would have played its more adequate role as the major fertility inhibiting factor, if the users would prefer perfect modern contraceptive methods than traditional methods and used continuously and uniformly in rural and urban areas in Bangladesh.

Again, in the analyses of inhibiting effect of marriage on fertility; it is observed that the effect of marriage on fertility is higher in recent times. The divorced and widowhood have also significant contribution on fertility reduction. It is clear that whatever the causes of changing marriage patterns, their net effect have not been large enough. A downward effect on fertility at younger ages has not been large. A downward effect on fertility at younger ages caused by rising age at first marriage have been balanced by an upward effect at older ages caused by decreasing widowhood and divorce from 1975-2000 and increasing widowhood and divorced from 1999/2000-2011 time period.

According to our analysis, lactational infecundability has placed in the second highest fertility inhibiting effect factor but its fertility reducing helpfulness remains almost stable for the whole of our study period. Postpartum infecundability is concerned with breastfeeding practices. Although, there has been a universal and prolonged tradition in duration of breastfeeding in Bangladesh, but it is observed a trend toward shorter duration of breastfeeding practice since 1993/'94 (Mitra *et al.*, may 2005), this resulted a declining trend in the length of amenorrhea. Hence, this may be happening due to enhanced un-amicable modernization, lack of perfect knowledge and increased abuse of supplementary untimed baby food, mother's health status and prominent uses of family planning methods.

Although fetal wastage has been emerged as a fertility reducing factor over the world, also in Bangladesh; but its actual contribution could not be estimated due to gap of authentic statistical information from the survey data and reports. However, several studies and non-government sources, such as private clinic and hospitals records etc., reveal that a huge of some part fetal wastage are done under the name of menstrual regulation which are observed owing to legal and social constraints.

Finally, the discussion leads to the conclusion that contraceptive uses have been increased and being the most important fertility inhibiting factor but its use-effectiveness has remained about a stagnant point since 1996/'97. As a result its impact on overall fertility decline is not large as its capability in fertility reduction.

From the point of view of religious, cultural and social norms in Bangladesh, a rapid support in the age at first marriage and age at first birth especially for female population appear consequently clear. Although fetal wastage have been emerged as an indispensible factor in fertility decline in Bangladesh, but obviously policy should not be by any means to relieve abortion except for complicated pregnant mother.

Thus for further fertility decline in Bangladesh policy implications can be drawn from the above analyses may be as follows:

1. Awareness should be made-up to increase the use of modern contraceptive methods, which have better use-effectiveness to avoid unwanted pregnancy as well as birth and to build up a standard happy family.
2. Enhance family planning programs throughout the country to inspire couples and make them understand about worthwhile effects of contraceptive methods that are not currently using family planning methods.
3. Make available information regarding bad effect of teenage pregnancy through different electronic and print media and to campaign for further increase the age at first birth consulting with partner especially in rural areas.
4. Find out quality and quantity method mix that meet up the demand of couples.
5. Provide information among couples, low costing and greater benefit for the mother and the child for a long term exclusive breastfeeding.

# Chapter Six

# PATH MODEL ANALYSIS AND BINARY LOGISTIC REGRESSION ANALYSIS

## 6.1 Introduction

It has been shown in the previous chapters that there are influences of demographic, socio-demographic, socio-economic and cultural factors on children ever born or fertility. It is unlikely that the relationship among many of these variables and children ever born or fertility and contraceptive use are straightforward. As many of these variables are interrelated, so we need to ascertain the variables, which have direct influences and which have indirect influences on fertility that means influences on children ever born and contraceptive use matter.

For the purpose of examining the relative importance of all the variables simultaneously and by partly, we need to apply some multivariate techniques. Two important multivariate techniques: Multiple Regression analysis and Discriminant Analysis are difficult to apply when the dependent variables are categorical (dichotomous or polychotomous). In an analysis, dealing with dichotomous dependent variables, it is better to fit Binary Logistic Regression model, and on the other hand for many other continuous variables, we would like to use another well-recognize multivariate technique namely Path Analysis.

The specific nature of the determinants of fertility is difficult and complex. While fertility behavior influences population growth, which has consequences towards pressure on resources, employment situation, health and other social facilities and savings and investment, in turn, such consequences have great bearing on the socio-demographic, socio-economic variables that affect reproductive behavior. Socio-demographic and socio-economic factors are in turn affected by the demographic factors. These factors directly and indirectly affect the interaction processes. Socio-demographic variables directly influence fertility and socio-economic variables cannot directly influence fertility but must act on fertility through their effect on one or more of the intervening variables.

The interrelationships among socio-demographic, demographic and socio-economic variables are a new phenomenon. Davis holds that the demographic changes are both reflective and behavioral (Chou, C. P. & Bentler, P. M. 1995; Duncan, *et al.*, 1994, 1997, 1999; Bloom, Wypij, & das Gupta, 2001; Saleem & Bobak, 2005)). Although numerous conceptual frameworks have been put forward in order to specify or analyze the factors determining the levels and trends of fertility (Bongaarts, 1978 and Bongaarts' and potter, 1982; Bongaarts & Bruce, 1995; Hemmings, Wubshet, Lemma, Antoni, & Cherinet, 2008; Mesfin, 2002). ), few analyzes have focused on the specific mechanisms through which socio-economic factors affect fertility (Bongaarts, 1978, 1982; Hemmings *et al.*, 2008, p.53).). One of the difficulties in such an analysis is that the independent variables affecting fertility are often inter-correlated to such an extent that if statistical control were introduced for one of the variables, the influence of the other variable, on fertility would be substantially altered.

The main objectives of this chapter are to examine the direct, indirect and interaction effects of some selected socio-demographic, demographic and socio-economic factors on fertility and contraceptive use.

## 6.2 Variables included in the Analysis

In the 2011 BDHS a number of demographic, socio-demographic, socio-economic and cultural variables are available. Among them, eleven variables have been taken in order to examine a correlation matrix and to construct a path model. Table 6.1 gives a detailed description of the variables. Women's (wife's) and husband's (partner's) education, de facto place of residence and wealth index are considered as the socio-economic and background variables, while the demographic as well as socio-demographic variables regarded in this study are women current age, women age at first marriage, women age at first birth, number of dead sons (index of mortality part), Women currently working as house wife or other works and ever use contraception. Finally, the number of children ever born to each woman is used here as a measure of fertility. It has been assumed here that these selected variables affect reproductive behavior of women according to the hypothetical framework of Bongaarts and others (1984; Heeks, 2008; Hogan *et al.*, 1999).

**Table 6.1: Description of Variables Considered for Correlation and Path analysis.**

| Variable Name | Variable Level | Causal Order | Type of Variable | Codes and Categories |
|---|---|---|---|---|
| De facto place of Residence (DPR) | $X_1$ | 1 | Categorical | 1= City , 2= Town , 3= Rural area |
| Women current age (WCA) | $X_2$ | 2 | Continuous | Completed years |
| Husband's current age (HCA) | $X_3$ | 3 | Continuous | Completed years |
| Women educational attainment (WEDUA) | $X_4$ | 4 | Categorical | 0 = No education,<br>1 = Incomplete primary<br>2 = Complete primary,<br>3 = Incomplete Secondary<br>4 = Complete secondary,<br>5 = higher |
| Wealth index (WI) | $X_5$ | 5 | Categorical | 1= Poorest, 2= Poorer, 3= Middle, 4= Richer, 5= Richest |
| Women age at first marriage (WAFM) | $X_6$ | 6 | Continuous | Completed years |
| Women age of at first birth (WAFB) | $X_7$ | 7 | Continuous | Total number of dead children |
| Sons who have died (SWHD) | $X_8$ | 8 | Continuous | Completed years |
| Women currently working (WCA) | $X_9$ | 9 | Dummy | 0= Works as housewife<br>1= Works outside home |
| Ever use contraception (CONT) | $X_{10}$ | 10 | Dummy | 0= Never use<br>1= Ever use |
| Index of Fertility (CEB) | $X_{11}$ | 11 | Continuous | Number of living children |

It was documented that the current age of women has a high correlation with their fertility and fertility variations may be observed due to characteristics of women with age cohort 15-49 years (S.M. Shafiqul Islam, 1995; Khan *et al*, 2007). It is revealed that fertility increases with higher order cohorts of women, which we have shown in chapter five above. Thus, the correlation and the path analysis have been applied for 15-49 years age cohorts of women.

**Table 6.2: Presents number of women (N), minimum value (Min.), maximum value (Max.), the means ($\overline{X}$) and standard deviations (S.D.) of the variables included in this study for the age cohort 15-49 years age of women, Bangladesh.**

| Variable Name | Variable Level | N | Min. | Max. | ($\overline{X}$) | S.D. |
|---|---|---|---|---|---|---|
| De facto place of Residence (DPR) | $X_1$ | 13951 | 1 | 3 | 2.54 | 0.687 |
| Women current age (WCA) | $X_2$ | 13951 | 13 | 49 | 31.01 | 8.679 |
| Husband's current age (HCA) | $X_3$ | 13951 | 17 | 96 | 40.24 | 10.711 |
| Women educational attainment (WEDUA) | $X_4$ | 13951 | 0 | 5 | 1.97 | 1.552 |
| Wealth index (WI) | $X_5$ | 13951 | 1 | 5 | 3.17 | 1.415 |
| Women age at first marriage (WAFM) | $X_6$ | 13951 | 10 | 45 | 15.63 | 2.849 |
| Women age of at first birth (WAFB) | $X_7$ | 13951 | 11 | 40 | 17.94 | 3.302 |
| Sons who have died (SWHD) | $X_8$ | 13951 | 0 | 12 | 0.15 | 0.449 |
| Women currently working (WCW) | $X_9$ | 13951 | 0 | 1 | 0.12 | 0.320 |
| Ever use contraception (CONT) | $X_{10}$ | 13951 | 0 | 1 | 0.87 | 0.331 |
| Index of Fertility (CEB) | $X_{11}$ | 13951 | 1 | 21 | 2.79 | 1.744 |

## 6.3 Correlation Analysis

At first we construct a correlation matrix, in order to examine the quantitative relationship between socio-demographic, demographic and socio-economic variables and cumulative fertility. The correlation coefficient measures the degree of closeness of the linear relationship between two variables. When two variables are seeing to be correlated, it is tempting to infer a cause and effect relationship between them. But it must be remembered that such measures tells us nothing about the causality (Liberatrau, 1983; MacCallum & Austin, 2000; Hoyle, 1995). The simple zero order correlation coefficients matrix for all the variables used in the analysis for age cohort 15-49 years, Bangladesh.

According to the Table 6.3, in the next page strong significant positive relationship are seen between women current age ($X_2$) and current age of husband ($X_3$), current age of women ($X_2$) and women education ($X_4$), husband current age ($X_3$); women age at first marriage ($X_6$) and women age at first birth ($X_7$); women current age ($X_2$) and total children ever born ($X_{11}$); husband current age ($X_3$) and total children ever born ($X_{11}$); women educational attainment ($X_4$) and wealth index ($X_5$); sons who have died ($X_8$) and total children ever born ($X_{11}$); women educational attainment ($X_4$) and women age at first marriage ($X_6$) with $r_{xy}$ values respectively are 0.861, 0.743, 0.627, 0.583, 0.475, 0.449, 0.401.

The significant negative relationship are seen to be between de fact place of residence ($X_1$) and wealth index ($X_5$); women educational attainment ($X_4$) and total children ever born ($X_{11}$); husband current age ($X_3$) and women educational attainment ($X_4$); women current age ($X_2$) and women educational attainment ($X_4$); de facto place of residence ($X_{1)}$ and women educational attainment ($X_4$); women age at first marriage ($X_6$) and total children ever born ($X_{11}$); women age at first birth ($X_7$) and total children ever born ($X_{11}$); de facto place of residence ($X_{1)}$ and women age at first marriage ($X_6$); de facto place of residence ($X_{1)}$ and women currently working ($X_9$) with the $r_{xy}$ values are: –0.475, -0.429, -0.275, -0.267, -0.217, -0.233, -0.214, -0.153, -0.135 respectively.

**Table 6.3: Zero order correlation coefficients among selected variables, using 2011 BDHS Bangladesh.**

| Variables | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | 1.000 | -0.042** | -0.019* | -0.217** | -0.475** | -0.153** | -0.132** | 0.053** | -0.135** | -0.071** | 0.110** |
| $X_2$ | | 1.000 | 0.861** | -0.267** | 0.091** | 0.019* | 0.180** | 0.232** | 0.037** | -0.099** | 0.627** |
| $X_3$ | | | 1.000 | -0.275** | 0.067** | -0.057** | 0.077** | 0.211** | 0.005 | -0.114** | 0.583** |
| $X_4$ | | | | 1.000 | 0.457** | 0.401** | 0.309** | -0.191** | 0.040** | 0.107** | -0.429** |
| $X_5$ | | | | | 1.000 | 0.245** | 0.210** | -0.099** | 0.020** | 0.043** | -0.155** |
| $X_6$ | | | | | | 1.000 | 0.743** | -0.092** | 0.081** | -0.023** | -0.233** |
| $X_7$ | | | | | | | 1.000 | -0.076** | 0.088** | -0.079** | -0.214** |
| $X_8$ | | | | | | | | 1.000 | -0.016* | -0.088** | 0.449** |
| $X_9$ | | | | | | | | | 1.000 | 0.040** | -0.051** |
| $X_{10}$ | | | | | | | | | | 1.000 | -0.061** |
| $X_{11}$ | | | | | | | | | | | 1.000 |

'**' Correlation is significant at the 0.01 level (2-tailed); '*' Correlation is significant at the 0.05 level (2-tailed).

And the significant weak positive and negative relationships are observed between de facto place of residence ($X_{1)}$ with wealth index ($X_5$), total children ever born ($X_{11}$); women current age ($X_2$) with wealth index ($X_5$), women age at first marriage ($X_6$), women age at first birth ($X_7$), sons who have died ($X_8$), women currently working ($X_9$); husband current age ($X_3$) with wealth index ($X_5$), women age at first birth ($X_7$), sons who have died ($X_8$); women educational attainment ($X_4$) with women age at first birth ($X_7$), women currently working ($X_9$), ever used contraception ($X_{10}$); wealth index ($X_5$) with women age at first marriage ($X_6$), women age at first birth ($X_7$), women currently working ($X_9$), ever used contraception ($X_{10}$); women age at first marriage ($X_6$) with women currently working ($X_9$); women age at first birth ($X_7$) with women currently working ($X_9$); women currently working ($X_9$) with ever used contraception ($X_{10}$); the $r_{xy}$ values are respectively: 0.053, 0.110; 0.091, 0.019, 0.180, 0.232, 0.037; 0.067, 0.077, 0.211; 0.309, 0.040, 0.107; 0.245, 0.210, 0.020, 0.043; 0.081; 0.088; 0.040.

The significant weak negative relationships are observed between de facto place of residence ($X_{1)}$ with women current age ($X_2$), husband current age ($X_3$), women age at first birth ($X_7$), ever used contraception ($X_{10}$); women current age ($X_2$) with ever used contraception ($X_{10}$); husband current age ($X_3$) with women age at first marriage ($X_6$), ever used contraception ($X_{10}$); women educational attainment ($X_4$) with sons who have died ($X_8$); wealth index ($X_5$) with sons who have died ($X_8$), total children ever born ($X_{11}$); women age at first marriage ($X_6$) with sons who have died ($X_8$), ever used contraception ($X_{10}$); women age at first birth ($X_7$) with sons who have died ($X_8$), ever used contraception ($X_{10}$); sons who have died ($X_8$) with women currently working ($X_9$), ever used contraception ($X_{10}$); women currently working ($X_9$) with total children ever born ($X_{11}$) – the values are respectively -0.042, -0.019, -0.132, -0.071; -0.099; -0.057, -0.114; -0.191; -0.099, -0.155; -0.092, -0.023; -0.076, -0.079; -0.016, -0.088; -0.015; -0.061.

All the relationships are significant with $p<=0.01$ and only association between women current age ($X_2$) and women age at first marriage ($X_6$) is significant with $p<=0.05$ and a relation between husband current age ($X_3$) and women currently working ($X_9$) is statistically insignificant with r-values 0.019 and 0.005 respectively.

The various relationships examined in this section are, in fact, quite complex, and as a result, path model will be applied to identify more precisely the underlying empirical causation. The analysis is taken up in the following section.

## 6.4 Results and discussion

Under the assumption of causal ordering, presented earlier, a set of recursive regression equations were fitted. Utilizing these regressions the standardized Beta-coefficients (Path coefficients) and the residual path coefficients are estimated. All together, the path models have 40 paths for the cohort of women. The t-test is used to identify the estimated path coefficients that are significant. Various path coefficients are shown in figure 6.1. Out of 40 hypothesized paths, 34 paths are found to be statistically significant.

The discussion that follows on direct and indirect effects is based on these significant coefficients only. In worth mentioning that, the elimination of the non-significant paths have only a small effect on the power of explanation of the model. Coefficient of determination ($R^2$), standard error of the estimate and mean square residual of the model (using ANOVA, with significant value) of the regression equations in respect of the corresponding dependent variables are presented in Table 6.4.

There is an important note that for the currently married women, the total set of independent variables linked by the causal relationship explain 60.5 percent ($R^2$ = 0.605) of the variance in cumulative fertility that is total children ever born followed by about 19.1 percent and 58.7 percent for women age at first marriage (WAFM) and women age at first birth; 8.1 percent of the variance for the sons who have died (SWHD); only 3.0 percent and 4.0 percent of the variance for the women currently working (WCW) and ever use contraception (CONT) respectively; again, 74.1 percent, 13.0 percent and 40.6 percent of the variance for husband current age (HCA), women educational attainment (WEDUA) and wealth index (WI) respectively.

**Table 6.4: Presents coefficient of determination ($R^2$), standard error of the estimate and mean square residual for each model included variables in the study from 2011 BDHS, Bangladesh .**

| Dependent variable name | Variable level | $R^2$ (Coeff. of determi.) | Std. Error of the estimate | Mean square residual of the model |
|---|---|---|---|---|
| De facto place of Residence (DPR) | $X_1$ | - | - | - |
| Women current age (WCA) | $X_2$ | 0.002 | 0.9991364 | 0.998 |
| Husband's current age (HCA) | $X_3$ | 0.741 | 0.5087374 | 0.259 |
| Women educational attainment (WEDUA) | $X_4$ | 0.130 | 0.9327868 | 0.870 |
| Wealth index (WI) | $X_5$ | 0.406 | 0.7706132 | 0.594 |
| Women age at first marriage (WAFM) | $X_6$ | 0.191 | 0.8994058 | 0.809 |
| Women age at first birth (WAFB) | $X_7$ | 0.587 | 0.6431612 | 0.414 |
| Sons who have died (SWHD) | $X_8$ | 0.081 | 0.9587652 | 0.919 |
| Women currently working (WCW) | $X_9$ | 0.030 | 0.9851387 | 0.970 |
| Ever use contraception (CONT) | $X_{10}$ | 0.040 | 0.9801079 | 0.961 |
| Index of fertility (CEB) | $X_{11}$ | 0.605 | 0.6284569 | 0.395 |

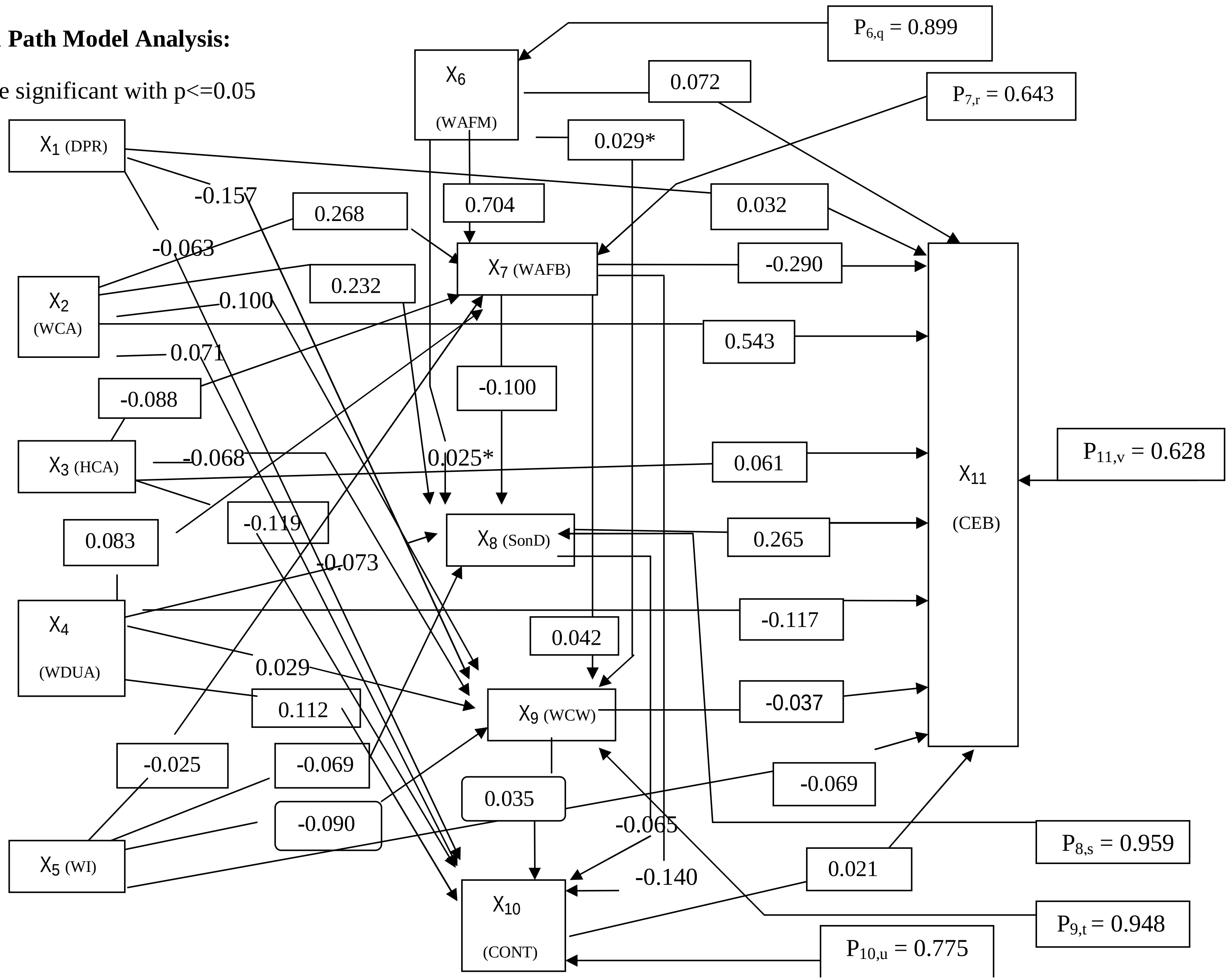
Since, the Comparative Fit Index (CFI) is equal to the discrepancy function adjusted for sample size. CFI ranges from 0 to 1 with a larger value indicating better model fit. Our standard error of the estimate of the models value lies ranges from 0 to 1; also the value of any best model fit, the mean square residual ranges lies from o to 1 (Hu & Bentler, 1999). Therefore, we may arrive at a conclusion that our models are best fit.

## 6.5 Discussion about path analysis

Out of 40 paths, there are 34 paths are found statistically significant. Thirty-two paths are significant with $p<= 0.01$, indicated by (*) and another two paths significant with $p<= 0.05$, indicated by (**) in figure 6.1. Note that women age at first marriage $X_6$ and sons who have died $X_8$, we could not shown by arrowhead in the figure for my limitation and for complexity; it is similar for variables women age at first marriage $X_6$ and women currently working $X_9$ variable.

