UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL AND HUMAN SCIENCES

DIVISION OF SOCIAL STATISTICS AND DEMOGRAPHY

FERTILITY TRANSITION IN PAKISTAN: NEGLECTED DIMENSIONS AND POLICY IMPLICATIONS

By

Jamal Abdul Nasir

Thesis for the degree of Doctor of Philosophy

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CHAPTER 1: ABSTRACT

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This research addresses some of the neglected non-program dimensions related to stagnant fertility transition in Pakistan. Previous research identified a range of factors influencing fertility in Pakistan, particularly the effect of distortions in reported ages, fertility inhibiting variables, timing of first marriage and first birth, and birth intervals. The literature provides evidence that there is no systematic analysis of these dimensions particularly at the regional levels. This research addresses these dimensions by evaluating the fertility and reproductive health data in particular using the cross-sectional data from the 1990 and 2006 Pakistan Demographic and Health Survey, and 2000-01 Pakistan Reproductive Health and Family Planning Survey.

Based on the application of relevant demographic and statistical techniques, the study demonstrates evidence of clear discrepancies in age reporting among married females across the seven geographic regions. This had influence on the estimated marital fertility rates which tend to be significantly higher when the reporting effects were adjusted. The analysis of fertility inhibiting factors reveals that timing of marriage and contraceptive use are crucial determinants associated with fertility reduction in Pakistan. By far, the strongest factor driving increase at first marriage in Pakistan is the level of female education which tends to vary significantly across different geographic regions. The analysis of the duration between marriage and first conception shows rather unexpected complex hazard functions with two peaks suggesting the behaviour of two different groups of women: those adhering to the traditional pattern in which conception take place soon after marriage; and those who postpone conception after marriage. Punjab, Baluchistan and urban regions are ahead of the fertility transition at the national level, confirming the effect of longer birth intervals. Based on the analysis of the proximate determinants framework, it can be concluded that Pakistan has entered the early third phase of the fertility transition. Urban Punjab and Baluchistan have also showed convergence to the third phase of the fertility transition. Breastfeeding and amenorrhea have emerged as significant determinants of birth interval duration.

The results of this study highlight various areas for programme intervention and policy development. There is a dire need for a policy to improve the levels of female literacy

and education especially in poorly developed regions which are in the second phase of fertility transition. A cost-effective intervention would be using mass media, for example radio broadcasting as the medium to disseminate reproductive health and family planning information. Pakistan needs specific policy interventions aimed at empowering girls with education for delaying marriage and encouraging contraceptive use. In formal education programmes, the syllabus should include the introduction to contraception, sexual health education as well as information on sexually transmitted diseases.

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DECLARATION OF AUTHORSHIP

I, **Jamal Abdul Nasir** declare that the thesis entitled

Fertility transition in Pakistan: neglected dimensions and policy implications

and the work presented in the thesis is both my own, and have been generated by me as the result of my own original research. I confirm that:

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List of abbreviations

AFB	Age at first birth
AFC	Age at first conception
AFM	Age at first marriage
AJK	Azad Jammu Kashmir
CPR	Contraceptive Prevalence Rate
DHS	Demographic Health Survey
FATA	Federally Administered Tribal Areas
FC	First Conception
FP	Family Planning
ICPD	International Conference for Population and Development
IEC	Information, Education and Communication
IUCD	Intrauterine contraceptive device
LHW	Lady Health Worker
MOH	Ministry of Health
MPW	Ministry of Population Welfare
NGO	Non-Governmental Organization
NIPS	National Institute of population studies
NWFP	North West Frontier Province
PDHS	Pakistan Demographic and Health Survey
PHER	Public Health Education Research
PPD	Population Planning Division
PRHFPS	Pakistan Reproductive Health and Family Planning Survey
PSPP	Population Sector Perspective Plan
PWP	Population Welfare Programme
TF	Total fecundity rate
TFR	Total fertility rate
USAID	United States Agency for International Development

VBFPW	Village based family planning worker

1 INTRODUCTION

What is already known about fertility transition in Pakistan?

Previous work has focused more on the inadequacies of the family planning supply side issues to explain the slow fertility transition in Pakistan.

There has been less analysis on the demand side factors accounting for the slow uptake of birth control in Pakistan.

What will this study add?

This thesis will focus on the missing dimensions from the demand side factors of fertility transition in Pakistan to bridge the gap in literature.

1.1 Objectives of the study

The overarching objective of this research is to provide policy makers with useful information as well as to address the neglected dimension systematically using appropriate statistical methods. The specific objectives of the study are:

I. To examine the extent of digit preference in age statistics at national and provincial level since 1990s, with an assessment of the possible effect of age misreporting on the fertility estimates.