**Figure 6.1 Path Model Analysis:**

‘*’ Indicate significant with p<=0.05



The direct and indirect effects through exogenous, endogenous variables with ultimate endogenous variables after analysis of each of the explanatory variable are presented in Table 6.5

**Table 6.5: Demographic and socio-economic variables used in the path model for explaining of fertility through exogenous, endogenous variables of currently married women using 2011 BDHS, Bangladesh.**

| Ultimate endogenous variable | Endogenous variable | Exogenous variable | Indirect effect through endogenous variables | | | | | Other Variables (co-effect) | Direct effect |
|---|---|---|---|---|---|---|---|---|---|
| | | | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | | |
| | | $X_1$ | -0.001 | 0.002 | 0.001 | 0.0 | 0.0 | 0.032 | |
| | | $X_2$ | 0.001 | -0.057 | 0.067 | -0.001 | -0.002 | 0.543 | |
| | | $X_3$ | -0.001 | -0.003 | 0.007 | 0.0 | 0.0 | 0.061 | |
| | | $X_4$ | -0.007 | 0.021 | 0.012 | 0.0 | -0.001 | -0.117 | |
| | | $X_5$ | -0.002 | 0.008 | 0.004 | 0.0 | 0.0 | -0.069 | |
| $X_{11} = Y_1$ | $X_6$ | | _ | -0.031 | -0.004 | 0.0 | 0.0 | | 0.072 |
| | $X_7$ | | _ | _ | 0.012 | 0.002 | 0.001 | | -0.290 |
| | $X_8$ | | _ | _ | _ | 0.0 | -0.001 | | 0.265 |
| | X9 | | _ | _ | _ | _ | 0.0 | | -0.037 |
| | $X_{10}$ | | _ | _ | _ | _ | _ | | 0.021 |

Percentages of the direct and indirect effects through exogenous and endogenous variables with ultimate endogenous variable after analysis of each of the explanatory variable are presented in Table 6.6.

**Table 6.6: Percentages of the total effect of variables used in the path model for explaining on fertility through exogenous and endogenous variables of currently married women using 2011 BDHS, Bangladesh.**

| Ultimate endogenous variable | Endogenous variable | Exogenous variable | Indirect effect through endogenous variables | | | | | Other Variables (co-effect) | Direct effect | Percentage (%) total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | | | |
| $Y_1 = X_{11}$ | | $X_1$ | 2.778 | 5.556 | 2.778 | 0.0 | 0.0 | 88.889 | | 100.0 |
| | | $X_2$ | 0.149 | 8.495 | 9.985 | 0.149 | 0.298 | 80.924 | | 100.0 |
| | | $X_3$ | 1.389 | 4.167 | 9.722 | 0.0 | 0.0 | 84.722 | | 100.0 |
| | | $X_4$ | 4.430 | 13.291 | 7.595 | 0.0 | 0.633 | 74.051 | | 100.0 |
| | | $X_5$ | 2.410 | 9.639 | 4.819 | 0.0 | 0.0 | 83.133 | | 100.0 |
| | $X_6$ | | – | 28.972 | 3.738 | 0.0 | 0.0 | | 67.290 | 100.0 |
| | $X_7$ | | – | – | 3.934 | 0.656 | 0.328 | | 95.082 | 100.0 |
| | $X_8$ | | – | – | – | 0.0 | 0.376 | | 99.624 | 100.0 |
| | X9 | | – | – | – | – | 0.0 | | 100.0 | 100.0 |
| | $X_{10}$ | | – | – | – | – | – | | 100.0 | 100.0 |

**Table 6.7: Percentages of total association in terms of causal and non-causal effect of variables used in the path model for explaining on fertility through exogenous and endogenous variables of currently married women using 2011 BDHS, Bangladesh.**

| Ultimate endogenous variable | Endogenous variable | Exogenous variable | Total association | Total effect/ Causal effect | Non-causal effect* | Absolute percentage | | Percentage (%) total |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Causal effect | Non-causal effect | |
| | | $X_1$ | 0.110 | 0.034 | 0.076 | 30.909 | 69.091 | 100.0 |
| | | $X_2$ | 0.627 | 0.551 | 0.076 | 87.879 | 12.121 | 100.0 |
| | | $X_3$ | 0.583 | 0.064 | 0.519 | 10.978 | 89.022 | 100.0 |
| | | $X_4$ | -0.429 | -0.092 | -0.337 | 21.445 | 78.555 | 100.0 |
| | | $X_5$ | -0.156 | -0.059 | -0.097 | 37.821 | 62.179 | 100.0 |
| | $X_6$ | | -0.233 | 0.037 | -0.270 | 12.052 | 87.948 | 100.0 |
| | $X_7$ | | -0.214 | -0.275 | 0.061 | 81.845 | 18.155 | 100.0 |
| | $X_8$ | | 0.445 | 0.264 | 0.185 | 58.797 | 41.203 | 100.0 |
| $X_{11} = Y_1$ | X9 | | -0.051 | -0.037 | -0.088 | 29.600 | 70.400 | 100.0 |
| | $X_{10}$ | | -0.061 | 0.021 | -0.082 | 20.388 | 79.612 | 100.0 |

**'*'Non-causal effect = Total association – Total effect**

Total association in terms of causal effect (total effect) and non-causal effect through exogenous and endogenous variables with ultimate endogenous variable after analysis of each of the explanatory variable with their percentage are presented in table 6.7

After analysis from table 6.5 we have seen that the de facto place of residence (DPR), $X_1$; women current age (CAW), $X_2$; husband's current age CAH), $X_3$; women age at first marriage (WAFM), $X_6$; sons who have died (SWHD), $X_8$ (partial index of mortality) and ever use contraception (CONT), $X_{10}$ are found to have statistically significant direct positive effect with ultimate endogenous variable $Y_1$ that is with fertility. Again women educational attainment (WEDUA), $X_4$; wealth index (WI), $X_5$; women age at first birth (WAFB), $X_7$ and women currently working (WCW), $X_9$ are found to have statistically significant direct negative effect on children ever born or fertility.

The indirect effect for the combination of exogenous and endogenous variables, de facto place of residence (DPR), $X_1$ and women age at first marriage (WAFM), $X_6$; women current age (CAW), $X_2$ with women age at first birth (WAFB), $X_7$ ever use contraception (CONT), $X_{10}$ and ever use contraception (CONT), $X_{10}$; husband's current age CAH), $X_3$ with women age at first marriage (WAFM), $X_6$ and women age at first birth (WAFB), $X_7$; women educational attainment (WEDUA), $X_4$ with women age at first marriage (WAFM), $X_6$ and ever use contraception (CONT), $X_{10}$; wealth index (WI), $X_5$ and women age at first marriage (WAFM), $X_6$; women age at first marriage (WAFM), $X_6$ with women age at first birth (WAFB), $X_7$ and sons who have died (SWHD), $X_8$ and finally sons who have died (SWHD), $X_8$ with ever use contraception (CONT), $X_{10}$ are found to have statistically significant indirect negative effect on fertility.

De facto place of residence (DPR), $X_1$ with women age at first birth (WAFB), $X_7$ and sons who have died (SWHD), $X_8$ ; husband's current age (CAH), $X_3$ and sons who have died (SWHD), $X_8$ ; women current age (CAW), $X_2$ with women age at first marriage (WAFM), $X_6$ sons who have died (SWHD), $X_8$; women educational attainment (WEDUA), $X_4$ with women age at first birth (WAFB), $X_7$ and sons who have died (SWHD), $X_8$; wealth index (WI), $X_5$ with women age at first birth (WAFB), $X_7$ and sons who have died (SWHD), $X_8$; women age at first birth (WAFB), $X_7$ with sons who have died (SWHD), $X_8$ women currently working (WCW), $X_9$ and ever use contraception (CONT), $X_{10}$ are found to have statistically significant indirect little positive effect on fertility.

The other pairs: De facto place of residence $X_1$ and women currently working $X_9$; De facto place of residence $X_1$ and ever use contraception $X_{10}$; husband's current age $X_3$ and women currently working $X_9$; husband's current age $X_3$ and ever use contraception (CONT) $X_{10}$; women educational attainment (WEDUA) $X_4$ and women currently working $X_9$; wealth index (WI) $X_5$ and women currently working $X_9$; wealth index (WI) $X_5$ and ever use contraception (CONT) $X_{10}$; women age at first marriage (WAFM) $X_6$ and women currently working $X_9$; women age at first marriage (WAFM) $X_6$ and ever use contraception (CONT) $X_{10}$; sons who have died (SWHD) $X_8$ and women currently working $X_{9;}$ and women currently working $X_9$ with ever use contraception (CONT) $X_{10}$ used in the path model have no indirect effect on children ever born or fertility.

After using analytical tools, we have seen from table 6.6 that the variable de facto place of residence (DPR), $X_1$ has 89 percent (absolute effect for all calculation) direct effect on fertility and other 11 percent indirect effect of which 3 percent is intermediary through women age at first marriage (WAFM) $X_6$, 5 percent through women age at first birth (WAFB) $X_7$ and 3 percent mediated through sons who have died (SWHD) $X_8$ variable and remaining variables women currently working $X_9$ and ever use contraception (CONT) $X_{10}$ have no mediatory effect on fertility.

The variable, women current age (CAW), $X_2$ has 81 percent direct effect and remaining 19 percent indirect effect of which 8 percent is mediated through women age at first birth (WAFB) $X_7$, 10 percent is intermediated through sons who have died (SWHD) $X_8$ variable, 1 percent mediated through other three variables women age at first marriage (WAFM) $X_6$, women currently working $X_9$ and ever use contraception (CONT) $X_{10}$ used as endogenous variable.

The variable, husband's current age (CAH), $X_3$ has 85 percent direct effect and remaining 15 percent indirect effect of which 1 percent is intermediated through women age at first marriage (WAFM) $X_6$ variable, 4 percent is mediated through women age at first birth (WAFB) $X_7$ variable, 10 percent is mediated by sons who have died (SWHD) $X_8$ variable and women currently working $X_9$, ever use contraception (CONT) $X_{10}$ used as endogenous variable have no mediatory indirect effect on fertility.

The exogenous variable, women educational attainment (WEDUA), $X_4$ has 74 percent direct effect on fertility and remaining 26 percent indirect effect of which 4%, 13%, 8% and 1% respectively intermediated through women age at first marriage (WAFM) $X_6$ variable, women age at first birth (WAFB) $X_7$ variable, sons who have died (SWHD) $X_8$ variable and ever use contraception (CONT) $X_{10}$ variable. Also, variable women currently working $X_9$ has no mediatory indirect effect with $X_4$ variables on fertility.

The last exogenous variable, wealth index (WI), $X_5$ has 83% direct effect on fertility and 17% indirect effect of which 2%, 10% and 5% mediated through women age at first marriage (WAFM) $X_6$ variable, women age at first birth (WAFB) $X_7$ variable and sons who have died (SWHD) $X_8$ variable respectively.

The endogenous variable women age at first marriage (WAFM) $X_6$, has 67% direct effect and 33% indirect effect on ultimate endogenous variable $Y_1$ or fertility variable. Out of 33% indirect effect, of which 29% and 4% mediated by the variables women age at first birth (WAFB) $X_7$ variable and sons who have died (SWHD) $X_8$ variable respectively.

The endogenous variable women age at first birth (WAFB) $X_7$, has 95% direct effect on ultimate endogenous variable $Y_1$ or fertility variable and 5% indirect effect of which 4% mediated through sons who have died (SWHD) $X_8$ variable and other 1% combinational intermediated through women currently working $X_9$ and ever use contraception (CONT) $X_{10}$ variable. The other three endogenous variables sons who have died (SWHD) $X_8$, women currently working $X_9$ and ever use contraception (CONT) $X_{10}$ have approximately 100% direct effect on the ultimate endogenous variable $Y_1$ ($X_{11}$) or children ever born variable.

From deep observation of the table 6.5 and table 6.6, we found that all exogenous variables indirect effect through variables women currently working $X_9$ and ever use contraception (CONT) $X_{10}$ have no mediatory effect on the ultimate endogenous variable $Y_1$ or fertility variable.

From the table 6.7, we seen that the ultimate endogenous variable $Y_1$ and de facto place of residence (DPR), $X_1$, women current age (CAW), $X_{2,}$ husband's current age (CAH), $X_3$, sons who have died (SWHD) $X_8$ variables have positively associated and remaining other variables women educational attainment (WEDUA), $X_4$, wealth index (WI), $X_5$, women age at first marriage (WAFM) $X_6$ variable, women age at first birth (WAFB) $X_7$ variable, women currently working $X_9$ and ever use contraception (CONT) $X_{10}$ variable negatively associated with the ultimate endogenous variable $Y_1$.

In table 6.7, a relation has showed for ultimate endogenous variable and remaining other variables in terms of total association which divide into two segment causal (total) effect and non-causal effect. Causal effect are found by adding mediating indirect effect between variables and single exogenous, endogenous respective variable with ultimate endogenous variable direct effect. Ultimate endogenous variable $Y_1$ on de facto place of residence (DPR), $X_1$ variable has 0.11 total association with 31% causal and 69% non-causal effect; $Y_1$ on women current age (CAW), $X_2$ has 0.627 total association with 88% causal and 12% non-causal effect; $Y_1$ on husband's current age (CAH), $X_3$ has 0.583 total association with 11% causal and 89% non-causal effect; $Y_1$ on women educational attainment (WEDUA), $X_4$ has -0.429 total reciprocal association with 21% causal and 79% non-causal effect; $Y_1$ on wealth index (WI), $X_5$ has -0.156 negative total association with 38% causal and 62% non-causal effect.

In similar way we could explain relation between ultimate endogenous variable $Y_1$ on other endogenous variables total association with their respective percentage of causal and non-causal effect from the same table 6.7.

## 6.6 Conclusion

These studies have attempted to show empirically the caused links between the selected demographic and socio-economic variables on children ever born or fertility. The relationship between and within the variables were examined by applying path model and path analysis.

We have seen from our analysis that the de facto place of residence, women current age, husband's current age, women age at first marriage, sons who have died (number of male child dead that is partial index of mortality) and ever use contraception, are found statistically significant direct positive effect on fertility. Again women educational attainment, wealth index, women age at first birth and women currently working are found to have statistically significant direct negative effect on children ever born or fertility.

The indirect effect for the combination of exogenous and endogenous variables, de facto place of residence and women age at first marriage; women current age with women age at first birth ever use contraception and ever use contraception; husband's current age with women age at first marriage and women age at first birth; women educational attainment with women age at first marriage and ever use contraception; wealth index and women age at first marriage; women age at first marriage with women age at first birth and sons who have died and finally sons who have died with ever use contraception are found to have statistically significant indirect negative effect on fertility.

It is well known fact that work facilities of female and now also for male in Bangladesh is severely limited, so creating work facilities (female in home and outside home) into various sectors such as official, non-official and NGO's might be decreased fertility level. The result of this chapter, it may be suggested that the Government and the planners of different organization's and NGO's attention should be focused on the need of providing work facilities, particularly in rural areas in order to decrease or constant level of fertility.

The total effect of female education is found to be negative influence of fertility. Education may provide better employment opportunities outside home and women age at first marriage can be raise by providing education to females, especially at the secondary and higher levels. Based on the results of this section, it may be suggested that attention should be focused on the need of providing work oriented educational facilities, particularly in rural areas in order to depress the level of fertility in Bangladesh. Also the results suggested that application of contraceptive method must be increased to decrease fertility in the less developed countries like Bangladesh.

Thus we may arrive at a conclusion that we need to decentralize our economic zone for mobilize economic ability for mass population. Quality education should be confirmed by the government and policy makers should need to indicate working area with strong economic output which involves women and men.

Fetal loss or total number of dead children appears to have a significant direct positive effect on fertility in Bangladesh, which means that mothers who have experienced children dead are found to have higher fertility. Mothers always try to replace their dead child as early as possible. Such behavior is a result of social horror about the survival of children. Therefore government should fulfill all issues of health, family planning (FP) service and planners should confirm to get easier way service from government health and FP employee for maximum family of the country for survival of children to get satisfactory family size.

## 6.7 Logistic Regression Analysis Approach

Binary Logistic regression method performed to identify significant determinants of the ever use of contraceptive methods using 2011 BDHS data in Bangladesh. Logistic regression is used to model the relationship between a binary response variable and one or more predictor variables, which may be either discrete or continuous. There are a variety of multivariate statistical techniques that can be used to estimate a binary dependent variable from a set of independent variables. Multiple regression analysis and discriminate analysis are two related techniques but these techniques are applicable only when the dependent and independent variables are measured in interval scale and under the assumption that they are normally distributed. However, in most applications, dependent variable may be dichotomous one and one or more explanatory variables are qualitative or measured in nominal or ordinal scales and the assumption of normality is violated. Therefore, work out this problem, a very interesting and appropriate technique is the binary logistic regression method. We use Enter method to construct regression model for the same set of variables. We utilize the computer package SPSS (Statistical Package for Social sciences) for windows base 15.0 version and the binary logistic regression parameters $\beta_i$'s were iteratively solved with the help of this package program.

## 6.8 Description of variables used in binary logistic regression model

**Ever use contraception**

Birth control process or contraceptive use prevents pregnancy by interfering with the normal process of ovulation, fertilization, and implantation. Ever use of contraception method is an important factor in any demographic analysis. This variable has a prime importance relating to women reproductive behavior. Therefore the said variable included in this study. Ever use of contraceptive method by women (man also) means any woman who wanted to prevent pregnancy using a reliable structure of birth control. Only women who were not pregnant at the time of interview were asked are you ever used anything or tried to delay or avoid getting pregnant? Respondents who are currently using any contraceptive method at the time of survey are assigned the value 1 and those not currently using any contraceptive method are assigned the vale 0.

**De facto place of residence**

The de place where a respondent virtually lives is called 'de place of residence'. Respondent virtually lives in either city corporation area or town (other than city corporation) or in rural area. It is found to be impossible for a developing country like Bangladesh to provide all the facilities equally to those are required for the people of the country. Most of the time, it is observed that the people of the city corporation or town area are getting facilities more than that of the rural part of the country. Such lack of homogeneity is apparent from different background characteristics in BDHS 2011.

**Women current age and husband current age**

From the data we observed that the demand for contraceptive method use vary by the age variation of currently married or ever married women, which influence me to include this variable in the model. For same reason I include in this model, husband current age in the model. Their level, codes and categories describe in table 6.8

**Women Educational Attainment**

Education is essential facet for accumulate knowledge. Women educational attainment seems to be very important factor which influence women (as like men) to ever use contraceptive method including uncountable works perception. Thus the level of women educational attainment is sub-divided into: no education, incomplete primary, complete primary, incomplete secondary, complete secondary and higher. Each level indicates as a variable assuming two vales, ever use contraception is one and never use is indicated zero.

**Region of Residence**

In my study I assume that women ever use contraception may vary over geographic (divisional) region. Thus I include all administrative divisions of Bangladesh as region of residence to compare the women knowledge and use matter by using binary logistic regression model. There are seven administrative divisions in the country.

**Number of sons died**

The number of sons that a woman has ever died till the date of interview is included into son's mortality experience. This is usually high in all the societies where knowledge of child-care, child-nutrition, mother's nutrition during pregnancy period etc., are found to be very pitiable. According to the studies conducted earlier, this variable is important in making policies towards family planning. Our interest is to see the very recent attitude of it on the dependent variable. I include this variable in place of child mortality experience for finding more segments and for deep analysis.

**Number of living children**

Ever used anything that is women use contraception very much depend on total number of living children of any family. Classification describe in table 6.8. The main reason of computing this variable in the study is to detect its effect on the dependent variable.

**Women Currently Breastfeed**

A woman's breastfeeding practice has high influence whether she use or not contraceptive method in her reproductive period. It also a detail discussing factor for mother and child. Since, this variable is cultural; I include this variable in my study to observe and want to pick up real scenario of Bangladesh.

**Spousal desire for children**

The women currently married who were not sterilized in the 2011 BDHS sample were asked, "Does your husband want the same number of children that you want, or does he want more or fewer than you want?" Responses to these questions are presented as spousal agreement in desired number of children by background characteristics of women. The provision of sufficient and reachable family planning services depends on the availability of any couple desire of children information. The information about the couple desire for more children is important for understanding future reproductive behavior. Thus I include this variable in my study.

**Occupational/ working status of husband and wife**

Ever used anything or avoid getting pregnant of a women is affected by the working status of a women and by her husband occupational status. So, such situation inspired me to include this variable in the model for analysis. To compare the impact of women currently working for ever use contraceptive method, I divided the currently married women into two categories-

1. Women working as a housewife or women working in the house;
2. Women working outside home or service

Husband occupation is divided into five categories for interpreted the husband occupational results.

1. Agricultural works; 2. Non-agricultural works; 3. Service; 4. Business; and 5. Others

**Table 6.8: Variables considered for binary logistic regression analysis with codes and categories.**

| Variable name | Variable Level | Type of Variable | Codes and Categories |
|---|---|---|---|
| **Ever used contraception, CONT (Dependent variable)** | Y = N302A | Dummy | Never use = 0 Ever use = 1 |
| **Independent variables** | | | |
| **De facto place of residence** | $X_1$ = V026 | Categorical | City = 1; Town = 2; Rural area = 3 |
| **Women current age (WCA)** | $X_2$ = N012 | Categorical | <20= 1; 20-24= 2; 25-29= 3; 30-34= 4; 35-49= 5 |
| **Husband's current age (HCA)** | $X_3$ = N730 | Categorical | 15-24= 1; 25-34= 2; 35-44= 3 45-54= 4; $55^+$ = 5 |
| **Women educational attainment (WEDUA)** | $X_4$ = V149 | Categorical | No education=0; Incomplete primary= 1; Complete primary=2; Incomplete secondary=3; Complete secondary = 4; Higher= 5 |
| **Region of residence (RR)** | $X_5$ = V024 | Categorical | Barisal=1; Chittagong=2; Dhaka=3; Khulna=4; Rajshahi=5; Rangpur=6; Sylhet=7 |
| **Number of dead sons (NDS)** | $X_6$ = N206 | Categorical | No sons died=0; One son died=1; At least two sons died=2 |
| **Number of living children (NLC)** | $X_7$ = N218 | Categorical | No=0; One alive =1; Two alive=2; (3-4) alive=3; (5-10) alive=4 |
| **Currently breastfeeding (CB)** | $X_8$ = V404 | Dummy | No = 0; Yes = 1 |
| **Spousal desire for children (SDC)** | $X_9$ = V621 | Categorical | Both want same=1; Husband want more=2; Husband want fewer=3; Don't know=4 |
| **Husband's occupation (HO)** | $X_{10}$ = N704 | Categorical | Agriculture=1; Non-agricultural works=2; service=3; Business=4; Others=5 |
| **Women currently working (WCW)** | $X_{11}$ = V714 | Dummy | Household works= 0; Outside home works/service = 1 |

## 6.9 Empirical results

**Table 6.9: Results of binary logistic regression analysis for the simultaneous effects of all factors used in the model of ever use contraception, using 2011 BDHS data, Bangladesh.**

| Background characteristics (Variables) | Estimated coefficients | S.E. | Wald Statistic | p-value | Odds ratio [Exp(β)] | 95% C. I. for odds ratio. | |
|---|---|---|---|---|---|---|---|
| **De facto place of residence** | | | | | | | |
| City | 0.834 | 0.109 | 58.032 | 0.000 | 2.303 | (1.858 | 2.854) |
| Town | 0.334 | 0.072 | 21.280 | 0.000 | 1.397 | (1.212 | 1.610) |
| Rural area (R) | _ | _ | _ | _ | 1.000 | | |
| **Women current age** | | | | | | | |
| <20 | 1.225 | 0.179 | 45.738 | 0.000 | 3.403 | (2.395 | 4.834) |
| 20-24 | 1.179 | 0.143 | 67.958 | 0.000 | 3.250 | (2.456 | 4.301) |
| 25-29 | 0.998 | 0.120 | 69.335 | 0.000 | 2.712 | (2.145 | 3.430) |
| 30-34 | 0.683 | 0.106 | 41.634 | 0.000 | 1.980 | (1.609 | 2.436) |
| 35-49 (R) | _ | _ | _ | _ | 1.000 | | |
| **Husband current age** | | | | | | | |
| 15-24 | 1.012 | 0.201 | 25.318 | 0.000 | 2.750 | (1.855 | 4.079) |
| 25-34 | 1.028 | 0.141 | 53.147 | 0.000 | 2.796 | (2.121 | 3.686) |
| 35-44 | 0.828 | 0.111 | 55.678 | 0.000 | 2.290 | (1.842 | 2.846) |
| 45-54 | 0.767 | 0.086 | 78.694 | 0.000 | 2.154 | (1.818 | 2.552) |
| $55^+$ (R) | _ | _ | _ | _ | 1.000 | | |
| **Women educa. attainment** | | | | | | | |
| No education (R) | _ | _ | _ | _ | 1.000 | | |
| Incomplete primary | -0.874 | 0.153 | 32.598 | 0.000 | 0.417 | (0.309 | 0.563) |
| Complete primary | -0.538 | 0.156 | 11.852 | 0.001 | 0.584 | (0.430 | 0.793) |
| Incomplete secondary | -0.487 | 0.161 | 9 .127 | 0.003 | 0.614 | (0.448 | 0.843) |
| Complete secondary | -0.311 | 0.148 | 4.436 | 0.035 | 0.733 | (0.548 | 0.979) |
| Higher | -0.247 | 0.188 | 1.726 | 0.169 | 0.781 | (0.541 | 1.129) |