II. To examine the role of proximate determinants of fertility model for seven geographic regions of Pakistan since 1990s.

III. To examine the timings of female age at marriage and births by age and birth cohorts since 1990s; and to examine the effects of social, cultural and economic variables on the timing of first marriage and duration of first parenthood in Pakistan.

IV. In a multivariate analytical perspective, to study the important time independent and time varying determinants of timing of births within a woman`s reproductive career since 1990s in Pakistan.

1.2 Study rationale

During the past five decades, Pakistan has experienced a slow-paced change in the level and pattern of fertility. The total fertility rate has declined from eight children per woman in the early 1960s to only four by the end of 2000s (Figure 1.1). Figure 1.1 shows that fertility started to decline steadily from early 1990s.

It is well established fact that changes in fertility are interplay of two key dimensions. The first dimension covers the FP provision and services, so called supply side factors. Slow programme implementation, unstable political support, inadequate administrative supervision and frequent changes in the programme strategies are reported to be the key reasons of unsatisfactory performance of the supply side input (Hakim 2001).

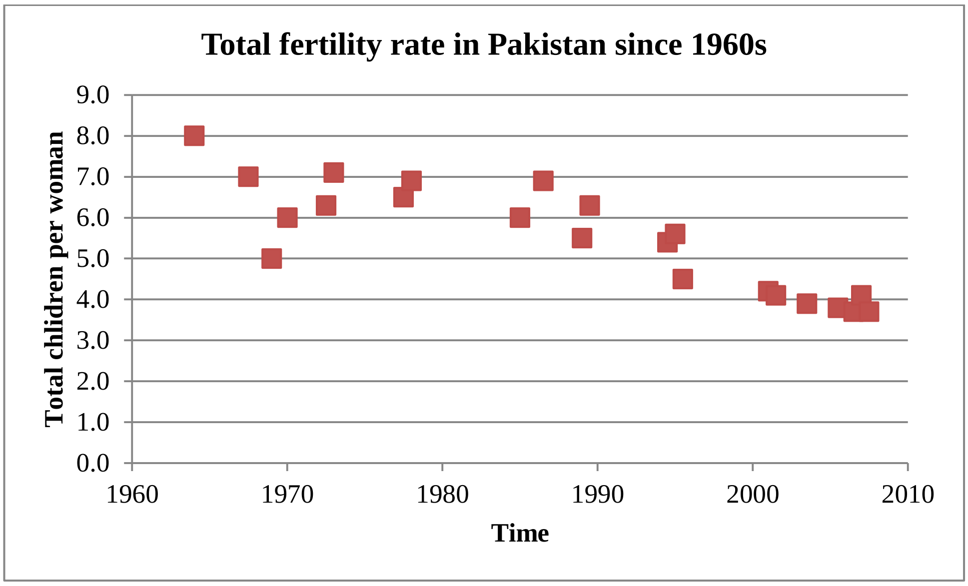

Figure 1.1: Trends in total fertility rate of Pakistan since 1960s

The second dimension involves understanding reproductive needs and contraceptive use behaviour of the population. This dimension can be designated as demand side factors. The family planning programme of Pakistan would be effective when couples have the motivation for smaller families. Alternatively, the balanced interplay of both supply and demand factors results an effective change in fertility behaviour. Notably, much attention on stimulating fertility decline has been devoted to the provision of FP services in Pakistan, whereas previous research related to the demand side is not only relatively scarce, but also, lack major insights, the demand side remains an area of demographic research which needs to be addressed.

This study aims to contribute to an understanding of trends and differentials in Pakistani fertility focusing on the demand side dimensions (non-programme factors) to bridge the gap in the previous research. Generally, it is expected that fertility is more likely to undergo changes in urban areas of society first as compared to rural areas during the demographic transition. The case of Pakistan in urban-rural fertility differential is interesting and challenging. Earlier findings based on 1975 Pakistan Fertility Survey (PFS) and 1979 Population Labour Force and Migration Survey (PLM) found that urban marital fertility exceeded their rural counterpart in Pakistan. The studies conducted in mid 1980s brought interesting urban-rural fertility differentials in Pakistan. The total fertility rate of urban areas was found to be lower than that for rural areas based on the Pakistan Contraceptive Prevalence Survey (PCPS) in 1984 (Sathar and Akhtar 1988). The pattern of urban-rural fertility differential was relatively not distinct until the late 1980s. There is a strong need to understand the magnitude of urban-rural fertility differential in Pakistan. Demographic transition theory envisages a decline first in mortality and then in fertility alongside the economic development of a particular country. Mortality has been declining in Pakistan in recent decades together with persistently slow declining fertility. Since fertility declines in most countries have been associated with increasing urbanization (White et al. 2008, Tacoli 2012). Previous research until late 1980s in Pakistan has not observed the inverse relationship between urbanization and fertility decline (Sathar 1979, Casterline 1984). The fertility transitions in Pakistan since 1990s do not account for rural-urban as well as provincial-level differentials and remained a missing dimension. Pakistani society should not be considered as a 'homogeneous' society. It is religiously homogenous society, at least, but, in terms of regional, racial, linguistic and cultural differentials; there exist substantial diversity in the population.