**(Continued)**

| Variables | Estimated coefficients | S.E. | Wald Statistic | p-value | Odds ratio [Exp(β)] | 95% C. I. for odds ratio. | |
|---|---|---|---|---|---|---|---|
| **Region of residence (RR)** | | | | | | | |
| **Barisal** | 1.447 | 0.110 | 172.394 | 0.000 | 4.252 | **(3.426** | **5.277)** |
| **Chittagong** | 0.510 | 0.086 | 35.362 | 0.000 | 1.666 | **(1.408** | **1.970)** |
| **Dhaka** | 1.168 | 0.094 | 154.954 | 0.000 | 3.215 | **(2.675** | **3.864)** |
| **Khulna** | 1.494 | 0.105 | 203.573 | 0.000 | 4.456 | **(3.629** | **5.471)** |
| **Rajshahi** | 1.581 | 0.107 | 217.168 | 0.000 | 4.861 | **(3.939** | **5.999)** |
| **Rangpur** | 1.649 | 0.110 | 225.140 | 0.000 | 5.201 | **(4.193** | **6.451)** |
| **Sylhet (R)** | _ | _ | _ | _ | 1.000 | | |
| **Number of dead sons (NDS)** | | | | | | | |
| **No sons died (R)** | _ | _ | _ | _ | 1.000 | | |
| **One son died** | 0.356 | 0.162 | 4.858 | 0.011 | 1.426 | **(1.040** | **1.961)** |
| **At least two sons died** | 0.156 | 0.172 | 0.918 | 0.026 | 1.180 | **(0.841** | **1.654)** |
| **Number of living children** | | | | | | | |
| **No child (R)** | _ | _ | _ | _ | 1.000 | | |
| **One alive** | -3.532 | 0.264 | 176.539 | 0.000 | 0.029 | **(0.017** | **0.049)** |
| **Two alive** | -1.1800 | 0.121 | 223.051 | 0.000 | 0.165 | **(0.130** | **0.209)** |
| **(3-4) children alive** | -0.499 | 0.106 | 22.271 | 0.000 | 0.607 | **(0.493** | **0.747)** |
| **(5-10) children alive** | -0.008 | 0.093 | 0.008 | 0.929 | 0.992 | **(0.827** | **1.189)** |
| **Currently breastfeeding** | | | | | | | |
| **No (R)** | _ | _ | _ | _ | 1.000 | | |
| **Yes** | 0.434 | 0.074 | 33.903 | 0.000 | 1.543 | **(1.333** | **1.786)** |

**(Continued)**

| Variables | Estimated coefficients | S.E. | Wald Statistic | p-value | Odds ratio [Exp(β)] | 95% C. I. for odds ratio. | |
|---|---|---|---|---|---|---|---|
| **Spousal desire for children** | | | | | | | |
| **Both want same** | 0.977 | 0.138 | 50.046 | 0.000 | 2.655 | (2.026 | 3.481) |
| **Husband wants more** | 0.814 | 0.156 | 27.272 | 0.000 | 2.257 | (1.663 | 3.063) |
| **Husband wants fewer** | 1.446 | 0.181 | 63.839 | 0.000 | 4.246 | (2.978 | 6.053) |
| **Don't know (R)** | _ | _ | _ | _ | 1.000 | | |
| **Husband's occupation** | | | | | | | |
| **Agricultural works** | 0.775 | 0.118 | 43.046 | 0.000 | 2.171 | (1.722 | 2.737) |
| **Non-agricultural works** | 0.502 | 0.114 | 19.387 | 0.000 | 1.651 | (1.321 | 2.064) |
| **Service holder** | 1.095 | 0.180 | 37.010 | 0.000 | 2.990 | (2.101 | 4.255) |
| **Business** | 0.869 | 0.123 | 50.290 | 0.000 | 2.385 | (1.875 | 3.032) |
| **Others (R)** | _ | _ | _ | _ | 1.000 | | |
| **Women currently working** | | | | | | | |
| **Household works (R)** | _ | _ | _ | _ | 1.000 | | |
| **Outside home works/service** | -0.397 | 0.100 | 15.597 | 0.000 | 0.672 | (0.552 | 0.819) |
| **Intercept** | -1.215 | 0.298 | 16.647 | 0.000 | 0.297 | | |

| | | | |
|---|---|---|---|
| **-2log likelihood*** | 8927.745 | | |
| **Cox & Snell $R^2$** | 0.109 | | |
| **Nagelkerke $R^2$** | 0.206 | | |
| **Model chi-square ( $\chi^2$ )** | 1612.592 | | 0.000 |
| **Degrees of freedom (df)** | 36 | | |

### 6.9.1 Results and Discussion

The estimated multiple binary logistic regression models are as the following:

$$\log_e\left[\frac{p(x_i)}{1-p(x_i)}\right]=-$$

$$1.215+0.834X_{11}+0.334X_{12}+1.225X_{21}+1.179X_{22}+0.998X_{23}+0.683X_{24}+1.012X_{31}$$
$$+1.028X_{32}+0.828X_{33}+0.767X_{34}-0.874X_{41}-0.538X_{42}-0.487X_{43}-0.311X_{44}$$
$$-0.247X_{45}+1.447X_{51}+0.510X_{52}+1.168X_{53}+1.494X_{54}+1.581X_{55}+1.649X_{56}$$
$$+0.356X_{61}+0.165X_{62}-3.532X_{71}-1.800X_{72}-0.499X_{73}-0.008X_{74}+0.434X_{81}$$
$$+0.977X_{91}+0.814X_{92}+1.446X_{93}+0.775X_{101}+0.502X_{102}+1.095X_{103}+0.869X_{104}-0.397X_{111}$$

The empirical results of the multiple binary logistic regression analysis are presented in the Table 6.9, where I have present the estimated value of the regression coefficient (β), standard error (S.E) of the regression coefficient (β), Wald statistic, p-value, relative odds that are calculated for each of the categorical variable and 95% confidence interval (C.I) for odds ratio, [Exp (β)]. According to the fitted model, this is shown in table 6.8 above. There are all eleven variables appear as the significant predictors in case of ever use contraception.

In accordance with the variables importance, women educational attainment, numbers of living children and women currently working have statistically significant negative effect on ever use contraceptives. Also the variables, de facto place of residence, women and husband current age, region of residence, number of sons died, women currently breastfeeding, spousal desire for children and husband's occupation have statistically significant positive effect on ever use contraceptives.

There are always differences among the living standards of City Corporation, town (other than City Corporation) and rural areas population in our country. The people living in City Corporation as well as living in town get some extra facilities about health care services as well as all standards of living. These symbols are also reflected in our study.

From the results of multiple logistic regression analysis, it appears that de facto place of residence is found to have a significant ($p<0.001$) positive effect on the ever use of contraceptive method. Considering rural area as de facto place of residence for women as reference category, the regression coefficients of ever use contraceptive method of City Corporation and in town as de facto place of residence for women are 0.834 and 0.334 respectively and these are positive in sign. The results illustrate that the city corporation and town residential women are use contraceptive method 2.303 times and 1.397 times more respectively than the rural de facto place of residential women.

The regression coefficients of the women current age are being calculated. From the results, it is observed that the women current age is the most significant factor, affecting ever use contraceptives. It has also been found from the bivariate analysis in chapter four that the children ever born is higher among those women who belong to the age group <20 (15-19). So, it is important to need to take obstruction in this age group and after some age groups as possible. From the table 6.9, it is observed that the women current age have a significant ($p<0.001$) positive effect on the ever use contraceptive or tried to delay or avoid getting pregnant. Considering the women current age group 35-49 as reference category, the regression coefficients of ever use contraceptive method of women age groups <20 (15-19), 20-24, 25-29 and 30-35 are 1.225, 1.179, 0.998 and 0.683 respectively and these are all positive in sign. This estimated result gives us the information that the women current age groups <20, 20-24, 25-29 and 30-34 are ever use contraceptive method 3.403 times, 3.250 times, 2.712 times and 1.980 times more respectively in accordance of reference category age group 35-49. In another point of view, women age groups <20, 20-24, 25-29 and 30-34 are use contraceptives $(3.403-1.000)\times100$ = 240.3%, 225.0%, 171.2% and 98% more respectively than the reference category age group 35-49. It means the lower the age group of women, higher the probability of getting ever use contraceptive method.

From the table 6.9 results of husband's current age are also estimated. It is found that husband current age is also the most significant ($p<0.001$) positive factor for ever use contraceptives. For husband age groups 15-24, 25-34, 35-44, 45-54 and $55^+$, we took age group $55^+$ as a reference category, since this age group has neutrality to impose restriction on ever use contraception. The regression coefficients of ever use contraceptive method of husband current age groups 15-24, 25-34, 35-44 and 45-54 are 1.012, 1.028, 0.828 and 0.434 respectively and all values are positive in sign. In accordance of reference category, the odds ratios of husband age groups 15-24, 25-34, 35-44 and 45-54 are 2.750 times, 2.796 times, 2.290 times and 2.154 times respectively more uses contraceptive method. In an additional point of view, husband age groups 15-24, 25-34, 35-44 and 45-54 are uses contraceptives respectively (2.750-1.000) × 100 = 175.0%, 179.60%, 129.0% and 115.4% more than the reference category age group. Age group 25-34 is the highest contraceptive user group, since this age group is vital working group in any sector.

Women educational attainment is another important component for ever use contraceptive method because knowledge motivated people to construct suitable family size. It is observed from analyses in table 6.9 that the women educational attainment is found significant ($p<0.001$) negative effective factor on ever used contraception. For women educational attainment, we took no education (0) as the reference category, then the regression coefficients of incomplete primary, complete primary, incomplete secondary, complete secondary and higher education are -0.874, -0.538, -0.487, -0.311 and -0.247 respectively and we seen that all values are negative. In accordance of reference category, the odds ratios of incomplete primary, complete primary, incomplete secondary, complete secondary and higher educated women are ever used contraception respectively 0.417 times, 0.584 times, 0.614 times, 0.733 (with $p<0.05$) times and 0.781 (with insignificant $p<0.189$) times more than their no educated counterparts. In further point of view, incomplete primary, complete primary, incomplete secondary, complete secondary and higher educated women are took (1.000-0.417) × 100 = 58.3%, 41.6%, 38.6%, 26.7% and 21.9% lower risk to getting pregnant respectively than no educated (assume 100% getting risk to pregnant) women. We seen from our educational difference, the deviation between incomplete and complete primary is (58.3-41.6) % = 16.7%, deviation between complete primary and incomplete secondary is 3%, deviation between incomplete secondary and complete secondary is 11.9%, deviation between complete secondary and higher education is 4.8% and deviation between no education and incomplete primary is 41.7% which is higher than any other deviation. Therefore, we may arrive at a decision that the higher the educational attainment more the use of contraception and people shall have build suitable family.

Region of residence is an important independent variable, as it is finds out the real picture of regional basis usage of women ever use contraceptive method. It is observed from analyses of binary logistic regression table 6.9 that the regions of residence for ever use contraceptives is found significant with $p<0.001$ positively effective factor. From divisional region, we took Sylhet as a reference category, then the regression coefficients of the regions: Barisal, Chittagong, Dhaka, Khulna, Rajshahi and Rangpur are respectively 1.447, 0.51, 1.168, 1.494, 1.581 and 1.649 and all these values are positive. According to the reference category Sylhet division, the odds ratios of Barisal, Chittagong, Dhaka, Khulna, Rajshahi and Rangpur divisions are ever use contraceptive method respectively 4.252 times, 1.666 times, 3.215 times, 4.456 times, 4.861 times and 5.201times more than Barisal region. It indicates that the Barisal region women are lowest contraceptive user than any other regional divisions of Bangladesh. From our result it is found that the higher order of magnitude contraceptive user regions are Rangpur, Rajshahi, Khulna, Barisal, Dhaka and Chittagong; the values respectively are 5.201, 4.861, 4.456, 4.252, 3.215 and 1.666. It is evident from the data of 2011 using for our analysis that there are identical variation of ever use contraception with Sylhet division from other highest contraceptive user division Rangpur, Rajshahi, Khulna respectively. Therefore, we found that this result is consistent one. It may be the impact of formal procedure opinion. Thus, in order to achieve our goal, the family planning program, rural women education and adult education should be strengthened in Sylhet and Chittagong region as early as possible by the government of Bangladesh.

The number of sons died or partial index of mortality is another important independent variable for women ever uses contraceptive method. From table 6.9, we found that for the number of sons died has significant with $p<0.01$ positive effective factor on ever use contraceptive method. For the number of dead sons is a categorical variable where no sons died (0), we took as the reference category, then the regression coefficients of one son died is 0.356 ($p<0.05$) and at least two sons died is 0.165 ($p<0.338$, insignificant value) and the values are positive in sign. According to reference category no son died, the odd ratio of one son died is 1.428 times lower use of contraceptive method and for at least two sons died is 1.180 times lower using of contraceptive method. In additional point of view, for one son died women use contraceptive is $(1.000\text{-}1.428) \times 100 = -42.8\%$ that is about 57% women never use of contraceptive method when women lose one son and $(1.000\text{-}1.180) \times 100 = -18.0\%$ that is 82% women never use contraceptive method when at least two sons died comparing with no son died as reference category. From the result indicated earlier, we may arrive at a conclusion that when women lost their sons, they reduced use of contraceptive method. So, government need to prevent infant mortality and should be strengthening child and mother health care facilities.

Number of living children is an important independent variable of women ever uses contraceptives. It is observed from analyses of binary logistic regression table 6.9 that the number of living children significant with $p<0.001$, negative effective factor of women ever use contraceptive method. For the number of living children is a categorical variable where no children alive (0), we took as the reference category, then the regression coefficients of one living children, two living children, (3-4) living children and (5-10) living children are -3.632 ($p<0.001$), -1.800 ($p<0.001$), -0.499 ($p<0.001$) and -0.008 (insignificant $p<0.929$) respectively and all values are negative in sign. According to the reference category, no children alive (0), the odds ratio for one living children, two living children, (3-4) living children and (5-10) living children are 0.029 times, 0.165 times, 0.607 times and 0.992 times more respectively women ever use contraceptive or avoid getting pregnant. In other point of view with no children alive (0), took as the reference category women use contraception who have one living children, two living children, (3-4) living children and (5-10) living children are $0.029 \times 100 = 3\%$, 16.5%, 60.6% and

99.2% respectively highest contraceptive user. It means that, number of living children increases then contraceptive uses also increases for women.

From the results of multiple logistic regression analysis, it appears that women currently breastfeeding is significant with $p<0.001$ positive effect on ever use of contraception. Considering no breastfed as reference category, the regression coefficient of women currently breastfeeding is 0.434 and the value is of positive in sign. In accordance of reference category, women currently not breastfed their children, the odd ratio for women currently breastfeeding is 1.543 (with $p<0.001$) times more ever use contraceptive method. In additional point of view, the women currently breastfeeding $(1.000-1.543) \times 100\% = -54.3\%$, that is 54.3% more uses contraceptive method. Thus, we may arrived at a conclusion that the women who currently breastfeeding their child, they ever uses contraceptives 54% higher than the reference category women currently not breastfed.

The spousal desire for children is another important independent variable of women ever uses contraceptives. It is observed from analyses of binary logistic regression table 6.9 that the spousal desire for children is found statistically significant with $p<0.001$ positive effective factor of ever uses contraceptives. We took "don't know" as reference category, then the values of regression coefficients of both want same, husband want more and husband want fewer are respectively 0.977, 0.814 and 1.446. The odds ratios of both want same, husband want more and husband want fewer are 2.655, 2.257 and 4.246 respectively. According to reference category, the values of both want same, husband want more and husband wants fewer are 2.655 times, 2.257 times and 4.246 times more uses contraceptive method. The deviation between both want same and husband want more is $(2.655-2.257) = 0.398$; again the deviation between both want same and husband wants fewer is $(2.655-4.246) = -1.591$ that is husband's desire preferred finally. Thus, the result illustrated that in our society the desire about children, husband is the final decision maker and taker. This abash social system should be changed by the government taking help of electronic and print medias righteous fruitfully deed.

From the analysis of multiple logistic regression of table 6.9, we seen that the husband occupation is statistically significant variable with p<0.001 positive effective of women ever uses contraception. We took others (Imam/Religious leader / student) as reference category and then the regression coefficients of agricultural worker, non-agricultural worker, service holder and businessman are 0.775, 0.502, 1.095 and 0.869 respectively. The odds ratios of agricultural worker, non-agricultural worker, service holder and businessman are 2.171, 1.651, 2.990 and 2.385 respectively. This means that, agricultural worker, non-agricultural worker, service holder and businessman are uses contraceptives respectively 2.171 times, 1.651 times, 2.990 times and 2.385 times more than the reference category, others (Imam/Religious leader / student). It is seen from this analysis that service holder is the highest contraceptive user and businessman is second highest contraceptive user with comparing reference category others (Imam/Religious leader / student). The result of 2011 BDHS data's original analysis is as same as that of the result of mine with little difference of occupational category.

Women's currently working is negatively related with ever uses of contraception. This predictor variable women currently working is statistically significant with p<0.001 negative effective for women ever use contraception. For this dummy variable, we took women works as a housewife (0) the reference category, then the regression coefficient for women works outside home (service) is -0.397 and the odd ratio is 0.672. The result indicates that the woman who works as service holder uses contraceptive method 0.672 times more than the woman who works in house as a housewife. In further point of view, we show that the women works outside home as a service holder uses contraceptive method $0.672\times 100\% = 67.2\%$ higher than the women who works in house.

Although this result encourage women working outside home, but in practical, most of the family are separated or divorced with working zone for women outside home. As a result, family formation should be breakdown; child bearing and rearing would also be difficult; infertility is another result which is not suitable side for any society. So, planners should need to take proper initiative for future nonviolent family formation and country's development.

# Chapter Seven

# PREDICTION OF FACTORS TO ACHIEVE TARGET FERTILITY

## 7.1 Introduction

Interdisciplinary studies that draw on long-term, global or regional population projections often make limited use of projection results, due at least in part to the historically opaque nature of the projection process. Demographic factors are important components of both the causes of and responses to future economic, environmental and social change. Interdisciplinary studies of future global or regional change can draw on projected trends in population size and growth rate, age structure, urbanization, and migration, among other variables. Often, however, integration does not proceed far beyond uncritical acceptance of a single projection of future population size and future fertility.

Population projections differ widely in their geographic coverage, time horizon, types of output and use. Spatial dimensions can range from local areas like countries or cities to the entire world. Local-area projections tend to use shorter time horizons, typically less than 10 years, whereas national and global projections can extend decades into the future, and in some cases more than a century. These longer-term projections typically produce a more limited number of output variables, primarily population broken down by age and sex. In contrast, projections for smaller regions often include other characteristics as well, which might include educational and labor force composition, urban/ rural residence, or household type.

The policy community, including advocacy groups, often would like alternatives to a single most likely scenario, including projections that reflect the influence of policy. Global change researchers often use projections as exogenous inputs to studies on topics such as energy consumption, food supply, and global warming. These studies usually require projections with long time horizons a century or more and a range of scenarios rather than a single most likely projection.

We focus here on a relatively small subset of projections: short-term, regional population projections that are sets of projections that may be made at the national or regional level but that cover the whole country Bangladesh. The time horizon of these projections typically ranges from 50 to 150 years. Demographers often feel uncomfortable making projections further than a few decades into the future; uncertainty grows with the time horizon, and increases substantially beyond 30-40 years, when most of the population will be made up of people not yet born. Nevertheless, long-term global projections are increasingly in demand by global change researchers and educators. Only a few institutions produce such projections, but research and practice has been developing rapidly.

Bongaarts model of proximate determinants is now used worldwide for fertility analysis. Moreover, it can be used for projecting future fertility and estimating required contraceptive prevalence rate (CPR) to reach a certain fertility level. Like many other developing countries Bangladesh emphasizes the importance of contraceptive use for reducing fertility as a part of her overall strategy to bring down the growth rate of total population. Family planning programs work in the country in order to achieve demographic targets through the reduction of fertility. For demographic targets of policy makers of different family planning methods to be recruited in each case.

Unfortunately, there has always been a gap between target fertility and its getting at the terminal year of target period in our country all its plan periods. Our country never gained either desired level of fertility or contraceptive prevalence rate or contraceptive use effectiveness annual at achieving the target fertility. For example, during the plan period 1980-1985 the target fertility that is total fertility rate (TFR) had been 4.10 and the desired CPR had been 38%. Whereas, the achievement had been a TFR per woman 5.55 and CPR had been 25%.

Since 1980 the program has stressed functionally integrated health and family planning programs. The target is to provide an essential package of high quality, client-centered reproductive and child health care, family planning services at a one-stop service point. The Health and Population Sector Program (HPSP) was formulated as part of the Fifth Five-Year Plan (1998-2003), keeping in view the principles of the Health and Population Sector Strategy (HPSS) that called for a single sector for both health and population.

Since 1998 the adoption of a Sector-Wide Approach (SWAp) under the HPSP has brought its own set of issues. Throughout these strategy changes, however, the family planning program has continued to function reasonably effectively, and contraceptive use has steadily become more widespread. The first SWAp—the HPSP was formulated as part of the fifth Five-Year Plan (1998-2003), where target TFR and CPR respectively had 2.5 and 60%. Whereas, the achievement had been a TFR per woman 3 and CPR had been 58% (MOHFW, 2004b; BDHS 2004). It was followed by the second SWAp, the Health, Nutrition and Population Sector Program (HNPSP), which began in 2003 and expired in June 2011, where target TFR and CPR respectively had 2.1 and 65%. Whereas, the achievement had been a TFR per woman 2.3 and CPR had been 61% (MOHFW, 2009; BDHS 2011). Additionally, the Health Population Nutrition Sector Development Program (HPNSDP) plans to reduce the TFR to 2.0 children per woman by 2016 (MOHFW, 2011).

To fulfillment such gaps there have raised questions about estimation equation used to project about CPR or contraceptive use effectiveness (UEC) in order to achieve TFR per woman at a desired level at the end of plan period.

## 7.2 Aim of this chapter

The aims of this chapter are as the following:

- Estimate TFR for given level of CPR
- Estimate CPR for achieving target fertility level of TFR taking account trends in few proximate determinants of fertility

- Estimate index of proportion married ($C_m$), index of non-contraception ($C_c$), index of lactational infecundability ($C_i$), and index of fetal wastage ($C_{fw}$) for achieving target fertility
- Estimate mean age at marriage, amenorrhea period and duration of breastfeeding for desired fertility level and
- Projection of different determinants of fertility

## 7.3 Target setting Models of Factors required achieve TFR

Estimate of total fertility rate (TFR) for given level of contraceptive prevalence rate (CPR=$X_i$) is made by fitting exponential regression, polynomial regression and linear regression equations are of forms

i) TFR ($Y_i$) = $\beta_0 \text{Exp} (\beta_1 X_i) + \varepsilon_i$ …………. (1)

ii) TFR ($Y_i$) = $\beta_0 + \beta_1 X_i + \beta_2 X_i^2 + \varepsilon_i$ ……... (2)

iii) TFR ($Y_i$) = $\beta_0 + \beta_1 X_i + \varepsilon_i$ ……………… (3)

Where TFR is total fertility rate, CPR is contraceptive prevalence rate and $\varepsilon_i$ is error term. Here β's are parameters. Estimates of β's are made by methods of least squares using longitudinal data of TFR and CPR and some other factors from 1975 to 2011 of several censuses and surveys. The practice of fitting regression equation to the data of TFR and CPR of which TFR is dependent variable is not a new one. Bongaarts (1984) (Also, Abedin, A & Islam, N 1994; Karim, R & Islam, N 2012) examine strength of relationships between TFR and CPR by fitting linear regression line of TFR and CPR. In this chapter, I would like fitting stated models using longitudinal data instead of cross sectional data as used by Bongaarts.

Again projection of CPR for attainment of specified level of fertility is made by Bongaarts target setting model (Bongaarts, 1984; Karim, R & Islam, N 2012) and this model Revised by Islam et al (2014), is defined as Revised Bongaarts Model relative to total fertility rate (TFR) with a few change in proximate determinants of fertility

TFR = $C_m \times C_c \times C_{fw} \times C_i \times TF$

Where, $C_m$, $C_c$, $C_{fw}$ and $C_i$ are indices of: proportion married, non-contraception, fetal wastage and lactational infecundability respectively. TF is total fecundity rate. Each of four indices varies from 0 to 1; the model can be applied for target setting of target year $t_2$ with respect to base year $t_1$.

That is, $$\frac{TFR(t_2)}{TFR(t_1)} = \frac{C_m(t_2)}{C_m(t_1)} \times \frac{C_c(t_2)}{C_c(t_1)} \times \frac{C_{fw}(t_2)}{C_{fw}(t_1)} \times \frac{C_i(t_2)}{C_i(_1)} \times \frac{TF(t_2)}{TF(t_1)}$$

The above equation indicates that a reduction in fertility from TFR ($t_1$) to the target TFR ($t_2$) depends on the trends in the indices of all proximate variables. The base year may be the present year or some recent year. Under assumption of no change in total fecundity, the absence of or a negligible effect of fetal wastage and trends in indices $C_m$ and $C_i$ compensate each other, and then the equation reduces to the form-

$$\frac{TFR(t_2)}{TFR(t_1)} = \frac{C_c(t_2)}{C_c(t_1)} \quad \ldots \ldots\ldots\ldots\ldots \quad (4)$$

Or, $$1 - \frac{TFR(t_2)}{TFR(t_1)} = 1 - \frac{C_c(t_2)}{C_c(t_1)}$$

i.e., $$\frac{TFR(t_1) - TFR(t_2)}{TFR(t_1)} = \frac{C_c(t_1) - C_c(t_2)}{C_c(t_1)} = -\frac{C_c(t_2) - C_c(t_1)}{C_c(t_1)}$$

Or, $$\frac{TFR(t_1) - TFR(t_2)}{TFR(t_1)} = -\frac{C_c(t_2) - C_c(t_1)}{C_c(t_1)}$$

The above expression indicates that the proportional reduction in fertility (PRF) between '$t_1$' and '$t_2$' depends on proportional increase in CPR from '$t_1$' and '$t_2$' on the assumption that with time, contraceptive prevalence rate will increase.

Since $C_c = 1 - 1.08 \times u \times e$. Where, u = contraceptive prevalence rate, e = use effectiveness of contraception.

Therefore, 1 - $\frac{TFR(t_2)}{TFR(t_1)}$ = 1- $\frac{C_c(t_2)}{C_c(t_1)}$

Or, $1-\frac{TFR(t_2)}{TFR(t_1)} = 1-\frac{1-1.08\times u(\ t_2\ )\times e(\ t_2\ )}{1-1.08\times u(\ t_1\ )\times e(t_1\ )} = PRF$

Or, 1-PRF = $\frac{1-1.08\times u(\ t_2\ )\times e(\ t_2\ )}{1-1.08\times u(\ t_1\ )\times e(t_1\ )}$

Or, (1-PRF) × {1-1.08 × u($t_1$) × e($t_1$)} = 1-1.08 × u($t_2$) × e($t_2$) ………… (5)

Here, u($t_2$) is the CPR among married women of reproductive age at the beginning of the target year '$t_2$'. Rearranging above equation, we get-

$$u(t_2) = \frac{1-(1-PRF\ )\times\{1-1.08\times u(t_1)\times e(t_1)\}}{1.08\times e(t_2\ )}$$

On the assumption of equal use effectiveness of contraception between base year and current year, we have

$$u(t_2) = \frac{1-(1-PRF\ )\times\{1-1.08\times u(t_1)\times e(t\ )\}}{1.08\times e(t\ )}$$

And $e(t_2) = \frac{1-(1-PRF\ )\times\{1-1.08\times u(t)\times e(t_1)\}}{1.08\times u(t)}$

Input data required for estimation of u($t_2$), the CPR and CUE at the target year $t_2$ are

PRF= $\frac{TFR(t_1)-TFR(t_2)}{TFR(t_1)}$......(*)

And, u ($t_1$) the CPR of the base year; e ($t_1$) and e($t_2$), the use effectiveness of contraception of base year and current year respectively.

Hence, fitting regression lines and incorporating target setting to above models for population of Bangladesh by which estimate CPR (also, use effectiveness of contraception, UEC) required to achieve target fertility.

## 7.4 Analyses of Results

### 7.4.1 Trends of observed TFR, CPR, UEC from 1975 to 2011 Bangladesh

(1) Using polynomial regression model (PRM), the equation of TFR on CPR is

TF□ = (-0.00004) × $CPR^2$ + (– 0.072) × CPR + 7.028; where $R^2 = 0.93$

$$CPR = \frac{0.072 \pm \sqrt{(-0.072\ )^2 - 4 \times (-0.00004) \times (7.028 - TFR)}}{2 \times (-0.00004)}$$

(2) Using exponential regression model (ERM), the equation of TFR on CPR is

TF□ = 7.901 × $e^{[-0.02 \times CPR]}$; where $R^2 = 0.92$

$$CPR = \frac{Log_e\left(\frac{7.901}{TFR}\right)}{0.02}$$

(3) Using linear regression model (LRM), the equation of TFR on CPR is

TF□ = 7.063 – 0.074 × CPR; where $R^2 = 0.93$

Or, CPR = (7.063 – TFR) / (0.074)

Observed contraceptive prevalence rates (CPR) and total fertility rates (TFR) for the population of Bangladesh from 1975 to 2011are shown in Table 7.1. The regression lines of TFR on CPR for this longitudinal data yielded regression lines stated above.

The degree of correlation between TFR and CPR is high (r = -0.96). Therefore, the temporal variation of fertility explain by CPR may be attributed 93% and remaining 7% of the total fertility variation unexplained by CPR may be attributed to the effect of other demographic, socio economic and cultural variables. Deviations from regression lines that is, excess fertility are due to measurement errors and partly variations in the other proximate determinants of which marriage and lactational infecundability are important.

**Table 7.1: Observed total fertility rate (TFR) and contraceptive prevalence rate (CPR) from 1975 to 2011, Bangladesh.**

| Year | TFR (observed) | CPR (observed) | Effectiveness (e) |
|---|---|---|---|
| 1975 | 6.33 | 7.7 | 0.82 |
| 1979 | 6.56 | 12.7 | 0.812 |
| 1981 | 5.042 | 18.6 | 0.8 |
| 1983 | 6.08 | 19.2 | 0.839 |
| 1985 | 4.502 | 25.3 | 0.867 |
| 1987 | 5.3 | 29.6 | 0.845 |
| 1989 | 4.895 | 30.8 | 0.848 |
| 1991 | 4.35 | 39.9 | 0.849 |
| 1993-‘94 | 3.44 | 44.6 | 0.886 |
| 1996-‘97 | 3.265 | 49.2 | 0.851 |
| 1999-‘00 | 3.31 | 53.7 | 0.811 |
| 2004 | 3.0 | 58.1 | 0.87 |
| 2007 | 2.705 | 55.8 | 0.87 |
| 2011 | 2.3 | 61.2 | 0.87 |

**Sources:** BFS 1975, 1989; CPS 1983, 1985, 1991; BDHS 1993/94, 1996/97, 1999/2000, 2004, 2007, 2011.

According to PRM, ERM and LRM the TFR equals, on average 7.0, 7.9 and 7.1 births per woman respectively in the absence of contraceptive use (CPR = 0) fertility decline at a rate approximately one birth per woman each 7% increment in the CPR for PRM and LRM, and 2% increment in the CPR for ERM. Also, we have seen from Table 7.1, the values indicated by PRM and LRM are close to each other; whereas the values of ERM differ from other two values. Under relationships between TFR and CPR, we can assess required contraceptive prevalence rate to achieve target fertility level.

### 7.4.2 Estimation of TFR on CPR Using PRL, ERM and LRM

Considering previous year of the current year to be the base year, the target setting models based on polynomial, exponential and linear regression, estimated CPR are not very close to observed levels from these three models of different years but there are less variation between PRM and LRM and more variations found from ERM values.

According to PRM, ERM and LRM, the estimated CPR of 2011 would be respectively around 63.6%, 61.7% and 64.4% instead of 61.2% as observed for a TFR of 2.3. The estimated CPR by the ERM was 0.5% more, which is very close to observed value of CPR of 2011. Contrarily, if the observed CPR is assuming true then by PRM, ERM and LRM estimated TFR would be respectively 2.37 births, 2.32 births and 2.51 births per woman. Very little variation we have found, which are only 0.07 births, 0.02 births and 0.21 births.

The observed CPR: 7.7%, 12.7%, 18.6%, 19.2%, 25.3%, 29.6%, 30.8%, 39.9%, 44.6%, 49.2%, 53.7%, 58.1%, 55.8% and 61.2% corresponding years were 1975, 1979, 1981, 1983, 1985, 1987, 1989, 1991, 1993-’94, 1996-’97, 1999-2000, 2004, 2007 and 2011. Estimated CPR using PRM are 9.64%, 6.5%, 27.3%, 13.1%, 34.4%, 23.7%, 29.2%, 36.5%, 48.8%, 50.9%, 50.2%, 54.3%, 58.3% and 63.6% respectively. Using ERM are 11.1%, 9.3%, 22.5%, 13.1%, 28.12%, 20%, 23.9%, 29.8%, 41.6%, 44.2%, 43.5%, 48.4%, 53.6% and 61.7% respectively. And the estimated values of CPR using LRM are 9.91%, 6.8%, 27.31%, 13.28%, 34.6%, 23.82%, 29.3%, 36.7%, 48.96%, 51.3%, 50.72%, 54.9%, 58.9% and 64.4%. Again, taking observed values of CPR and TFR to same three regression models the estimated CPR and TFR values have shown in Table 7.2.

**Table 7.2: Estimated TFR, CPR using PRM, ERM and LRM from 1975 to 2011.**

| Year | Observed | | Estimated values using | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | PRM | | ERM | | LRM | |
| | TFR | CPR | TFR | CPR | TFR | CPR | TFR | CPR |
| 1975 | 6.33 | 7.7 | 6.47 | 9.64 | 6.77 | 11.08 | 6.49 | 9.91 |
| 1979 | 6.56 | 12.7 | 6.11 | 6.5 | 6.23 | 9.3 | 6.12 | 6.8 |
| 1981 | 5.042 | 18.6 | 5.68 | 27.3 | 5.65 | 22.46 | 5.69 | 27.31 |
| 1983 | 6.08 | 19.2 | 5.63 | 13.1 | 5.63 | 13.1 | 5.64 | 13.28 |
| 1985 | 4.502 | 25.3 | 5.18 | 34.4 | 5.16 | 28.12 | 4.99 | 34.6 |
| 1987 | 5.3 | 29.6 | 4.86 | 23.7 | 4.87 | 20 | 4.87 | 23.82 |
| 1989 | 4.895 | 30.8 | 4.77 | 29.2 | 4.67 | 23.94 | 4.68 | 29.3 |
| 1991 | 4.35 | 39.9 | 4.09 | 36.5 | 4.06 | 29.84 | 4.11 | 36.7 |
| 1993-‘94 | 3.44 | 44.6 | 3.74 | 48.8 | 3.67 | 41.6 | 3.56 | 48.96 |
| 1996-‘97 | 3.265 | 49.2 | 3.38 | 50.9 | 3.58 | 44.2 | 3.62 | 51.3 |
| 1999-‘00 | 3.31 | 53.7 | 2.76 | 50.2 | 3.2 | 43.5 | 3.09 | 50.72 |
| 2004 | 3.0 | 58.1 | 2.71 | 54.3 | 2.67 | 48.42 | 2.76 | 54.9 |
| 2007 | 2.70 | 55.8 | 2.88 | 58.26 | 2.59 | 53.6 | 2.93 | 58.9 |
| 2011 | 2.3 | 61.2 | 2.37 | 63.6 | 2.32 | 61.7 | 2.51 | 64.4 |

Note: PRM, $R^2$ = 0.93; ERM, $R^2$ = 0.92; LRM, $R^2$ = 0.93

### 7.4.3 Estimation of contraceptive prevalence rate (CPR) to achieve target fertility

Using the equation (5), with considering the level of contraceptive prevalence rate (CPR = 61.2%), contraceptive use effectiveness (UEC = 87%) and total fertility rate (TFR = 2.3 births per woman) relative to base year 2011, the estimate CPR required to achieve different level of target fertility shown in Table 7.3. These rates were recurring Revised

Bongaarts Model (Islam et al 2014) taking 2011 BDHS as the base year. The prevalence rates are computed at use effectiveness of contraception levels 0.87, 0.89, 0.90 and 0.91; among them contraceptive use effectiveness has already reached to 0.87 from the year 2004 to 2011(NIPORT & BDHS 2004, 2007, 2011).

The results in the Table 7.3 indicate that if TFR 2.2 would reach with UEC: 0.87, 0.89, 0.90 and 0.91; raises the CPR's 63.17% (CPR require increase level is approximately 2%), 63.06% (CPR require increase level is 1.86%), 63.01% (CPR require increase level is 1.81%) and 62.96% (CPR require increase level is 1.76%) respectively. Again, if TFR 2.1 would reach with CUE: 0.87, 0.89, 0.90 and 0.91; raises the CPR's 65.13% (CPR require increase level is 3.93%), 65.93% (CPR require increase level is 4.73%), 64.82% (CPR require increase level is 3.62%) and 64.73% (CPR require increase level is 3.53%) respectively.

If we want to achieve TFR 2.05 with CUE: 0.87, 0.89, 0.90 and 0.91; raises the CPR's 66.12% (CPR require increase level is 4.92%), 65.85% (CPR require increase level is 4.65%), 65.73% (CPR require increase level is 4.53%) and 65.61% (CPR require increase level is 4.41%) respectively. Finally, If we want to achieve TFR 2.0 births per woman with CUE: 0.87, 0.89, 0.90 and 0.91; raises the CPR's 67.1% (CPR require increase level is 5.9%), 66.78% (CPR require increase level is 5.6%), 66.64% (CPR require increase level is 5.44%) and 66.48% (CPR require increase level is 5.3%) respectively. Proportional reduction in fertility (PRF), reduction in fertility from 2011 BDHS and different targets TFR given values of UEC have shown in Table 7.3. We have found from Table 7.3 that if UEC increases with fixed value of TFR then CPR will decrease sharply.

If we want to attain target fertility with fixed value of UEC then CPR will require increase. To attain TFR 2.1 with specified UEC 0.87 and 0.90 then CPR will be 65.1%

and 64.8% and we will require increase CPR approximately 4% and 3.6% respectively from the base year 2011.

**Table 7.3: Estimated contraceptive prevalence rate to achieve target TFR through specified level of contraceptive use effectiveness (UEC) with respect to 2011 BDHS.**

| Target TFR | PRF | Required CPR u(t), through specified levels of UEC e(t) | | | | Reduction in TFR from 2011 BDHS | Increase CPR in percentage (%) from 2011 BDHS | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | e(t) =0.87 | e(t) =0.89 | e(t) =0.90 | e(t) =0.91 | | e(t) =0.87 | e(t) =0.89 | e(t) =0.90 | e(t) =0.91 |
| 2.28 | 0.0087 | 0.6159 | 0.6157 | 0.6156 | 0.6155 | 0.02 | 0.393 | 0.370 | 0.362 | 0.350 |
| 2.25 | 0.0217 | 0.6218 | 0.62136 | 0.6211 | 0.6208 | 0.05 | 0.983 | 0.930 | 0.906 | 0.880 |
| 2.22 | 0.0348 | 0.6277 | 0.6269 | 0.6265 | 0.6261 | 0.08 | 1.573 | 1.490 | 1.45 | 1.410 |
| 2.20 | 0.0435 | 0.6317 | 0.6306 | 0.6301 | 0.6296 | 0.10 | 1.966 | 1.860 | 1.812 | 1.760 |
| 2.17 | 0.0565 | 0.6376 | 0.6362 | 0.6356 | 0.6349 | 0.13 | 2.556 | 2.420 | 2.356 | 2.290 |
| 2.14 | 0.0696 | 0.6435 | 0.6418 | 0.641 | 0.6402 | 0.16 | 3.146 | 2.980 | 2.899 | 2.820 |
| 2.12 | 0.0783 | 0.6474 | 0.6455 | 0.6446 | 0.6437 | 0.18 | 3.54 | 3.350 | 3.262 | 3.170 |
| 2.1 | 0.087 | 0.6513 | 0.6593 | 0.6482 | 0.6473 | 0.20 | 3.933 | 3.730 | 3.624 | 3.530 |
| 2.08 | 0.0957 | 0.6553 | 0.6529 | 0.6519 | 0.6508 | 0.22 | 4.326 | 4.090 | 3.987 | 3.880 |
| 2.05 | 0.1087 | 0.6612 | 0.6585 | 0.6573 | 0.6561 | 0.25 | 4.916 | 4.650 | 4.531 | 4.410 |
| 2.03 | 0.1174 | 0.6651 | 0.6623 | 0.6609 | 0.6596 | 0.27 | 5.31 | 5.030 | 4.893 | 4.760 |
| 2.0 | 0.1304 | 0.671 | 0.6678 | 0.6664 | 0.6648 | 0.30 | 5.91 | 5.580 | 5.44 | 5.280 |

**Source:** BDHS 2011, TFR = 2.3, CPR = 61.2%; PRF = Proportional reduction in fertility

### 7.4.4 Female Mean Age at Marriage and Total Fertility Rate

Marriage indicates the onset of exposure to the risk of pregnancy for most women and thus it is a significant fertility indicator. There is a universal belief that age at first marriage is inversely related to fertility, particularly in countries with no popular effective use of contraceptive method. This means delayed marriage increases the interval between generations and hence puts an independent barrier to longer-range population growth by reducing proportion of married female in the reproductive ages relative to the total population. As society develops, desired family size decline, because of the influences of different demographic, socio-economic and cultural determinants. The evidence for these view, the reproductive behavior includes the high degree of negative association between TFR and FMAM ($r_{TFR,MAM}$ = -0.71).

The projection for a dramatic decline in the birth rate do not appear to be bright given the age structure of the people, the early age at marriage, universality of marriage and the high traditional value given to childbearing and large families in the Islamic and Hindu cultures. The slow pace of mortality decline, particularly the persistence of infant and child mortality, does not provide a strong motivation for limitation either.

We apply PRM, ERM and LRM for each column relative with TFR on MAM. The regression equation, TFR on MAM are:

i) $\hat{TFR} = 136.7 - 13.67 \times MAM + 0.349 \times MAM^2$

$$MAM = \frac{13.67 \pm \sqrt{((-13.67)^2 - 4 \times (0.349) \times (136.7 - TFR)}}{2 \times (0.349)}$$

ii) $\hat{TFR} = 53.7 \times e^{-0.14 \times MAM}$

$$MAM = \frac{Log_e\left(\frac{53.7}{TFR}\right)}{0.14}$$

iii) $\hat{TFR} = 15.98 - 0.648 \times MAM;\ R^2 = 0.744$

MAM = (15.98 – TFR) / (0.648)

According to equation (iii), TFR is approximately 16 births per woman in the non-increasing of age at marriage and fertility declines at a rate of 6.5 births per woman for each 10% increment in MAM. It also indicates that MAM explains 74% ($R^2$ = 0.744) of the variation in TFR. Deviations from the regression line (iii) partly due to measurement errors and partly due to variations in the other determinants. Similar way we can explain other two regression models.

**Table 7.4: Female mean age at marriage relative to total fertility rate from 1975 to 2011 Bangladesh.**

| Year | TFR | MAM |
|---|---|---|
| **1975** | 6.33 | 16.4 |
| **1989** | 4.895 | 18 |
| **1991** | 4.35 | 17.9 |
| **1993-‘94** | 3.44 | 19.7 |
| **1996-‘97** | 3.265 | 20 |
| **1999-‘00** | 3.31 | 20.4 |
| **2004** | 3.0 | 20.5 |
| **2007** | 3.705 | 18.4 |
| **2011** | 2.3 | 18.6 |

**Source:** 1975 BFS, and 1991 CPS, (Mitra *et al.*, 1993); 1989 BFS (Huq and Cleland, 1990); 1993-1994 BDHS, (Mitra *et al,* 1994); 1996-1997 BDHS (Mitra *et al.,* 1997); 1999-2000 BDHS (NIPORT *et al.,* 2001); 2004 BDHS (NIPORT *et al.,* 2005); 2007 BDHS (NIPORT *et al.*, 2009) and BDHS 2011( NIPORT *et al.*, January 2013).

Also for each other column of the Table 7.4, we have separate three regression lines of TFR on CBR and ASFR’s. These are statistical relationships, but in most developing countries like Bangladesh, the increase in contraceptive use also might be another factor for declining fertility. From these equations, we can calculate approximately female MAM, ASFR’s and CBR for desired target level of fertility.

### 7.4.5 Estimated Female Mean Age at Marriage to Achieve Target Fertility

From Table 7.5 we have found by using polynomial and exponential regression model that mean age at marriage increase in reducing of target fertility. For achieving fertility level 2.2, 2.1, 2.08 and 2.0 it would raise mean age at marriage, approximately 21 years by estimating with polynomial regression model and approximately 23 years by estimating ERM. Now, target mean age at marriage is 23 years. This implies that to achieve replacement level fertility, one may raise mean age at marriage 23 years.

**Table 7.5: Female mean age at marriage to achieve target fertility, Bangladesh.**

| Target TFR | Estimated MAM using | |
|---|---|---|
| | PRM | ERM |
| 2.28 | 20.85 | 22.57 |
| 2.25 | 20.88 | 22.66 |
| 2.22 | 20.92 | 22.76 |
| 2.20 | 20.94 | 22.82 |
| 2.17 | 20.97 | 22.92 |
| 2.14 | 21.0 | 23.02 |
| 2.12 | 21.02 | 23.09 |
| 2.1 | 21.04 | 23.15 |
| 2.08 | 21.06 | 23.22 |
| 2.05 | 21.09 | 23.33 |
| 2.03 | 21.11 | 23.4 |
| 2.0 | 21.14 | 23.5 |

### 7.4.6 Current Use of Modern Contraception and Fertility

Any married couple who dependent practice undertaken consciously to reduce the risk of conception is considered as contraception (BDHS, 2011). Current use of contraception is defined as the proportion of currently married women who report that they are currently using a family planning method. Current use of contraception varies by age. There are also variations in the use of specific methods by age. Use of modern contraceptive method directly affects fertility level of a society to delay or limit the number of children to be born. From a historical point of view, modern contraceptive method use in our country had been very low, but substantial increases of modern contraceptive method practices are now being well documented. In various surveys, use of modern contraception is defined as the proportion of currently married women who report that they are using a family planning modern method at the time of survey.

The use of modern contraceptive method among married women in Bangladesh has increased dramatically, from 5% in 1975 to 52.1% in 2011, a greater than tenfold increase in fewer than four decades. Over the past four years alone, modern contraceptive use has increased by approximately 5%, from 47.5% in 2007 to 52.1% in 2011.

**Table 7.6: Trends of modern family planning methods from 1975 to 2011 Bangladesh.**

| Year | TFR | Pill | Condom | Injection | Long-acting permanent method (LAPM) | | | | Modern (total) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | IUD | Female Sterilization | Male Sterilization | Implant | |
| 1975 | 6.33 | 2.7 | 0.7 | 0 | 0.5 | 0.6 | 0.5 | - | 5.0 |
| 1983 | 5.042 | 3.3 | 1.5 | 0.2 | 1.0 | 6.2 | 1.2 | - | 13.8 |
| 1985 | 4.502 | 5.1 | 1.8 | 0.5 | 1.4 | 7.9 | 1.5 | - | 18.4 |
| 1989 | 4.895 | 9.6 | 1.8 | 0.6 | 1.4 | 8.5 | 1.2 | - | 23.2 |
| 1991 | 4.35 | 13.9 | 2.5 | 2.6 | 1.8 | 9.1 | 1.2 | - | 31.2 |
| 1993-'94 | 3.44 | 17.4 | 3 | 4.5 | 2.2 | 8.1 | 1.1 | - | 36.2 |
| 1996-'97 | 3.265 | 20.8 | 3.9 | 6.2 | 1.8 | 7.6 | 1.1 | 0.1 | 41.5 |
| 1999-'00 | 3.31 | 23 | 4.3 | 7.2 | 1.2 | 6.7 | 0.5 | 0.5 | 43.4 |
| 2004 | 3.0 | 26.2 | 4.2 | 9.7 | 0.6 | 5.2 | 0.6 | 0.8 | 47.3 |
| 2007 | 3.705 | 28.5 | 4.5 | 7.0 | 0.9 | 5.0 | 0.7 | 0.7 | 47.5 |
| 2011 | 2.3 | 27.2 | 5.5 | 11.2 | 0.7 | 5.0 | 1.2 | 1.1 | 52.1 |

**Note:** - = Unknown; **Source:** BFS 1975, 1989; CPS 1983, 1985, 1991; BDHS 1993-`94, 1996-`97, 1999-2000, 2004; Mitra and Associates, May 2005, 57; 2007 NIPORT March 2009 & 2011 BDHS, NIPORT, January 2013.

In 2011, the pill is the most widely used method 27.2%, followed by injectables 11.2%, male condoms 5.5%, and female sterilization 5%. About 1% each uses the IUD, male sterilization and other (implants, Vaginal). The use of oral pills declined slightly between 2007 and 2011, but the decline in injectables use seen in 2007 reversed in 2011, showing an increase from 7% to 11.2% of married women. The Table 7.6 indicate that the decline in injectables use, from 10% in 2004 to 7% in 2007. While female sterilization has stalled, holding steady at about 5% of married women since 2004, there is a hint that use of male sterilization may have increased slightly since 2007.

In 2011 only 8% of married couples use a long-acting permanent method (LAPM), namely sterilization, IUD, and implants. Use of LAPM was 12% in 1991. Use of LAPM started to decline in the early 1990s, stabilized in2007, and hints at a slight increase in 2011. Since 2004 there has been a slow increase in the use of male sterilization and implants, although the usage rate of these methods remains very low. The plateauing of LAPM methods should be of concern, as fertility is now so low that most childbearing is completed by the mid-to late-twenties, and women face two subsequent decades of reproductive life during which they must protect themselves from unwanted pregnancies.

### 7.4.7 Estimation of the Use of Modern Contraceptive Methods (MCM) Relative to Target Fertility

There are variations in the use of specific contraceptive methods. Use of modern contraceptive method directly affects fertility (TFR). We utilize PRM and ERM to each column relative to the regression equation of TFR on each modern contraceptive method. The summary results have shown in Table 7.7. For achieving of the fertility level (TFR) 2.2, 2.1, 2.08 and 2.05 there require increase use of pill approximately 36%, 37%, 38% and 39% respectively by estimating with exponential regression model (ERM) and approximately 30%, 31%, and for both TFR 2.08 and 2.05 the increase use of pill is approximately 32% by estimating polynomial regression model (PRM). Deviation of percentages of pill is perhaps due to ERM, which is non-linear increasing model and PRM is also non-linear decreasing model.

Achieving of the fertility level (TFR) 2.2, there require increase use of condom is 6% and for TFR 2.1, 2.08 and 2.05 there require increase use of condom is 6.3% by estimating with exponential regression model (ERM) and achieving TFR 2.2, 2.1, 2.08 and 2.05 there require increase use of condom respectively 5.24%, 5.36%, 5.38% and 5.42% by estimating polynomial regression model (PRM).

Achievement of the fertility (TFR) level 2.2, 2.1, 2.08 and 2.05 there require increase use of injectables respectively 12.8%, 13.5%, 13.6% and 13.8% by the estimation of ERM and 11.47%, 11.67%, 11.71% and 11.77% respectively by estimate with the PRM. Achieving target TFR 2.2, 2.1, 2.08 and 2.05 there require increase use of female sterilization 6.72%, 7.36%, 7.51% and 7.72% by ERM, and 5.78%, 5.7%, 567% and 5.65% respectively by the estimation of PRM. To achieve target TFR 2.1, 2.05 and 2.0 with use of total CPR's as taken 100% then modern contraceptive methods cover approximately 63%, 64% and 66% by estimate using ERM; and approximately 56% and 56.5%, and 57% respectively by estimation of PRM. Therefore, we may use ERM as modern contraceptive method standard level to achieve target fertility.

**Table 7.7: Estimated values of modern contraceptive methods (MCM) with specified values of target fertility, Bangladesh.**

| Target TFR | Pill | | Condom | | Injection | | Female Sterilization | | Modern (total) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ERM | PRM | ERM | PRM | ERM | PRM | ERM | PRM | ERM | PRM |
| 2.28 | 34.4 | 29.8 | 5.7 | 5.14 | 12.3 | 11.31 | 6.29 | 5.84 | 59.1 | 53.7 |
| 2.25 | 34.8 | 30.1 | 5.8 | 5.18 | 12.5 | 11.37 | 6.44 | 5.82 | 59.7 | 54.1 |
| 2.22 | 35.3 | 30.3 | 5.9 | 5.21 | 12.7 | 11.43 | 6.61 | 5.79 | 60.0 | 54.4 |
| 2.20 | 35.6 | 30.4 | 6.0 | 5.24 | 12.8 | 11.47 | 6.72 | 5.78 | 60.8 | 54.7 |
| 2.17 | 36.0 | 30.7 | 6.04 | 5.27 | 13.0 | 11.53 | 6.91 | 5.75 | 61.5 | 55.0 |
| 2.14 | 36.5 | 30.9 | 6.15 | 5.31 | 13.2 | 11.59 | 7.1 | 5.73 | 62.2 | 55.4 |
| 2.12 | 36.8 | 31.1 | 6.2 | 5.33 | 13.3 | 11.63 | 7.22 | 5.71 | 62.7 | 55.6 |
| 2.1 | 37.1 | 31.2 | 6.24 | 5.36 | 13.5 | 11.67 | 7.36 | 5.69 | 63.2 | 55.9 |
| 2.08 | 37.5 | 31.5 | 6.2 | 5.38 | 13.6 | 11.71 | 7.51 | 5.67 | 63.4 | 56.1 |
| 2.05 | 37.9 | 31.6 | 6.3 | 5.42 | 13.8 | 11.77 | 7.72 | 5.65 | 64.4 | 56.5 |
| 2.03 | 38.3 | 31.8 | 6.37 | 5.44 | 14.0 | 11.81 | 7.89 | 5.64 | 64.9 | 56.7 |
| 2.0 | 38.8 | 32.0 | 6.44 | 5.48 | 14.2 | 11.88 | 8.13 | 5.61 | 65.6 | 57.1 |

**Note:** [Modern: ERM, $R^2$= 0.94, PRM, $R^2$= 0.94]; [Pill: ERM, $R^2$= 0.91, PRM, $R^2$= 0.90]; [Condom: ERM, $R^2$= 0.94, PRM, $R^2$= 0.93]; [Injection: ERM, $R^2$= 0.88, PRM, $R^2$= 0.87]

**Figure 7.1: Use of modern contraceptive methods with specified values of target fertility.**

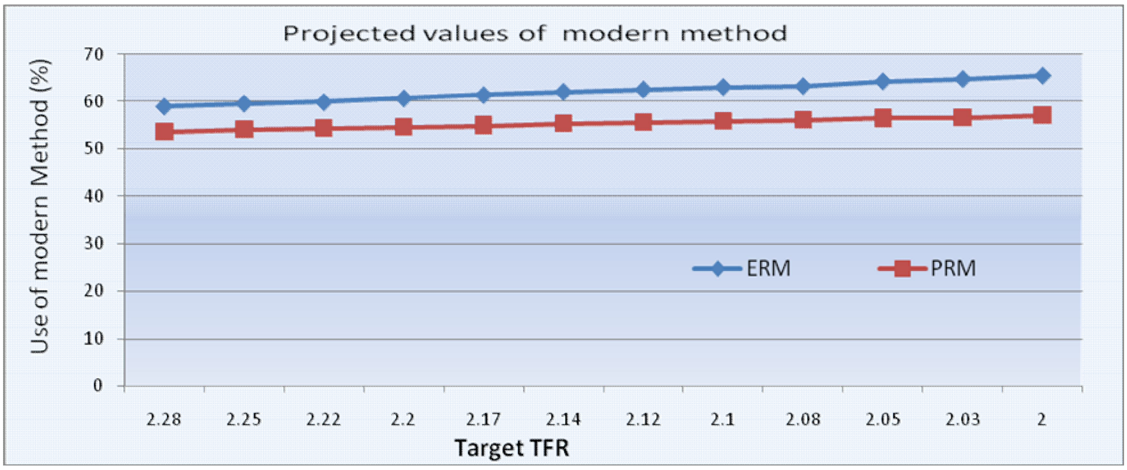



**Figure 7.2: Use of oral pills as MCM with specified values of target fertility.**

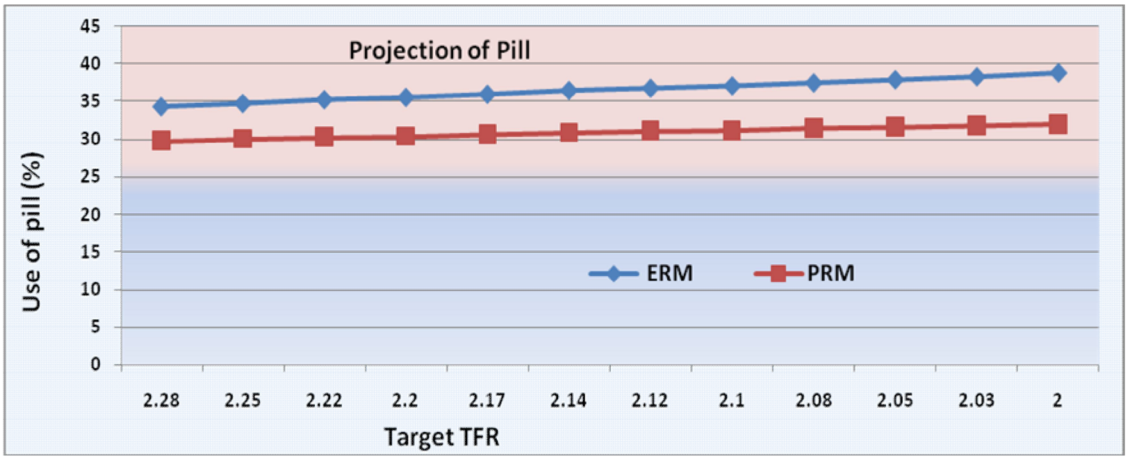



**Figure 7.3: Use of condom as MCM with specified values of target fertility.**

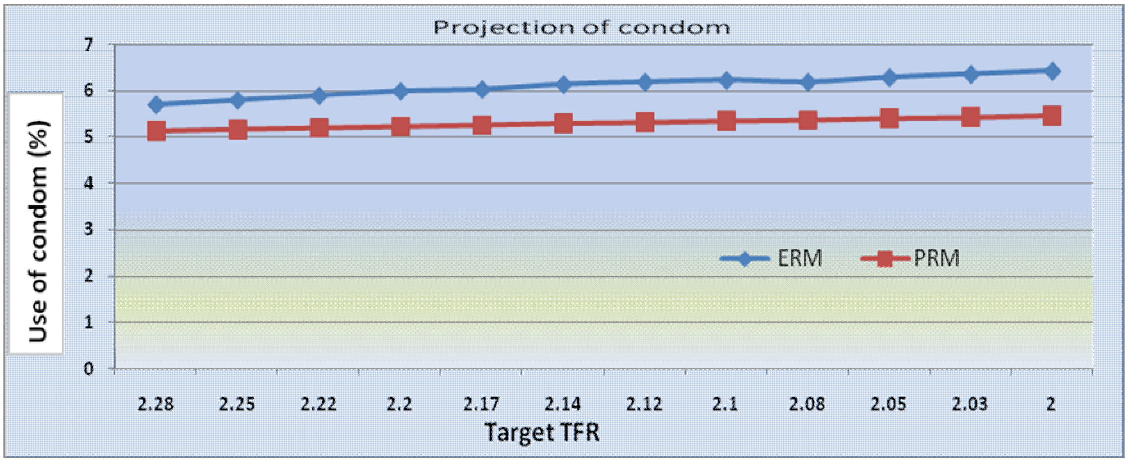


**Figure 7.4: Use of injectables as MCM with specified values of target fertility.**

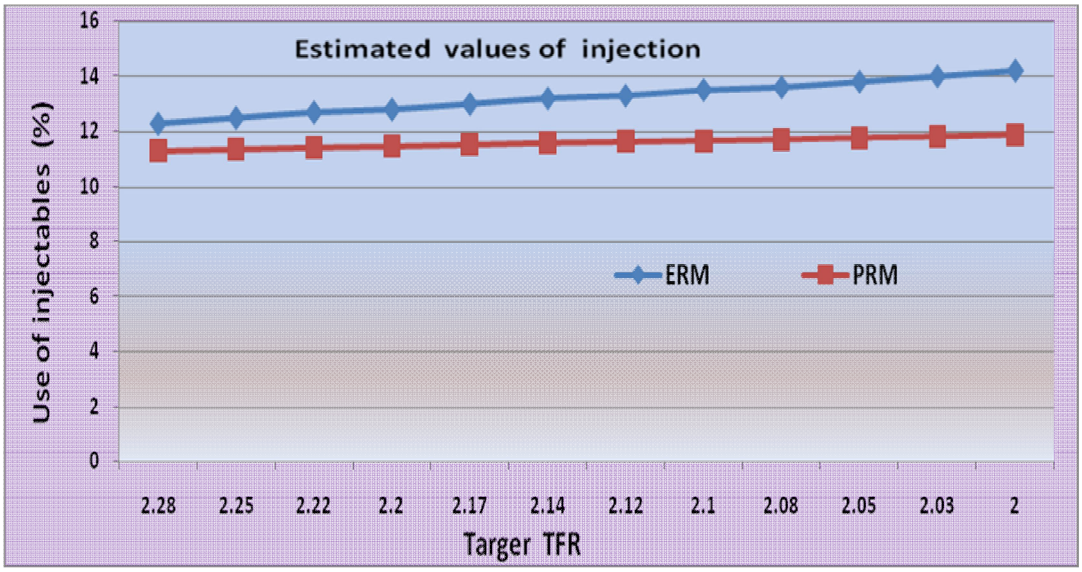
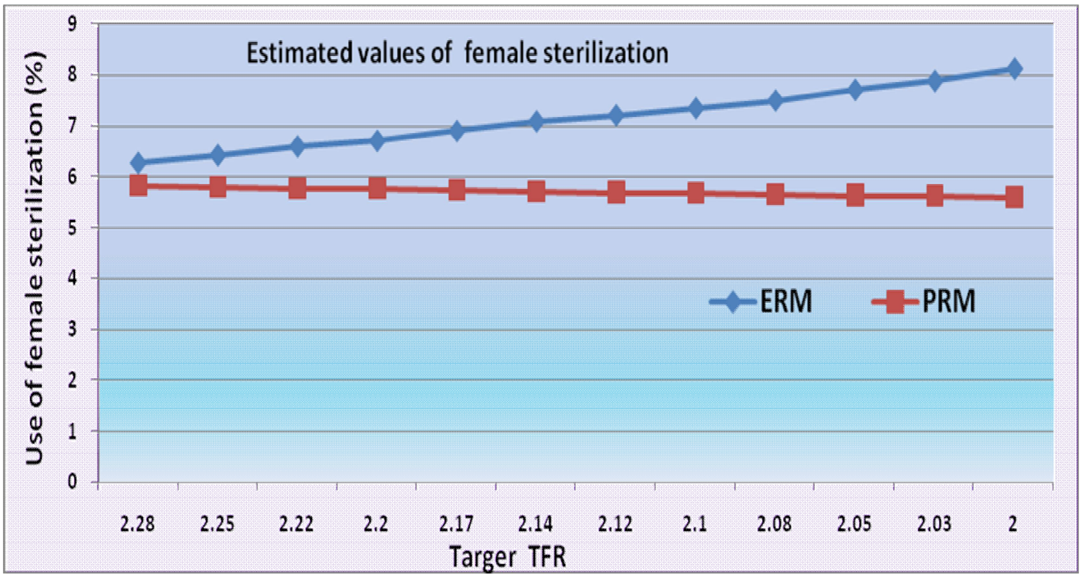



**Figure 7.5 Use of female sterilization as MCM with specified values of target fertility.**



**7.4.8 Estimation of indices to achieve target fertility**

Revised Bongaarts Model (Islam *et al.*, 2014) can be used to projecting of the indices: index of proportion married ($C_m$), index of lactational infecundability ($C_i$), index of non-contraception ($C_c$) and index of fetal wastage ($C_{fw}$) by using proportional reduction in fertility (PRF).

The index of proportion married is estimated by the equation $C_m = \frac{\sum m(a)g(a)}{\sum g(a)}$, Where m(a) is the age-specific proportion of females currently married and g(a) is the age-specific fertility rate.

Lactation has an inhibiting effect on fertility and thus increases the birth interval and reduces natural fertility (Potter, 1965). A typical average birth intervals with and without lactation is given by-

$$C_i = \frac{20}{18.5 + i} ,$$

Where, i is the average duration (in months) of infecundability from birth to the first post-partum ovulation (menses). An indirect estimates of i as developed by Bongaarts is given by, $i = 0.1753\times \exp[0.1396\times B - 0.001872\times B^2]$, Where, B is the average duration of breastfeeding in months.

The index of fetal wastage is given by

$$C_{fw} = \frac{TFR}{(TFR + AFW)}$$

Where, AFW equals the average number of birth averted per woman by the end of the reproductive years for all fetal wastage and which is estimated by

$AFW = 0.4 \times (1 + u) \times TFW$, where TFW is the total fetal wastage rate and AFW is the average number of all fetal wastage per woman at the end of the reproductive years.

The index of Non-contraception ($C_c$) can be written as

$$C_c = 1 - s \times u \times e,$$

Where, u is the average proportion of married women currently using contraception (average of age specific use rate), e is the average contraceptive effectiveness and a value for s = 1.08 obtain by Henry (1961) is likely to provide a good approximation for many countries (Bongaarts, 1978).

The Revised Bongaarts Model [solution of equation (*)] can be written as

$$C_m(t_2) \times C_c(t_2) \times C_i(t_2) \times C_{fw}(t_2) = (1\text{-PRF}) \times C_m(t_1) \times C_c(t_1) \times C_i(t_1) \times C_{fw}(t_1) \quad \ldots \quad (1)$$

Where, $C_m(t_2)$ is the index of proportion married at time $t_2$

$C_c(t_2)$ is the index of non-contraception at time $t_2$

$C_{fw}(t_2)$ is the index of fetal wastage at time $t_2$ , and

$C_i(t_2)$ is the index of lactational infecundability at time $t_2$

$C_m(t_1)$ is the index of proportion married to base year at 2011

$C_c(t_1)$ is the index of non-contraception to base year at 2011

$C_{fw}(t_1)$ is the index of fetal wastage to base year at 2011 , and

$C_i(t_1)$ is the index of lactational infecundability to base year at 2011

Now, if we eliminate the effect of fetal wastages, during the time period

i.e., $C_{fw}(t_2) = C_{fw}(t_1)$, then the equation (1) becomes-

$$C_m(t_2) \times C_c(t_2) \times C_i(t_2) = (1\text{-PRF}) \times C_m(t_1) \times C_c(t_1) \times C_i(t_1) \quad \ldots \ldots\ldots \quad (2)$$

If lactational infecundability is constant over time, then equation (2) becomes

$$C_m(t_2) \times C_c(t_2) = (1\text{-PRF}) \times C_m(t_1) \times C_c(t_1) \quad \ldots \ldots\ldots\ldots\ldots \quad (3)$$

Again if the index non-contraception is constant over time i.e. use of contraception may not be changed, then we have from equation (3)

$$C_m(t_2) = (1\text{-PRF}) \times C_m(t_1) \quad \ldots \quad (4)$$

If all the indices except, the index of $C_c$ are constant over time then the index of non-contraception becomes

$$C_c(t_2) = (1\text{-PRF}) \times C_c(t_1) \quad \ldots \quad (5)$$

Similarly, the index of lactational infecundability becomes

$$C_i(t_2) = (1\text{-PRF}) \times C_i(t_1) \quad \ldots \quad (6)$$, and The index of fetal wastage becomes

$$C_{fw}(t_2) = (1\text{-PRF}) \times C_{fw}(t_1) \quad \ldots \quad (7)$$

Using equation (4), (5), (6), and (7) we can estimate the values of $C_m(t_2)$, $C_c(t_2)$, $C_i(t_2)$ and $C_{fw}(t_2)$ for the required level of fertility (TFR).

Suppose we want to achieve specified fertility (TFR). Thus, there require increase age at marriage, contraceptive prevalence rate (CPR), use effectiveness of contraceptives (UEC) and duration of lactational period. Different sets of target fertility (TFR) are assumed for calculation of proportional reduction in fertility (PRF). Using these PRF, the estimated value of the indices $C_m(t_2)$, $C_c(t_2)$, $C_i(t_2)$ and $C_{fw}(t_2)$ are presented in Table 7.8. The values of $C_m$ from Table 7.8 and Figure 7.6 indicate that target fertility (TFR) would be declined when the index of proportion married is declined. The value of the index non-contraception $C_c$ in Table 7.8 and Figure 7.7 summarizes that the trend of the index $C_c$ would decreasing with declining of the value of specified target fertility (TFR).

The value of $C_i$ in Table 7.8 and Figure 7.8 reflect that if mothers would increases their breastfeeding duration then target fertility will be achieve. The value of the index fetal wastage $C_{fw}$ in Table 7.8 and Figure 7.9 suggest that if fetal wastages increasing (no moral ground) that is if the index of fetal wastage would be decrease then target fertility will achieve. Finally, Table 7.8 and Figure 7.10 demonstrated that if all indices increase in percentage with specified each value based on BDHS 2011 then target fertility will achieve.

**Table 7.8: Estimated indices $C_m$, $C_c$, $C_i$ and $C_{fw}$ relative to assumed values of TFR with PRF.**

[Calculation based on 2011 BDHS, $C_m$= 0.81422; $C_c$= 0.42496; $C_i$ = 0.6693; $C_{fw}$ = 0.84203]

| Target TFR | PRF | $C_m(t)$ | $C_c(t)$ | $C_i(t)$ | $C_{fw}(t)$ | Decrease each index (in%) from 2011 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $C_m(t)$ | $C_c(t)$ | $C_i(t)$ | $C_{fw}(t)$ |
| 2.28 | 0.0087 | 0.80741 | 0.42127 | 0.66348 | 0.8347 | 0.71 | 0.37 | 0.58 | 0.73 |
| 2.25 | 0.0217 | 0.79652 | 0.41573 | 0.65475 | 0.82372 | 1.77 | 0.92 | 1.46 | 1.83 |
| 2.22 | 0.0348 | 0.78591 | 0.41018 | 0.64602 | 0.81274 | 2.83 | 1.48 | 2.33 | 2.93 |
| 2.20 | 0.0435 | 0.77882 | 0.40649 | 0.6402 | 0.80542 | 3.54 | 1.85 | 2.91 | 3.66 |
| 2.17 | 0.0565 | 0.7682 | 0.40095 | 0.63147 | 0.79444 | 4.6 | 2.4 | 3.78 | 4.76 |
| 2.14 | 0.0696 | 0.75758 | 0.3954 | 0.62274 | 0.78345 | 5.66 | 2.96 | 4.66 | 5.86 |
| 2.12 | 0.0783 | 0.7505 | 0.39171 | 0.61692 | 0.77613 | 6.37 | 3.33 | 5.24 | 6.59 |
| 2.1 | 0.087 | 0.74342 | 0.38801 | 0.6111 | 0.76881 | 7.09 | 3.7 | 5.82 | 7.32 |
| 2.08 | 0.0957 | 0.73634 | 0.38432 | 0.60528 | 0.76149 | 7.78 | 4.60 | 6.4 | 8.05 |
| 2.05 | 0.1087 | 0.72572 | 0.37877 | 0.59655 | 0.7505 | 8.85 | 4.62 | 7.27 | 9.15 |
| 2.03 | 0.1174 | 0.71864 | 0.37508 | 0.59073 | 0.74318 | 9.56 | 4.99 | 7.86 | 9.88 |
| 2.0 | 0.1304 | 0.70803 | 0.36954 | 0.582 | 0.7322 | 10.62 | 5.54 | 8.73 | 10.98 |

Source: BDHS 2011, TFR=2.3

**Figure 7.6: Values of the index of proportion married with specified target fertility.**

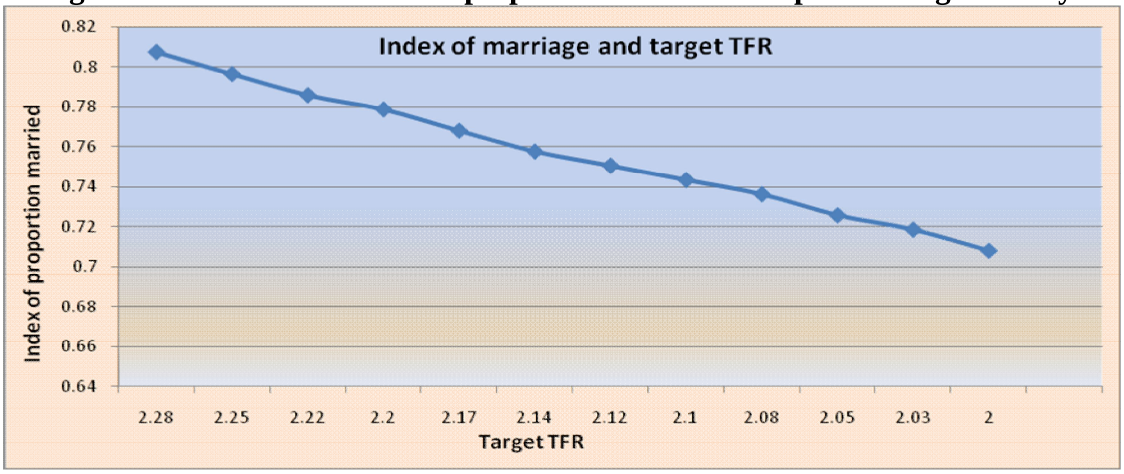



**Figure 7.7: Values of the index of non-contraception with specified target fertility.**

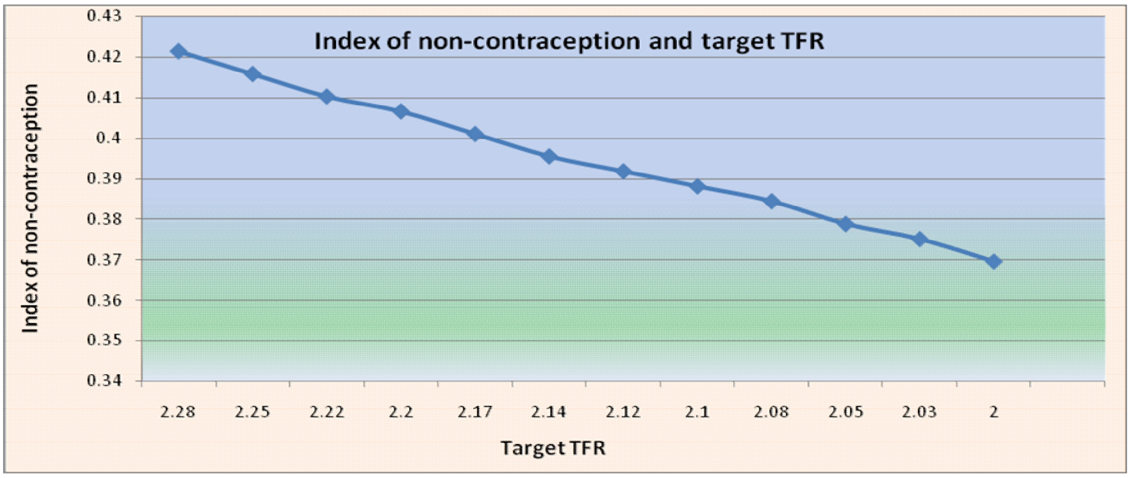



**Figure 7.8: Values of the index of lactational infecundability with specified target fertility.**

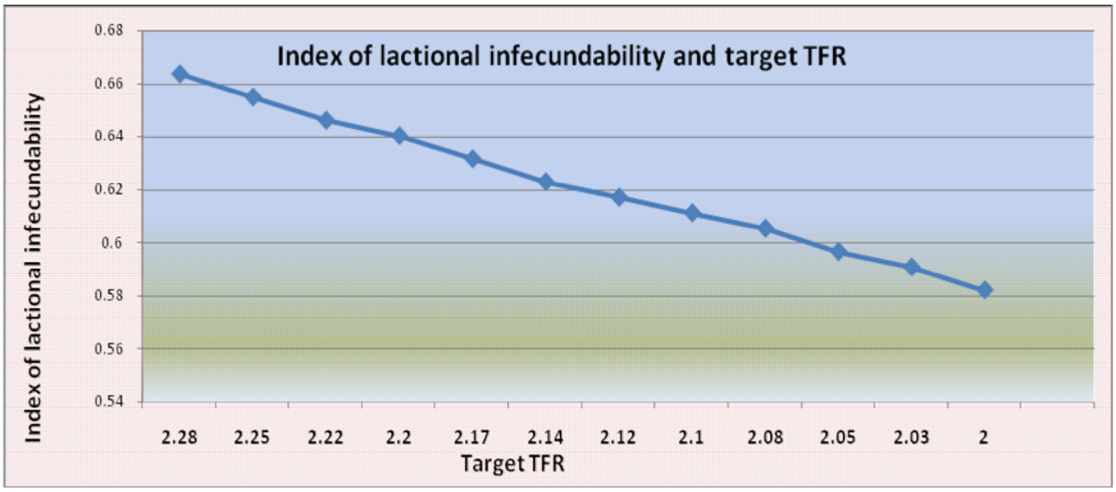


**Figure 7.9: Values of the index of fetal wastage with specified target fertility.**

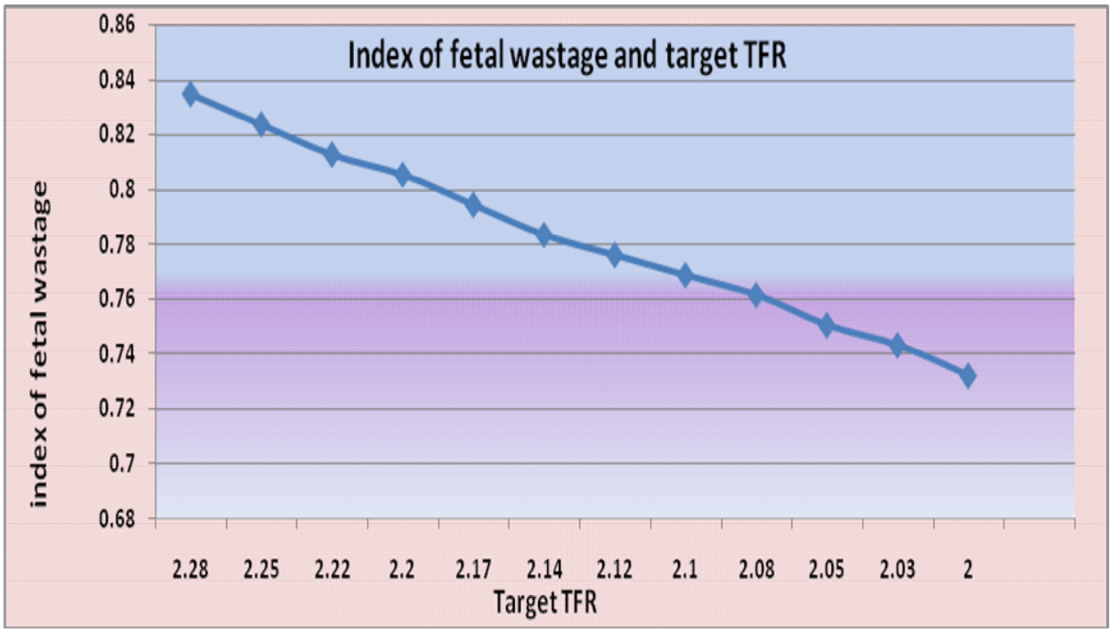
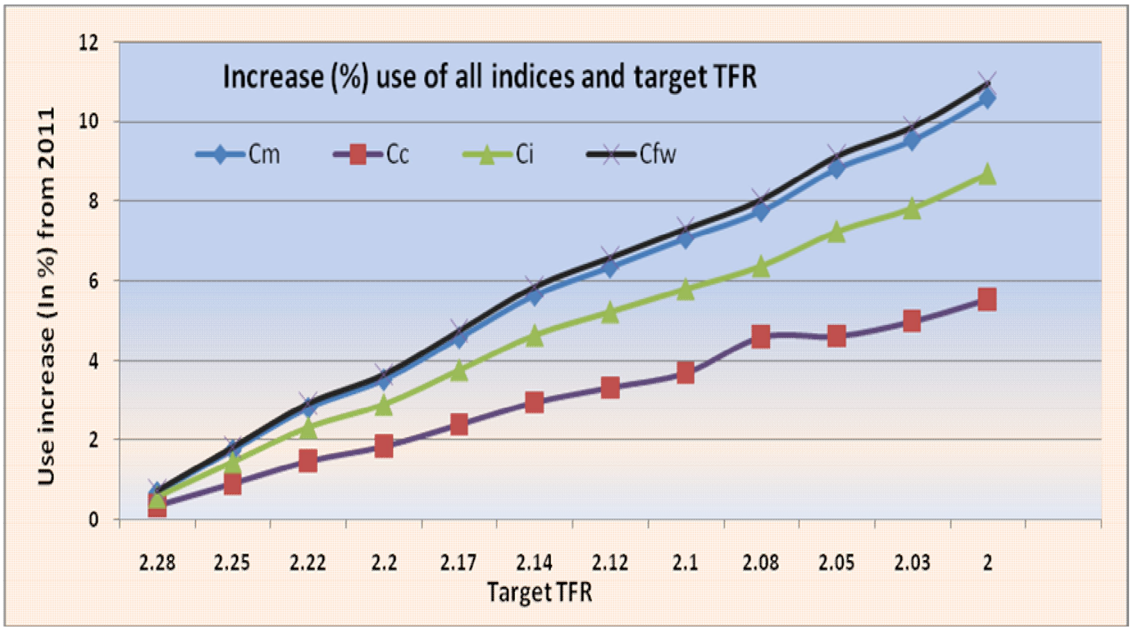



**Figure 7.10: Values of increase use in percentage of all indices with specified target fertility based on BDHS 2011, Bangladesh.**



### 7.4.9 Estimation of the median duration of breastfeeding and amenorrhea period relative to target fertility

Lactation has an inhibiting effect on fertility and thus increases the birth interval and reduces natural fertility (Potter, 1965). A typical average birth interval with and without lactation that is the index of lactational infecundability ($C_i$) is-

$$C_i = \frac{20}{18.5 + i} \quad \dots \quad (1)$$

Where, 'i' is the average duration (in months) of infecundability from birth to the first post-partum ovulation (menses). Putting the values of $C_i$ in equation (1), we can found the values of amenorrhea period 'i' in months.

The equation of relationships between the duration of breastfeeding (B in months) and amenorrhea period ('i' in percentage months), we can estimate the median duration of breastfeeding.

An indirect estimates of 'i' as developed by Bongaarts (1978) is given by

$$i = 0.1753 \times \exp\,[0.1396 \times B - 0.001872 \times B^2] \quad \dots \quad (2)$$

Where, B is the median duration of breastfeeding in months.

Taking log on both sides in equation (2) then we get

$$\text{Log}_e\left(\frac{i}{0.1753}\right) = 0.1396 \times B - 0.001872 \times B^2$$

Let, $\text{Log}_e\left(\frac{i}{0.1753}\right) = c$

$$c = 0.1396 \times B - 0.001872 \times B^2,$$

$$ax^2 + bx + c = 0,$$

Where, a = 0.001872; b = -0.1396; and B = x, is the median duration of breastfeeding in months.

The roots of the equation are

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Using this solution, we can estimate the median duration of breastfeeding and amenorrhea period.

From Table 7.9 and Figure 7.11 we have seen that the duration of amenorrhea period (in months) and the duration of breastfeeding (in months) are increasing for achievement of target fertility (TFR).

For the achievement of target fertility 2.2, 2.1, 2.08 and 2.0 there require increase duration of lactational amenorrhea period respectively about 12.8 months, 14.2 months, 14.6 months, 16 months and require increase duration of breastfeeding respectively about 32 months, 33 months, 33.1 months and 34 months. Very little absolute variations we have found for both duration of lactational amenorrhea and duration of breastfeeding periods compared with base value of 2011. For the achievement of target fertility 2.1, 2.05 and 2.0 there require increase duration of amenorrhea period respectively 25%, 32%, 39% and duration of breastfeeding period respectively 6%, 7% and 8% on the basis of 2011 (Figure 7.12).

**Table 7.9: Estimation of lactational infecundability, amenorrhea period and median duration of breastfeeding to achieve target fertility.**

[Taking BDHS 2011 as base year, i = 11.38 months and B = 31.2 months]

| Target TFR | $C_i$ | months | B months | Absolute increase from base year 2011 | | Percentage increase from base year 2011 | |
|---|---|---|---|---|---|---|---|
| | | | | i | B | i | B |
| 2.28 | 0.663 | 11.66 | 31.39 | 0.03 | 0.01 | 2.46 | 0.6 |
| 2.25 | 0.655 | 12.03 | 31.63 | 0.06 | 0.014 | 5.71 | 1.4 |
| 2.22 | 0.646 | 12.45 | 31.91 | 0.1 | 0.023 | 9.5 | 2.3 |
| 2.20 | 0.64 | 12.75 | 32.09 | 0.12 | 0.03 | 12.04 | 2.9 |
| 2.17 | 0.632 | 13.2 | 32.36 | 0.16 | 0.04 | 16 | 3.7 |
| 2.14 | 0.623 | 13.6 | 32.6 | 0.2 | 0.045 | 19.5 | 4.5 |
| 2.12 | 0.617 | 13.91 | 32.77 | 0.22 | 0.05 | 22.23 | 5 |
| 2.1 | 0.611 | 14.23 | 32.95 | 0.25 | 0.056 | 25.04 | 5.6 |
| 2.08 | 0.605 | 14.56 | 33.13 | 0.3 | 0.062 | 27.94 | 6.2 |
| 2.05 | 0.597 | 15.0 | 33.36 | 0.32 | 0.07 | 31.81 | 6.9 |
| 2.03 | 0.591 | 15.34 | 33.54 | 0.35 | 0.075 | 34.8 | 7.5 |
| 2.0 | 0.582 | 15.86 | 33.8 | 0.4 | 0.083 | 39.4 | 8.3 |

**Figure 7.11: Values of amenorrhea period (i) and duration of breastfeeding to achieve target fertility.**

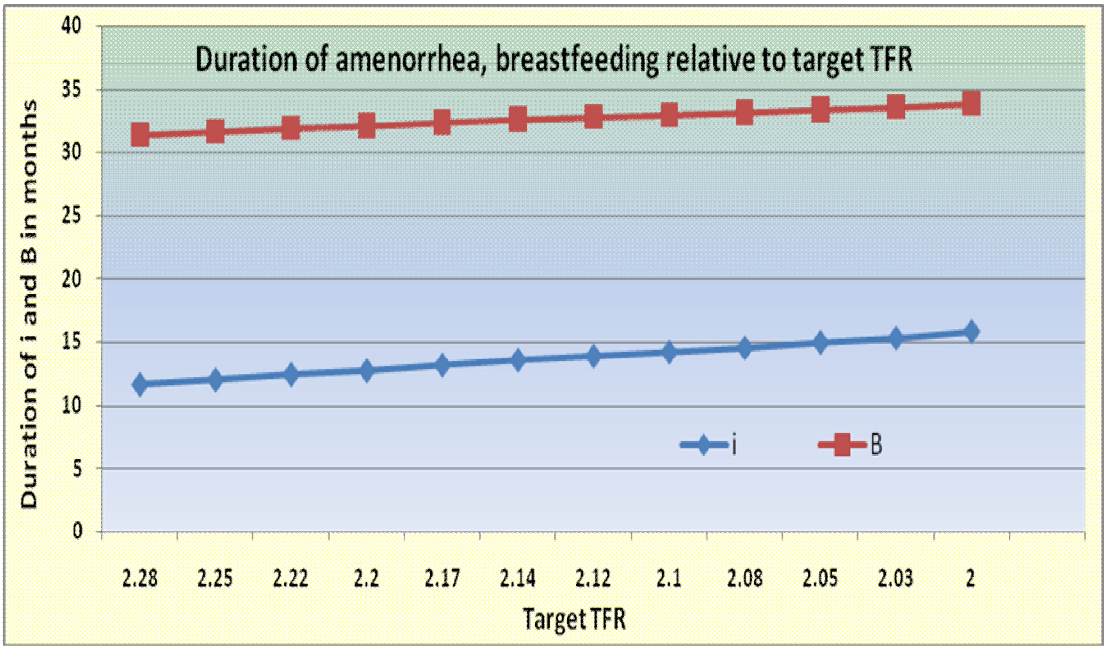
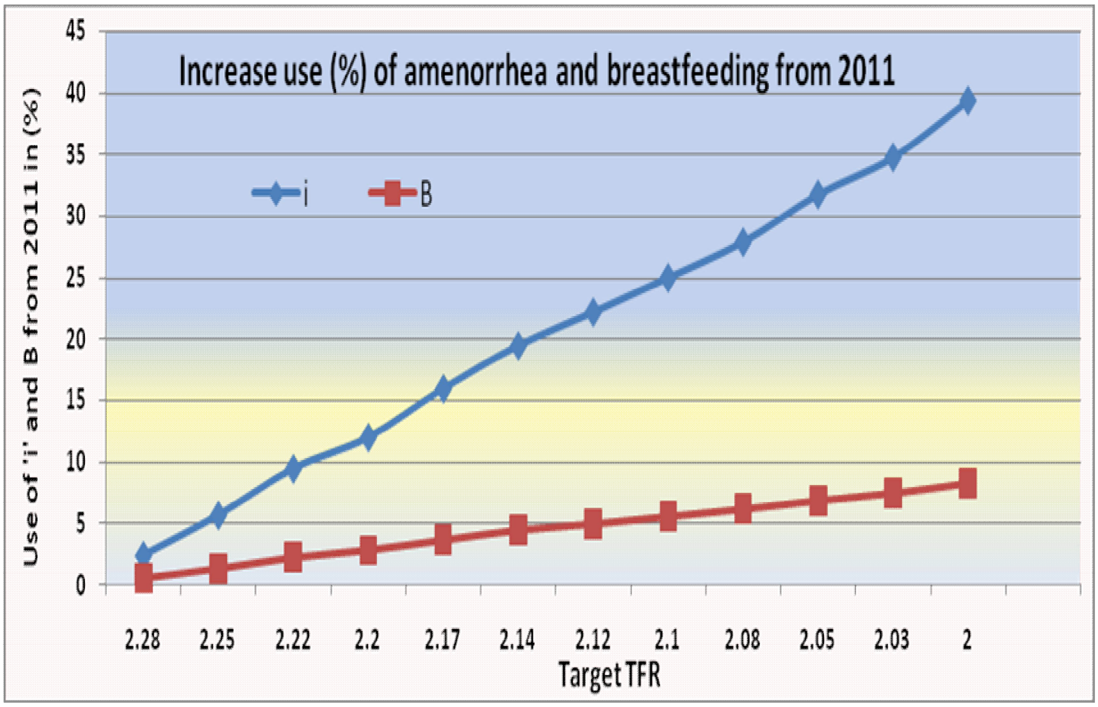



**Figure 7.12: Increase use of amenorrhea period (i) and duration of breastfeeding (B) relative to achieve target fertility from BDHS 2011.**



## 7.5 Conclusion

Estimation of CPR to achieve target fertility at a specific time period using four models viz., ERM, PRM, LRM and Revised Bongaarts model are found inconsistent results for obvious reasons. Apart from methodological differences, the estimate of CPR using ERM, PRM and LRM are based on completely by the face values of TFR and UEC. The trends of both factors while the estimate made by Revised Bongaarts model target setting TFR heavily depends only on the level of contraceptive use of the most recent year and ignores the effect of the two important proximate variables. One is marriage pattern and another one is lactational infecundability. There seems to be a change in marriage pattern in Bangladesh and also a norm of long duration of breastfeeding practice (showed earlier) the effects of which we cannot ignore to achieve target fertility. A high degree of correlation among TFR, with CPR bears the implication that it is possible to achieve specified level of target fertility if the present swiftness of progress in contraceptive practice is maintained. However, the estimation process of proximate determinants requires modern techniques.

For achieving fertility level 2.2, 2.1, 2.08 and 2.0 it would raise mean age at marriage, approximately 21 years by estimating with polynomial regression model and approximately 23 years by estimating ERM. Now, target mean age at marriage is 23 years. This implies that to achieve replacement level fertility, one may raise mean age at marriage 23 years.

For achieving of the fertility level 2.2, 2.1, 2.08 and 2.05 there require increase use of pill approximately 36%, 37%, 38% and 39% respectively by estimating with ERM and approximately 30%, 31%, and for both TFR 2.08, 2.05 the increase use of pill is approximately 32% by estimating with PRM. Achieving fertility level 2.2, there require increase use of condom 6% and for TFR 2.1, 2.08 and 2.05 need 6.3% increase by estimating with ERM and achieving TFR 2.2, 2.1, 2.08 and 2.05 there require increase use of condom respectively 5.24%, 5.36%, 5.38% and 5.42% by the PRM.

Achievement fertility level 2.2, 2.1, 2.08 and 2.05 there require increase use of injectables respectively 12.8%, 13.5%, 13.6% and 13.8% by the ERM and 11.47%, 11.67%, 11.71% and 11.77% respectively by the PRM. Achieving target TFR 2.2, 2.1, 2.08 and 2.05 require increase use of female sterilization 6.72%, 7.36, 7.51% and 7.72% by ERM, and 5.78%, 5.7%, 567% and 5.65% respectively by the PRM.

To achieve target TFR 2.1, 2.05 and 2.0 with use of CPR's as taken 100% then modern contraceptive methods cover approximately 63%, 64% and 66% using ERM; and 56%, 56.5%, and 57% respectively by PRM. These indicate that to achieve replacement level TFR, raise CPR approximately 63%.

If we want to achieve TFR 2.05 births per woman with CUE: 0.80, 0.85, 0.87 and 0.90; raises the CPR's 67% (CPR require increase from 2011 is 5.9%), 66.4% (CPR require increase from 2011 is 5.2%), 66% (CPR require increase from 2011 is 4.9%) and 65.7% (CPR require increase from 2011 is 4.5%) respectively. Finally, If we want to achieve TFR 2.0 births per woman with CUE: 0.80, 0.85, 0.87 and 0.90; raises the CPR's 68.3% (CPR require increase from 2011 is 7%), 67.4% (CPR require increase from 2011 is 6.2%), 67.1% (CPR require increase from 2011 is 5.9%) and 66.6% (CPR require increase from 2011 is 5.4%) respectively.

Besides, the estimation process of RBM of proximate determinants requires modern techniques, excluding short restrictions, one may use exponential regression model.

# Chapter Eight

# SUMMARY, LIMITATIONS AND POLICY RECOMMENDATIONS

## 8.1 Summary

The data suggests that marriage pattern has changed over time. It can be observed that the proportion of single women particularly in the age group 15-19 and 20-24 years have increased to the highest degree, with time the age at marriage begins has tended to increase the span of marriage and the maximum age beyond which first marriage is likely to take place have probably increased. Therefore, the indication is that the marriage pattern what has been expected to change over time is firstly established and thereby, causing changes in the marital fertility and hence overall fertility.

It is indicated from data that marriage and fertility has changed over time. The major increases MAM during the period 1993-1994 to 2004 and slightly decrease during the period 2007 to 2011. The impression is that in recent times the effect of marital reproductive behavior on reducing overall fertility is remarkable and the effect of change of marriage pattern is less than that of marital fertility.

It is evident that fertility is declining over the past 35 years. The trends in the crude birth rates from 1975 to 2011 indicates that the crude birth rate decreased around 45% per 1000 population throughout the period until 2007 then fertility has been declining moderately. Total fertility rate has declined about 64% from 6.3 births per women in the period 1975 to 2.3 births for the period 2011. It is truly an exceptionally steep decline.

The highest fertility age has shifted from 25-29 in 1975 to 20-24 in 1999-2000 to 2004. Again, it shifted from 20-24 to 15-19 in 2007 to 2011. Moreover, the completed family size in the case of cohort fertility will give the level of fertility of a particular cohort and it indicates that the mean number of children ever born per ever married women has been declining over time and it is slightly lower on recent years in each age group.

Inspection of the percentage changes indicated at a various time segments that the change could be a recent phenomenon. The change in marital fertility that has taken place in the country over time is contributed less by the change in marital fertility in comparison to the change in marriage pattern. Also, the effect of change of marriage pattern in reducing fertility level perhaps has increased over time.

Differential studies have shown that there are socio-economic variables like age at first marriage, place of residence, religion, education, member of NGO's, work status of women, husband's education and occupation have positive or negative effect on fertility. Education and age at first marriage have been found to be a strong discrimination on fertility. Increase of the age at first marriage and level of education may effectively reduce reproductive performance of the women in Bangladesh.

The urban-rural and regional differentials of fertility show that the rural fertility is higher than urban. Socio-economic variables that are women and men labor force participation and wealth index influence fertility or mean number of children ever born and living children born negatively. Again, it is usually seen that those who are engaged in mental work have less number of children, as compared with those who are in physical labor. Socio-cultural variables religion and others status of women prove that in our rural and illogical society, such variables help to increase fertility and improve of those, may be the result of education, occupation, urbanization and economic condition of that area.

The level of wanted fertility around the value of replacement level has increased recently. This is inductive of the fact that a slight reversal or offsetting effect has been taking place as the fertility or children ever born is approaching replacement level. This can be viewed as a cause of stalling fertility change.

Although researchers and policy makers tipped the family planning programs has the most important contribution to the decline fertility in the past, the BDHS data shows that about 50% of the users of contraception in all the regions discontinue within one year. In recent years, the discontinuation rates have increased slightly in most of the regions indicating a further decline in the efficiency of methods of contraception. In other words, the effective contraceptive prevalence rate has declined to small extent during the recent past in all regions. This decline in the effective contraceptive offsets helpful impact of rising CPR, which contributed installing of fertility change.

The results using Revised Bongaarts model indicates that there is a downward trend in three proximate indices except contraception. Between 1975 to 1999-2000, the amount of decrement of total fertility rate is about 48% and it is about 53% between 1975 to 2004 and the amount of decrement of total fertility is more than 60% between 1975 and 2011. This is primarily caused by an increase in the use and effectiveness of the contraceptive methods.

The inconsistencies have been observed owing to mainly the lack of exact information about fetal wastage. Some factors may have been associated with these inconsistencies. One of the important specification errors for use of the model is the consideration of the total fecundity, which have been assumed as 15.30 as suggested by Bongaarts (1978) on the basis of mainly the historical European experiences (Islam, N and others, 2004).

The analysis suggests that, though fertility change in Bangladesh sharply declined up to the period 1991; but thereafter total fertility rate did not change as we might expect. This investigation is evidently supported by the estimated values of each of the index of the model. Thus, the credit of such decline ultimately goes firstly to the extended uses of contraception. The contraception would have played its more adequate role as the major fertility inhibiting factor, if the users would prefer perfect modern contraceptive methods than traditional methods and used continuously and uniformly.

Again the analyses of inhibiting effect of marriage on fertility, it is observed that the effect of marriage on fertility is higher in recent times. The divorced and widowhood have also significant contribution on fertility reduction. It is clear that whatever the causes of changing marriage patterns, their net effect have not been large enough. A downward effect on fertility at younger ages has not been large and caused by rising age at first marriage have been balanced by an upward effect at older ages caused by decreasing widowhood and divorce from 1975 to 2000 and increasing widowhood and divorced from 1999/2000 to 2011.

According to our analysis, lactational infecundability has placed in the second highest fertility inhibiting effect but its fertility reducing helpfulness remains almost stable for the whole of our study period. Postpartum infecundability is concerned with breastfeeding practices. Although, there has been a universal and prolonged tradition in duration of breastfeeding in Bangladesh, but it is observed a trend toward shorter duration of breastfeeding practice since 1993/'94, this resulted a declining trend in the length of amenorrhea. Hence, this may be happening due to enhanced un-amicable modernization, lack of perfect knowledge and increased abuse of supplementary untimed baby food, mother's health status and prominent uses of family planning methods.

Although fetal wastage has been emerged as a fertility reducing factor over the world, also in Bangladesh its actual contribution could not be estimated due to gap of authentic statistical information from survey data and reports. However, several studies and non-government sources, such as private clinic and hospitals records etc., reveal that a huge of some part fetal wastage are done under the name of menstrual regulation which are not observed owing to legal and social constraints.

The discussion using RBM leads to the conclusion that contraceptive uses have been increased and being the most important fertility inhibiting factor but its use-effectiveness has remained about a stagnant point since 1996/'97. As a result, its impact on overall fertility decline is not large as its capability in fertility reduction.

From the point of view of religious, cultural and social norms in Bangladesh, a rapid support in the age at first marriage and age at first birth especially for female population appear consequently clear. Although fetal wastage have been emerged as an indispensible factor in fertility decline in Bangladesh, but obviously policy should not be by any means to relieve abortion except for complicated pregnant mother.

We have seen from path model analysis that the de facto place of residence, women current age, husband's current age, women age at first marriage, sons who have died (number of male child dead that is partial index of mortality) and ever use contraception, are found statistically significant direct positive effect on fertility. Again women educational attainment, wealth index, women age at first birth and women currently working are found to have statistically significant direct negative effect on fertility.

The indirect effect of the combination of exogenous and endogenous variables: de facto place of residence and women age at first marriage; women current age with women age at first birth ever use contraception and ever use contraception; husband's current age with women age at first marriage and first birth; women educational attainment with women age at first marriage and ever use contraception; wealth index and women age at first marriage; women age at first marriage with at first birth and sons who have died; sons who have died with ever use contraception are found to have statistically significant indirect negative effect on fertility. Fetal loss that means total number of dead children appears to have a significant direct positive effect on fertility in Bangladesh.

Binary logistic regression analysis appears that de facto place of residence is found to have a significant ($p<0.001$) positive effect on ever use of contraceptive method. Considering rural area as de facto place of residence as reference category, the regression coefficients of ever use contraceptive method of city corporation and in town as de facto place of residence women are 0.834 and 0.334 respectively and these are positive in sign. The results illustrate that the city corporation and town residential women are using contraceptive method 2.303 times and 1.397 times more respectively than that of rural residential women.

From the results of binary logistic regression analysis, it is observed that women current age is the most significant factor, affecting ever use contraceptives. It has also been found from the bivariate analysis in chapter four that the children ever born is higher among those women who belong to the age group <20 (15-19). So, it is important need to take obstruction in this age group. From the Table 6.2, it is observed that the women current age have a significant ($p<0.001$) positive effect on the ever use contraceptive. Considering the women age group 35-49 as reference category, the regression coefficients of ever use contraceptive method of women age groups <20 (15-19), 20-24, 25-29 and 30-35 are 1.225, 1.179, 0.998 and 0.683 respectively and these are all positive in sign. This estimated result gives us the information that the women age groups <20, 20-24, 25-29 and 30-34 are ever use contraceptive method 3.403 times, 3.250 times, 2.712 times and 1.980 times more respectively in accordance of reference category age group 35-49. In another point of view, women age groups <20, 20-24, 25-29 and 30-34 are use contraceptives 240.3%, 225.0%, 171.2% and 98% more respectively than the reference category. It means lower the age group of women, higher the probability of getting ever uses contraceptive method.

For women educational attainment, we took no education (0) as the reference category, then the regression coefficients of incomplete primary, complete primary, incomplete secondary, complete secondary and higher education are: -0.874, -0.538, -0.487, -0.311 and -0.247 respectively and we seen that all values are negative. In accordance of reference category, the odds ratios of incomplete primary, complete primary, incomplete secondary, complete secondary and higher educated women are ever used contraception respectively 0.417 times, 0.584 times, 0.614 times, 0.733 (with $p<0.05$) times and 0.781 (with insignificant $p<0.189$) times more than their no educated counterparts. In further point of view, incomplete primary, complete primary, incomplete secondary, complete secondary and higher educated women are took 58.3%, 41.6%, 38.6%, 26.7% and 21.9% lower risk to getting pregnant respectively than no educated (assume 100% getting risk to pregnant) women. The deviation between: incomplete and complete primary is 16.7%, complete primary and incomplete secondary is 3.0%, incomplete secondary and complete secondary is 11.9%, complete secondary and higher education is 4.8%, and no education and incomplete primary is 41.7% which is higher than any other deviation. Thus government should fulfill the education for all.

From divisional region, we took Sylhet as a reference category, then the regression coefficients of the regions: Barisal, Chittagong, Dhaka, Khulna, Rajshahi and Rangpur are respectively 1.447, 0.510, 1.168, 1.494, 1.581 and 1.649 and all these values are positive. According to the reference category Sylhet division, the odds ratios of Barisal, Chittagong, Dhaka, Khulna, Rajshahi and Rangpur divisions are ever use contraceptive method respectively 4.252 times, 1.666 times, 3.215 times, 4.456 times, 4.861 times and 5.201times more than Barisal region. It indicates that the Barisal region women are lowest contraceptive user than any other regional divisions of Bangladesh. From our result it is found that the higher order of magnitude contraceptive user regions are Rangpur, Rajshahi, Khulna, Barisal, Dhaka and Chittagong; the values respectively are 5.201, 4.861, 4.456, 4.252, 3.215 and 1.666. It is evident from the data of BDHS 2011 using for our analysis that there are identical variation of ever use contraception with Sylhet division from other highest contraceptive user division Rangpur, Rajshahi, Khulna respectively.

For the number of dead sons is a categorical variable where no sons died (0), we took as the reference category, then the regression coefficients of one son died is 0.356 ($p<0.05$) and at least two sons died is 0.165 ($p<0.338$, insignificant value) and the values are positive in sign. According to reference category no son died, the odd ratio of one son died is 1.428 times lower use of contraceptive method and for at least two sons died is 1.180 times lower using of contraceptive method. In additional point of view, for one son died women use contraceptives -42.8% that is about 57% women never use of contraceptive method when women lose one son and -18.0% that is 82% women never use contraceptive method when at least two sons died comparing with reference category.

It is observed from binary logistic regression analysis that the number of living children significant with $p<0.001$, negative effective factor of women ever use contraceptive method. For the number of living children is a categorical variable where no children alive (0), we took as the reference category, then the regression coefficients of one living children, two living children, (3-4) living children and (5-10) living children are -3.632 ($p<0.001$), -1.800 ($p<0.001$), -0.499 ($p<0.001$) and -0.008 (insignificant $p<0.929$)

respectively and all values are negative in sign. According to the reference category, the odds ratio for one living children, two living children, (3-4) living children and (5-10) living children are 0.029 times, 0.165 times, 0.607 times and 0.992 times took lower risk respectively to avoid getting pregnant. In other point of view, with the reference category women use contraception that have one living children, two living children, (3-4) living children and (5-10) living children are 3%, 16.5%, 60.6% and 99.2% respectively highest contraceptive user.

The spousal desire for children is another important independent variable of women ever uses contraceptives. We took “don’t know” as reference category, then the values of regression coefficients of both want same, husband want more and husband want fewer are respectively 0.977, 0.814 and 1.446. The odds ratios of both want same, husband want more and husband want fewer are 2.655, 2.257 and 4.246 respectively. According to reference category, the values of both want same, husband want more and husband wants fewer are 2.655 times, 2.257 times and 4.246 times more uses contraceptive method. The deviation between: both want same and husband want more is 0.398; between both want same and husband wants fewer is -1.591 that is husband’s desire preferred finally. Thus, the result illustrated that in our society the desire about children, husband is the final decision maker.

From the analysis of binary logistic regression analysis, we seen that the husband occupation is statistically significant variable with $p<0.001$ positive effective of women ever uses contraception. We took others (Imam/Religious leader / student) as reference category then the regression coefficients of agricultural worker, non-agricultural worker, service holder and businessman are 0.775, 0.502, 1.095 and 0.869 respectively. The odds ratios are: 2.171, 1.651, 2.990 and 2.385 respectively. This means that, agricultural worker, non-agricultural worker, service holder and businessman are uses contraceptives respectively 2.171 times, 1.651 times, 2.990 times and 2.385 times more than the reference category. It is seen from this analysis that service holder is the highest contraceptive user and businessman is the second highest contraceptive user with comparing reference category.

Women's currently working is negatively related with ever uses of contraception. This predictor variable women currently working is statistically significant with $p<0.001$ negative effective for women ever use contraception. We took women works as a housewife (0) the reference category, then the regression coefficient for women works outside home (service) is -0.397 and the odd ratio is 0.672. The result indicates that the women works outside home as a service holder uses contraceptive method 33% higher than the women who works in house.

For achieving fertility level 2.2, 2.1, 2.08 and 2.0 it would raise mean age at marriage, approximately 21 years by estimating with polynomial regression model and approximately 23 years by estimating ERM. Now, target mean age at marriage is 23 years. This implies that to achieve replacement level fertility, one may raise mean age at marriage 23 years.

Achieving fertility level 2.2, 2.1, 2.08 and 2.05 there require increasing use of pill approximately 36%, 37%, 38% and 39% respectively estimating by ERM and approximately 30%, 31%, and for TFR level 2.08, 2.05 is approximately 32% estimating by PRM. Achieving fertility level 2.2, there require increasing use of condom 6% and for TFR 2.1, 2.08 and 2.05 require 6.3% increase estimating by ERM and achieving TFR 2.2, 2.1, 2.08 and 2.05 there require increasing respectively 5.24%, 5.36%, 5.38% and 5.42% estimating by PRM.

Achievement fertility level 2.2, 2.1, 2.08 and 2.05 there requires increase use of injectables respectively 12.8%, 13.5%, 13.6% and 13.8% by the ERM and 11.47%, 11.67%, 11.71% and 11.77% respectively by the PRM. Achieving target TFR 2.2, 2.1, 2.08 and 2.05 requires increase use of female sterilization 6.72%, 7.36, 7.51% and 7.72% by ERM, and 5.78%, 5.7%, 5.67% and 5.65% respectively by the PRM.

To achieve target TFR 2.1, 2.05 and 2.0 with use of total contraceptive prevalence rate (CPR) as taken 100% then modern contraceptive methods raise approximately 63%, 64% and 66% using ERM; and approximately 56%, 56.5%, and 57% respectively using PRM. These indicate that to achieve replacement level TFR, raise CPR approximately 63%.

The results indicate that if TFR 2.2 would reach with UEC: 0.87, 0.89, 0.90 and 0.91; raises the CPR's 63.17% (CPR requires increase level is approximately 2%), 63.06% (CPR requires increase level is 1.86%), 63.01% (CPR requires increase level is 1.81%) and 62.96% (CPR requires increase level is 1.76%) respectively. Again, if TFR 2.1 would reach with CUE: 0.87, 0.89, 0.90 and 0.91; raises the CPR's 65.13% (CPR requires increase level is 3.93%), 65.93% (CPR requires increase level is 4.73%), 64.82% (CPR requires increase level is 3.62%) and 64.73% (CPR requires increase level is 3.53%) respectively.

## 8.2 Limitations of the study

The study based on survey data usually suffer from a number of limitations. The main limitations of the present study of which only a few mentions are highlighted in this section as follows:

- To meet the objectives of this study, information on some variables are not available in the data used for the study, which were vital important.
- In statistical calculations fractional digits differences are mainly affected different variables or determinants value. Secondary data are not free from these types of errors.
- Respondents (women's) parents' education play very significant role in determining age at first marriage of respondents but no information is available in this regard in the data.
- Steps mother /father can affect age at first marriage of respondents, which information is not available in 2011 BDHS data. Respondents from joint or extended families, also married at younger ages than those from nuclear families, which information are not provided in the data.
- Occupations of respondents have significant effect on age at first birth and at marriage. In 2011 BDHS data, it is not clear when respondents started working or earning money and consequently we were unable to include it into the analyses.

- Serious disease before marriage can delay age at first marriage or first birth of respondents. Such types of information were required for us to strengthen our study. Most of the marriages in Bangladesh are held by giving or taking dowry (Joutuk), which type of data, was essential to carry out a study of the type in the context of Bangladesh.
- From the BDHS 2011 data, we can only know whether the respondents ever used or currently using a contraceptive methods (Pill, Condom, Injectables, IUD, Sterilizations etc.), but when they used contraceptives to delay their first birth or succeeding births was not clear. Thus, we had no way to revise the effect of contraception on age at first birth or for succeeding births.
- Up-to-date data actually very rare in our country, lack of proper timed data is the main limitations for statistical research or projections in developing country, like Bangladesh.

Besides these inadequacies, some limitations go to our part. Perhaps, the results may possibly be presented and interpreted in better way than we have done or the number of variables may perhaps be enlarged even with these data.

## 8.3 Policy Recommendations

The **findings** of this study may have some guidelines that would help the planners and policy-makers of the Government to take necessary steps in achieving women's reproductive target and contraceptive use matter as well as possible. These are:

i. Adolescent marriage perhaps will be banded and need increase birth intervals, particularly the first birth interval. Campaign should be compulsory for further increase in the age at marriage, especially in rural areas;

ii. Education appears to the key factor through various causal mechanisms. It enhances maturity and delays marriage that may result in use of more effective contraception and hence decrease the index of fertility.

iii. Education increase the opportunity for paid employment in the modern sectors and this completes with the demand for child bearing and rearing. Through increasing her odds of becoming employed home and outside, and thus becoming an income producing member of a family. Hence it can be definitely concluded that an improvement female education levels will help to decrease fertility. Hence Government should make education up to graduate level (including technical education) completely free and compulsory for all areas in Bangladesh.

iv. There are need to husband's (male's) educational and occupational facilities and attainments should be improved which will help their daughter to be married at matured ages that will results fertility decline in Bangladesh.

v. Couple will be motivated to accept modern contraceptive methods in order to limit their family size. Great attention should be given for family planning service to them, particularly younger married couples and to provide them with motivational messages about decline of fertility. Need encourage efforts to increase the quantity and the quality of contraceptive use to achieve higher use-effectiveness that will lead to a greater contribution to fertility decline.

vi. Provide a method-mix that meets the varied needs of couples. The method-mix of contraception can be made more effective through encouraging longer acting methods. The birth space can be effectively widened through improving quality of care in the family planning programs. The mass media can bring dual benefits to help modernize the thinking of the people and help in other development activities and improve acceptance of family welfare program services. The use of audio-visual aids like radio and television in all areas in Bangladesh should be increased. Simultaneously, efforts to involve satisfied clients to motivate new accepters of family planning, efforts to remove fear about side effects of contraceptives, efforts for offering a wider contraceptive choice for various groups for women etc, also are to be promoted.

vii. There is need to improve child survival in Bangladesh, immunization programs need to be extended effectively in order to increase the extent of full coverage of essential vaccines to an optimum level. Also to reduce the impact of malnutrition, the programs on alleviation of poverty need to be strengthened that will results fertility decline.

viii. Religious fundamentalism or bigotry/fanatic results in higher fertility, which are needed to be, weed out by taking justly efficient steps.

ix. Taking initiation to identify the reasons, why geographical region appears significant for fertility variation. Need to increase program efforts to maintain current performance levels.

x. It is very essential to ensure the commitment of additional resources to maintain current program momentum.

## 8.4 Further Research

1. Adolescent Reproductive Behavior and Health Care Facilities in Bangladesh
2. Factors Influencing decision on Contraceptive Use among Currently Married Women in Bangladesh
3. Contraceptive Use and Implication of Female Adolescent on Fertility in Bangladesh

# BIBLIOGRAPHY


Abedin, S. (1982) Age Patterns of Marriage in a Rural Community of Bangladesh, Studies in Africa and Asia Demography, CDC Annual Seminar 1982, CDC Research Monograph, Series, 11: Cairo Demographic Centre, Cairo, Egypt.

Abedin, S., and Islam, M.N. (1994) Implication of Contraceptive practice of future trends in fertility in Bangladesh, Jonural of Family Welfare, 40(3): 37-41.

Adanu, R.M.K., Seffah, J.D. Hill, A.G. Darko, R. Duda, R.B. and Anarfi, J. F. (2009) Contraceptive Use by Women in Accra, Ghana: Results from the 2003 Accra Women's Health Survey, Afr J of Reproductive Health 2009, 13(1): 123-134.

Adebimpe, W.O., Asekun O. E., Bamidele, J.O. and Abodunrin, O. (2011) Comparative study of socio-demographic determinants and fertility pattern among women in rural and urban communities in southwestern Nigeria, Continental J of Medical Research, 5(1): 32 – 40.

Adhikari, R. (2010) Demographic, socio-economic and cultural factors affecting fertility differentials in Nepal, Geography and Population Department, Mahendra Ratna Campus, Tribhuvan University.

Agresti, A. (2002) Categorical Data Analysis, John Wiley & Sons, Inc

Agresti, A. (2007) An Introduction to Categorical Data Analysis, John Wiley & Sons, Inc.

Agyei-Mensah, S. (2005) The Fertility Transition in Ghana Revisited, Paper prepared for the XXV IUSSP International Population Conference, Tours, France 18-23 July 2005.

Ahmed, A. (1982) Marriage and Divorce in Bangladesh, Unpublished Ph. D. Dissertation Submitted to the Department of Sociology, University of Chicago.

Ahmed, A.U. (1986) Socio-economic determinants of age at first marriage in Bangladesh, Journal of Biosocial Science, 18: 35.

Ahmed, F. A. Mohammed, A. M. and Saleh, E. M. (1995) Age at first marriage determinants and effect on fertility level in Egypt, Cairo Demographic Centre Research Monograph Series, No. 24, p. 319

Alauddin, M. and Faruque, R. (1983) Population and Family Planning in Bangladesh, A Survey of the Research, World Bank Staff Working Papers No. 557, Washington, D.C.

Alauddin, M. and Faruque, R. (1983) Population and Family Planning in Bangladesh, A Survey of the Research, World Bank Staff Working Papers No. 557, Washington, D.C.

Alene, G.D., and Worku, A. (2008) Differentials of fertility in North and South Gondar zones, northwest Ethiopia: A comparative cross-sectional study. BMC Public Health 2008, 8: 397

Alo, O.A. (2011) Fertility Regimentation of the Rural Yoruba Women of South-west Nigeria: The Case of Ido and Isinbode, J of Soc Sic. 26(1): 57-65

Alwin D. F. and R.M. Hauser (1975) The decomposition of effects in Path Analysis, American Sociological Review, 40: 21-26.

Amin, R.; Ahmed, A. Chowdhury, J. Kabir, M. and Hill, R. (1994) Recent Evidence on Trends and Differentials in Bangladesh fertility, An Update Journal of Bio-social Science, 26: 235-241.

Anderson, J. C., and Gerbing, D. W., (1988) Structural equation modeling in practice: A review and recommended two-step approach, Psychological Bulletin, 103: 411 – 423.

Arnold, F. (1992) Sex Preference and its Demographic and Health Implications, International Family Planning Perspectives, 18: 93-101.

Arora, Y.L. and Kumar, A. (1987) Qualification of intermediate variables influencing fertility performance, Demography India, 16: 144-149.

Aryal, R. H. (1991) Socioeconomic and cultural differentials in age at marriage and the effect on fertility in Nepal, Journal of Biosocial Science 23: 167.

Bairagi, R. (2001) Fertility Transition in Bangladesh: Development versus Family Planning Argument for Fertility Decline, Paper presented in the dissemination seminar of Public Health Science Division (PHSD), International Centre for Diarrhoeal Diseases Research, Bangladesh (ICDDR,B).

Bangladesh Demographic and Health Survey, BDHS (1994) Bangladesh Demographic and Health Survey 1993-1994. National Institute of Population Research and Training (NIPORT), Dhaka, Bangladesh.

Bangladesh Demographic and Health Survey, BDHS (1997) Bangladesh Demographic and Health Survey 1996-1997. National Institute of Population Research and Training (NIPORT), Dhaka, Bangladesh.

Bangladesh Demographic and Health Survey, BDHS (1999-2000) Bangladesh Demographic and Health Survey 1999-2000. National Institute of Population Research and Training (NIPORT), Dhaka, Bangladesh.

Bangladesh Demographic and Health Survey, BDHS (2003-2004) Bangladesh Demographic and Health Survey 2003-2004 (Published May 2005), National Institute of Population Research and Training (NIPORT), Azimpur, Dhaka Bangladesh.

Bangladesh Demographic and Health Survey, BDHS (2007) NIPORT, Bangladesh Demographic and Health Survey Dhaka, Mitra & Associates and ORC Macro, Bangladesh and Calverton, MD, USA, March 2009.

Bangladesh Demographic and Health Survey, BDHS (2011) NIPORT, Mitra and Associates Dhaka, Bangladesh MEASURE DHS ICF International Calverton, Maryland, U.S.A. 2013.

Bangladesh Fertility Survey, BFS (1978) Bangladesh Fertility Survey 1975, Country Report, No. 1, Dhaka, Ministry of Population Control and Family Planning

Bangladesh Fertility Survey, BFS (1989) Bangladesh Fertility Survey, National Institute of Population Research and Training (NIPORT), Dhaka Bangladesh.

Baqui, A.M. *et al.*, (2011) Levels, timing, and etiology of stillbirths in Sylhet district of Bangladesh, Department of International Health, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, USA

Baschieri, A. and Hinde, A. (2007) The proximate determinants of fertility and birth intervals in Egypt: An application of calendar data, Demographic research 16, article 3: 59-96.

Bhattacharya, R.N. and Waymire, E.C. (2009) Stochastic Processes with Applications Philadelphia, Pennsylvania, United States

Bhuyan, K.C. (2005) Multivariate Analysis and Its Applications, New Central Book Agency (P) LTD, Kolkata, India

Black, A. Yang, Q. Wen, S. W. Lalonde, A.B. Guilbert, E. and Fisher, W. (2009) Contraceptive Use among Canadian Women of Reproductive Age: Results of a National Survey, Women's Health 2009, 627-640

Bloom, S.S., Wypij, D. and das Gupta, M. (2001) Dimensions of women's autonomy and the influence on maternal health care utilization in a North Indian city, Demography, 38(1): 67–78.

Bogaarts, J. (2005) The Cause of Stalling Fertility Transitions, Population Council Policy Research Division, Working Paper No. 204

Bongaarts, J. (1978) A Frame work for analyzing the Proximate Determinants of Fertility, Population and Development Review, 4 (1): 105-133

Bongaarts, J. (1982) The Fertility Inhibiting Effect of the Intermediate Fertility Variables, Studies In Family Planning, 13(6-7): 179-189.

Bongaarts, J. (1987) The Proximate Determinants of Exponential High Fertility, Population Development Review, Vol. 13

Bongaarts, J. (1999) Completing the Demographic Transition, Population and Development Review, 25(3): 515-529

Bongaarts, J. (2002) the end of the Fertility Transition in the Developing World, The Population Council, New York

Bongaarts, J. (2003) Completing the Fertility Transition in the Developing World, The Role of Educational Differences and Fertility Preferences, Population Council Policy Research Division, Working Paper No. 177

Bongaarts, J. and Bruce, J. (1995) The causes of unmet need for contraception and the social content of services, Studies in Family Planning, 2(6): 57–75

Bongaarts, J. and Feeney, G. (1998) On the Quantum and Tempo of Fertility, Population and Development Review, 24(2): 271-291.

Bongaarts, J. and Potter, R.G. (1983) Fertility, Biology and Behavior, an Analysis of the Proximate Determinants, Academic Press, New York.

Bongaarts, J., Frank, O. and Lesthaeghe, R. (1994) the proximate determinants of fertility in sub-Saharan Africa, Population and Development Review, Vol. 10, p. 511

Bulato, R. and Lee, R. (1983) Determinants of fertility in Developing Countries, New York, Academic Press

Bussarawan, T. and Amin S. (2010) The role of abortion in the last stage of fertility decline in Vietnam, Perspective Sex Report Health, 2010 Jan, 36(2): 80-9

Cain, G.G. and Weining, A. (1973) Economic Developments of fertility: Results from Cross Sectional Aggregate Data, Demography 10 (2): 205-223.

Caldwell, J.C. (1978) A General Theory of Fertility, Mimeo The Australian National University, Canberra

Caldwell, J.C., Barkat-E-Khuda, Bruce C. Caldwell, Indrani Pieris, and Pat Caldwell (1999) The Bangladesh Fertility Decline: an Interpretation, Population and Development Review, 25(1): 67-84.

Chatterjee, S. and Hadi, A. (2006) Regression Analysis by Example, John Wiley & Sons

Chowdhury, A.K.M. (1984) Application of a Marriage Models in Bangladesh, Journal of Biological Science, Vol. 15, Cambridge, England

Chowdhury, M.K. and Bairagi, R. (1992) The Effects of Age at Marriage on Fertility and Mortality in Rural Bangladesh, Paper presented at the annual meeting of the population association of America, Denver, Colorado, 1992.

Chowdhury, R.H. (1983) The influence of female education, labor force participation and age at marriage on fertility behavior in Bangladesh, Janasankhya, December 1983, 1(2): 62-143.

Cleland, J., James Phillips, Sajeda Amin, Kamal, G.M. (1993) Fertility Decline in Post-Independence Bangladesh: Evidence from recent Demographic Surveys, Population Council Division Working paper No. 54,

Coale, A.J. and Watkins, S.C. (1986) The decline of fertility in Europe since the eighteenth century as a chapter in human demographic history, The decline of fertility in Europe, Princeton University Press, Princeton, New Jersey.

Colin Newell (1988) Methods and Models in Demography First published in Great Britain in 1988, by Belhaven Press (a division of Printer Publishers Limited) London.

Corsi D. J. , Kyu, H. H., and Subramanian, S. V. (2011) Socioeconomic and geographic patterning of underweight and overweight among women in Bangladesh. The Journal of Nutrition, 14(1): 631-38

Das Gupta, M. and Narayana, D. (1997) Bangladesh’s fertility decline from a Regional Perspectives, genus, Vol. L III (3-4): 101-128

Deborah Balk (1994) Individual and Community Aspects of women’s Status and fertility in rural Bangladesh, Population Studies, Vol. 48: 21-45.

Defranzo, J. (1976) Cross Sectional Areal Analysis of Factor Affecting Marital Fertility: Actual versus Relative Income, Journal of Marriage and Family, 38(4): 669-676.

Dr. Bhuyan, K.C. (1997) BOHUCHALAK BISLESHAN ABONG ER PROYOG, Published by Anisur Rahman, Director (In charge), Textbook Division, Bangla Academy, Dhaka, Bangladesh.

Duncan O D (1971) Path analysis: Sociological examples (addenda), In Hubert M Blalock (Jr) (Ed). Causal Models in the Social Sciences, Chicago: Aldine–Atherton, p. 136–8

Duncan O D (1975) Introduction to Structural Equation Models, New York, Academic Press,

Duncan, T. E., Duncan, S. C., Alpert, A., Hops, H., Stoolmiller, M. and Muthen, B. (1997) Latent variable modeling of longitudinal and multilevel substance use data, Multivariate Behavioral Research, 32(3): 275-318.

Duncan, T. E., Duncan, S. C., Strycker, L. A., Li, F. and Alpert, A. (1999) An introduction to latent variable modeling: Concepts, issues, and applications, Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Duncan, T.E., Oman, R. and Duncan, S. C. (1994) Modeling incomplete data in exercise behavior research using structural equation methodology, Journal of Sport and Exercise Psychology, 16: 187-203.

Duza, M.B. and Baldwin, C.S. (1977) Nuptiality and Population Policy: An Investigation in Tunisia, Sri Lanka and Malaysia, The Population Council, New York.

Duza, M.B. and Nag, M. (1993) High contraceptive prevalence in Matlab, Bangladesh: Underlying process and implications, in Richard Leete and Iqbal Alam (eds.), The Revolution in Asian Fertility: Dimensions, causes and Implications, Oxford: Calrendon Press.

Ellis M. M. (2011) studied about the Intrapartum-related stillbirths and neonatal deaths in rural Bangladesh, a prospective, community-based cohort study, Perinatal Care Project, Bangladesh Diabetic Summit, BIRDEM, and 2011 May 127(5): e 1182-90

Eltigani, E. (2003) Stalled Fertility Decline in Egypt, Why? Population and Environment, 25(1)

Famule, F.D. (2010) Regional Levels and Differentials of Fertility in Osun State, Nigeria, Pacific Journal of Science and Technology, 11(1): 449-454

Feeney, G. (1991) Fertility Decline in Taiwan: a study using parity progression ratios, Demography, 24: 413-430.

Fialova, L.; Pavlik, Z. and Veres, P. (1990) Fertility decline in Czechoslovakia during the last two centuries, Population Studies, 44: 89.

Garson, D. (2009) Logistic Regression with SPSS, North Carolina State University, Public administration Program

Gertler, P.J. and Molyneaux, J.W. (1994) How Economic Development and Family Planning Programs Combined to Reduce Indonesian Fertility, Demography, 31(1): 33-63.

Gordon, C. and Sabates, R (2011) Women's education and modern contraceptive use in Ethiopia, International Journal of Education, ISSN 1948-5476, 3(1): E9

Government of Bangladesh, GOB (1994) Country report: Bangladesh, International Conference on Population and Development, Cairo, September 5-13, 1994, Dhaka.

Government of Bangladesh, GOB (1997) The Fifth Five Year Plan 1997-2002, Planning Commission, Ministry of Planning, Dhaka.

Guha Roy (1981) Path analysis of areal fertility in rural India, Rural Demography, 8(2): 1-2.

Gyimah, S. O. Takyi, B. Tenkorang, E. Y. (2008) Denominational affiliation and fertility behaviour in an African context: An examination of couple data from Ghana, J of Biosoc. Sic. 2008, 40: 445–458

Hatti, N. and Ohlsson, R. (1985) Impact of education on age at marriage, Demography India, 14: 129.

Hemmings, J., Wubshet, T., Lemma, S., Antoni, T. and Cherinet, T. (2008) Ethiopian Women's Perspectives on Reproductive Health: Results from a PEER study in the Guraghe Zone, London: Marie Stopes International

Henry A. and Piotrow P.I. (1979) Age at Marriage and Fertility, Population Reports Series M. No.4, Population Information Program, John Hopkins University Baltimore

Hosmer, D.w. and Lemeshoe, S. (1989) Applied Logistic Regression. New York: Wiley.

Hu, L. and Bentler, P. M., (1999) Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling, 6: 1–55.

Huq, N. and Cleland, J. (1990) Bangladesh Fertility Survey, NIPORT, Azimpur, Dhaka, Bangladesh

Ijaiya, G.T., Raheem, U.A., Olatinwo, A.O., Ijaiya, Munir-Deen A. and Ijaiya, Mulaila A. (2009) Estimating the impact of birth control on fertility rate in Sub-Saharan Africa. African Journal of Reproductive Health, 13(4): 137-145.

Islam and Islam (1993) Biological and Behavioral Determinants of Fertility in Bangladesh: 1975-1989, Asia Pacific Population Journal, 8(1).

Islam M.N., Hossain M.G., Karim M.R., Islam M.R., Lestrel P.E. and Islam M.A. (2014) Fertility Analysis of Bangladesh Population Using the Revised Bongaart's Model, Advances in Life Sciences, 4(2): 44-51.

Islam, M. N. and Ahmed, A. U. (1998) Age at First Marriage and its Determinants in Bangladesh, Asia-Pacific Population Journal, 13(2): 23-37.

Islam, M. R., (2012) Mathematical Modeling of Age and of Income Distribution Associated with Female Marriage Migration in Rajshahi, Bangladesh, Research Journal of Applied Sciences, Engineering and Technology, 4(17): 3125-3129.

Islam, M. R., Islam, M. N., Rahman, M. M., Hossain, M. G. and Islam, M. R. (2015), Fertility Situation in Bangladesh: Application of Revised Bongaarts Model, Science and Technology, 5 (2): 33-38.

Islam, M. R., Nurullah, M., Rahman, M. O. and Hossain, M. S. (2013). Factors Affecting on Migration to Chapai-Nawabganj City in Bangladesh: Multivariate Approach, American Journal of Economics, 3(6): 273-277.

Islam, M.A. (2003) Demographic Transition and Policy Challenges, Paper 22, CPD-UNFPA Program on Population and Sustainable Development, CPD, Dhaka.

Islam, M.A., Islam, M.M., and Chakraborty, N. (2002) Achieving Replacement Level Fertility in Bangladesh: Challenges and Prospects, Paper no. 18, CPD-UNFPA Program on Population and Sustainable Development, CPD, Dhaka.

Islam, M.N. (1982) Levels and Patterns of Fertility and Mortality in Two Rural Areas of Bangladesh, M. Phil paper, Cairo Demographic Centre, Cairo, Egypt

Islam, N. (1996) Trends and Correlates of Marriage and Fertility in Bangladesh, Unpublished Ph.D. Thesis, Department of Statistics, and University of Rajshahi, Bangladesh

Islam, N. and Abedin, S. (1991) Proximate Determinants of Fertility in Bangladesh, 1975-1989, Proceedings of the one-day seminar on Applied and Theoretical Statistics, Organized by the Bangladesh Statistical Association, ISRT, and Dhaka University, Bangladesh.

Islam, N. and Abedin, S. (1996) Some Observations on Marriage, Contraception and Fertility in Bangladesh, Genus-Vol. L-II, No. 1-2.

Islam, N. and Abedin, S. (2001) Effect of Education on age at marriage and fertility in Bangladesh, Man in India, 81(3&4): 339-343.

Islam, R., Rokib, A., Alam, R., Mondal, N. I., and Raman, S., (2015) Effects of socio-demographic factors on female migrants: path model approach, American Journal of Operational Research 2015, 5(1): 9-14

Islam, S. (2010) High fertility regions in Bangladesh: a marriage cohort analysis, J Bioscope Sic 2010 Nov 42(6): 705-19

Jayaraman, A., Mishra, V., and Arnold, F. (2008) The effect of family size and composition on fertility desires, contraceptive adoption, and method choice in South Asia. DHS working papers no. 40. Calverton, MD: Macro International, p. 26.

Kabir, M. and Rab, A.K.U. (1990) Fertility and Its Proximate Determinants, South Asia Study of Population and Programs: Bangladesh, UNFPA, Dhaka, Bangladesh

Kendall, M. G., and 'Muircheartaigh, C. A. O (1977) Path Analysis and Model Building, World Fertility Survey Technical Bulletin No. 2/ Tech 414, Voorburg, The Netherlands: International Statistical Institute

Khan HT. Raeside, R. (1997) Factors affecting the most recent fertility rates in urban-rural Bangladesh, Department of Mathematics, Napier University, Edinburgh, Scotland, U.K. Socsic Med 1997 Feb, 44(3): 89-289.

Khan M.M. et al. (2011) Trends in socio-demographic and health-related indicators in Bangladesh, 1993-2007: will inequalities persist, Bull World Health Organ, 2011 Aug 1; 89(8): 583-93, E-pub 2011May 26

Khan, M.F.H. and Shirmeen, A. (2007) Proximate determinants of fertility and reproductive health, Ulster Medical Journal, 76(1): 6-7

Khuda, B. (1985) Age at Marriage and fertility in a rural area of Bangladesh, Asian Profile, 13(6): 541.

Knodel, J. and Van De Walle, E. (1986) Lessons from the past: policy implications of historical fertility studies, The Decline of Fertility in Europe, Edited by A.J. Coale and S.C. Watkins, Princeton University Press, Princeton, New Jersey.

Koo, H.P.; Bilsborrow, R.E. and Suchindaran, C.m. (1978) Long-term marital disruption, fertility and socio-economic achievement associated with adolescent childbearing, Carolina Population Center Papers No. 2, Chapel Hill, NC Carolina Population Center, University of North Carolina at Chapel Hill.

Kpedekpo, G.M.K. (1982) Essentials of Demographic Analysis for Africa

Lesthaeghe, R.J., I.H. Shah and H.J. Page (1981) Compensating Changes in Intermediate fertility Variables and the onset of natural Fertility transition, In processing of the ISSUP General Conference, Manila, Ordina, Liege.

Lingner, w. J. (1974) A handbook for population Analysis Part A: Basic Methods and Measures, International Program of Laboratories for Population Statistics; The University of North Carolina at Chapel Hill, U.S.A.

Maloney, et al., (1981) Beliefs and Fertility in Bangladesh, The International Centre for Diarrheal Disease Research, Bangladesh (ICDDR'B), Dhaka.

Martin, E. Palamuleni (2013) Socio-Economic and Demographic Factors Affecting Contraceptive use in Malawi, Afr J of Reproductive Health September 2013, 17(3): 91-104.

Mekonnen, W. and Worku, A. (2011) determinants of fertility in rural Ethiopia: the case of Butajira Demographic Surveillance system (DSS), BMC Public Health 2011, 11: 782

Milton, A.H., Smith, W., Raman, B., Ahmed, B., Shahidullah, S. M., Hossain, Z., Hasan, Z.,and Sharmin, S. (2010) Prevalence and determinants of malnutrition among reproductive aged women of rural Bangladesh, Asia Pacific Journal of Clinical Nutrition, 22(1): 110-17.

Mondal, M. N. I., Shitan, M. (2013) Factors affecting the HIV/AIDS epidemic: an ecological analysis of global data, African Health Sciences, 13(2): 301-10

Mondal, M.N.I. and Shitan, M. (2014) Relative Importance of Factors on Life Expectancy in the Low and Lower Middle Income Countries, J. Epidemiol., 24(2): 117-124.

Muller, E. (1977) The Impact of Demographic Factors on Economic Development in Taiwan, Population and Development Review, 3(1, 2): 1-22.

Mutharay, R. et al. (1997) Is son preference Slow India's Transition to Low Fertility? NFHS Bulletin No. 4.

Neter, J. Wasserman, W. and Kutner, M. (1985) Applied Linear statistical Models, Second edition, Irwin Homewood

NIPORT (2014) Bangladesh Urban Health Survey 2013 (Preliminary Results), National Institute of Population Research and Training (NIPORT), MEASURE Evaluation, and ICDDR'B, Nov. 2014

Nortman, D.L. and Hofstatter, E. (1978) Population and family Planning Programs, Ninth Edition, A Population Council Fact Book, The Population Council New York.

Nurullah, M. and Islam, M. R. (2008) Study the Socio-economic Conditions of Migrant's Monthly Income (Before and After Migration): An Application of Multiple Classification Analysis, Middle East J. of Age and Ageing, 5(3): 18-23.

Nurullah, M. and Islam, M. R. (2011) Determinants of Socio-demographic Characteristics on Female Migrants: Logistic Regression Model Approach, International Journal of Applied Mathematical Analysis and Applications, 6(1-2): 95-102.

Nwankwo, B. O. and Ogueri, E. (2006) Influence of Husband's Decision on the Use of Modern Contraceptives among Rural and Urban Married Women in Imo State, Nigeria. International Journal of Tropical Medicine 2006, 1(40): 140-144.

Ogawa, N. (1981) The socioeconomic determinants of age at first marriage and its impact on fertility in Sri Lanka, Population Studies, 35(4): 41.

Pathak, K. B. and P. B. Murthy (1985) Socio Economic Determinants of Fertility and Mortality Decline in India, Demography India, 14(I).

Patricia Donavan (2005) International Family Planning Perspectives, 3192), June 2005

Population and Housing Census (2011) Bangladesh Bureau of Statistics (BBS) Statistics and Informatics Division (SID), Ministry of Planning, Socio-economic and Demographic Report, December 2012, National Report, vol.- 4

Pritchett, Lent, H. (1994) Desired fertility and the impact of Population policies, Population and Development Review 20(1): 1-54.

Rahman, M. S., Akter, S., Abe, S., K., Islam, M. R., Mondal, M. N. I., Rahman, J. A. M. S. and Raman, M. M., (2015) awareness, treatment, and control of diabetes in Bangladesh, PLOS ONE | DOI:10.1371/journal.pone.0118365 February 18, 2015.

Raman, M. M. & Nasrin, S.O., (2009) Mothers nutritional status in an impoverished nation: Evidence from rural Bangladesh. The Internet Journal of Nutrition and Wellness, 7(1)

Raman, M. S, Mondal, M. N. I., Islam, M. R., Ahmed, K.M., Karim, M. R. and Alam, S. M., (2015) Under Weightiness among Ever-married Non-pregnant Women in Bangladesh: A Population Based Study, Universal Journal of Food and Nutrition Science 3(2): 29-36.

Razzque, A. and Streafield, K. (2000) The fertility in Bangladesh: Past, Present and Future, ICDDR'B, Centre for Health and Population Research, Bangladesh.

Richard, A. Johnson and Dean, W. Wicharn (1996) Applied Multivariate Statistical Analysis, Third Edition.

Ryder, N.B. (1967) The Character of Modern Fertility, In W. Peterson (ed) Readings in Population. The McMillan Company, New York.

Saleem A. and Pasha, G. R. (2008) Women's reproductive autonomy and barriers to contraceptive use in Pakistan, Eur J Contracept Reprod Health Care, 13(1): 83-89.

Saleem, S. and Bobak, M. (2005) Women's autonomy, education and contraceptive use in Pakistan: a national study, Reproductive Health, 2(8): 1–8

Salkind, N.J. (2007) Encyclopedia of measurement and statistics, USA; SAGE Publication, Inc

Salway, S., N.C. Roy and M.A. Koeing (1993) Levels and Trends in Post-partum Amenorrhea, Breastfeeding and Birth Intervals in Matlab, Bangladesh, 1978-1989, Asia Pacific Population Journal, 8(2): 3-22.

Singh, S.; Casterline, j. and Cleland, J.G. (1985) The proximate determinants of fertility: sub-national variations, Population Studies, 39: 113.

Sirajeldin, I. et al. (1975) Fertility in Bangladesh: Fact and Fancies, Population Studies, 29(2): 207-215.

Skirbekk, V. (2008) Fertility trends by social status, Demographic Research, 18 (5): 145-180.

SOWC (2015) The State of the World's Children 2015: Reimagine the Future: Innovation for Every Child digital report is available at http://sowc2015.unicef.org

Spoorenberg, T. (2009) Changes in the proximate determinants of fertility decline in post-socialist Mongolia, J of Biosoc Sci., 41(5): 607-624.

Statistical Pocket Book of Bangladesh (1999) Health and Demographic Survey, Summer findings, 1994-95, 1996 and 1999, Dhaka Bangladesh Bureau of Statistics (BBS).

Statistical Pocket Book of Bangladesh (2001) Bangladesh Population Census Report 2001 National Volume, Dhaka, Bangladesh Bureau of Statistics (BBS)

Statistical Pocket Book of Bangladesh (2005) Statistical Pocket Book of Bangladesh, 2005, Published November 2006.

Statistical Pocket Book of Bangladesh, (2008) Published January 2009, Dhaka; Bangladesh Bureau of Statistics (BBS), Planning Division, Ministry of Planning; Government of the People's Republic of Bangladesh.

Statistical Pocket Book of Bangladesh, (2013) Published April 2014, Dhaka; Bangladesh Bureau of Statistics (BBS), Planning Division, Ministry of Planning; Government of the People's Republic of Bangladesh

Stephen, A. M. & Daniel, M. P. (2013) Progress in Spatial Demography, Demographic Research, 28(10): 271-312.

Stover, J. (1997) Revising the Proximate Determinants of Fertility- A paper presented at the 1997 annual meeting of the Population Association of America, Washington, DC, and March 1997.

Sweeney, M. M. Castro-Martin, T. & Mills, M. (2015) The reproductive context of cohabitation in comparative perspective: Contraceptive use in the United States, Spain and France, Demographic Research, 32(5): 147−182. http://www.demographic-research.org/Volumes/Vol32/5/

Tey, N.P. Ng, S.T. and Yew, S.Y. (2012) Proximate determinants of fertility in peninsular Malaysia, Asia Pac J of Public Health, 24 (3): 495-505, PMID: 21490114

Thapa, S. (1987) Determinants of fertility in Nepal: Application of an aggregate model, Journal of Biosocial Science, 19: 351-356.

Thein, T. M. et al. (1988) Evaluation of the Female Education Scholarship Program, the Asia Foundation Dhaka

United Nations (1981) Population of Bangladesh, Economic and Social Commission for Asia and the Pacific, Country Monograph Series No. 8, New York.

United Nations Children's Fund, UNICEF (2014) Published by UNICEF Division of Communication 3 United Nations Plaza New York, NY 10017, USA

United Nations Development Program, UNDP (2009) Human Development Report 2009, Oxford University Press, New York and Oxford, 2009

United Nations, UN (2011) World Contraceptive Use data sheet, New York, 2011

Vera Zlider, Rober Gardner (2001) Why Increasing Contraceptive Use Doesn't always results in immediate decline of total Fertility rate.

Wang, S. X. (1987) Proximate determinants of fertility and Policy implementation in Beijing, Studies in Family Planning.

Wang, Wenjuan, Soumya Alva, Rebecca Winter, and Clara Burgert, (2013) Contextual Influences of Modern Contraceptive Use among Rural Women in Rwanda and Nepal. DHS Analytical Studies No. 41. Calverton, Maryland, USA: ICF International

World Bank (1995) Bangladesh: From Stabilization to Growth, Washington, DC, and the World Bank.

Wright S (1960) Path coefficients and path regressions: Alternative or complementary concepts, Biometrics, 16: 189 – 202

Yang, Q. (1990) Age at first marriage and fertility in rural Anhui, China, Journal of Biosocial Science, 22: 143.