The four provinces of Pakistan are not homogenous in cultural settings. Fertility levels in Balochistan were higher as compared to other provinces of Pakistan in early 1990s (Hakim 1994). In another study by the same author using a different data set has showed fertility levels in NWFP (North West Frontier Post: currently Khyber Pakhtunkhwa province) were higher followed by Balochistan, Punjab and Sind (Hakim 1999). Not only the fertility differentials exists by region and place of residence but also the use of contraceptives differs (Hakim 2000).

1.3 Neglected dimensions

This study will focus on the following neglected dimensions and in particular will pay equal attention on provincial as well as rural-urban regions.

1.3.1 Age reporting

One of the most fundamental questions asked in demographic research is the age question. The accuracy of age reporting is very important for reliable demographic research particularly in developing countries (Seng 1959), because indices calculated from inaccurate age statistics may not exhibit the true or real level of fertility and mortality unless proper adjustments are made (Caldwell 1966). Estimates based on inaccurate age statistics may be incorrect. As far as demographic research in Pakistan largely dealing with fertility component is concerned, age reporting errors are a familiar problem. Age reporting bias in Pakistan was identified in early 1960s (Krotki 1961).

Later on, the first attempt using Myer`s approach was made to observe the pattern and extent of digit preference using single year age data from the Population Growth Estimation (PGE) project (Myers 1954, Yusuf 1967). One possible solution to overcome the effect of age reporting bias is the necessary adjustments on age distribution in the form of adjusted rates. Sets of adjusted age specific fertility rates under three different assumptions were also attempted in mid 1970s (Karim and Alam 1975). There seemed a substantial effect of unusual age misreporting in determining the state of fertility decline. This result was empirically confirmed through other studies using different data that no change in fertility levels were observed (Retherford et al. 1987, Yusuf and Hussain 1985). The erroneous age misreporting was held responsible as an explanation for no change in fertility levels in Pakistan till mid-1980s.

From 1990s to the present time, one census (1998) and various population surveys have been conducted to understand the fertility dynamics of Pakistan, but, insufficient attention has been given to the age reporting dimension particularly at the regional level. Few large scale attempts at global level have been made to assess the magnitude and impact of age misreporting for total population (Pullum 2005). This study addresses the issue and tends to explore that whether age distortions influence the estimation of fertility rates in Pakistan. In particular, following research question is addressed in this thesis.

Do age distortions influence fertility levels in Pakistan?

This question will determine whether a different picture emerge when fertility rates are accounted for age misreporting effects. The analysis will be extended on detailed geographic regions including urban, rural, four provinces and urban-rural within provinces in Pakistan since 1990s.

1.3.2 Proximate determinants of fertility

Human natural reproductive performance is influenced by social factors including economic, cultural, political and environmental differentials. In the mid-1950s, Davis and Blake introduced a scheme in which social, economic, cultural, political, and environmental factors were mediated by other factors called 'intermediate factors' or variables (Davis and Blake 1956). Davis and Blake categorized the intermediate variables into three main groups namely: intercourse-related, conception-related and gestation related variables. Later on, Bongaarts examined the intermediate variables and proposed the proximate determinants framework for fertility analysis (Bongaarts 1978). From a list of eight proximate determinants, Bongaarts rated four determinants as important in predicting the observed level of fertility in a population: the proportion of women married, contraceptive use, duration of postpartum amenorrhea and induced abortion.

Information on the first three of these determinants is widely available in Pakistan. At the national level, this is widely researched dimension of fertility transition in Pakistan (Aziz 1994, Soomro 2000, Nasir et al. 2009b). The proximate determinants model needs further research in two ways in the context of Pakistan: first, analysis at the regional level is still required in order to fully understand the fertility transition; second, to contribute to a better understanding of each of the four determinants of fertility from the time of the onset of fertility transition. In particular, following research question is addressed in this thesis.

What is the contribution of proximate determinants of fertility in Pakistan?

This question will identify since 1990s which determinant including marriage, contraception, abortion and amenorrhea, contribution is higher? The analysis will be extended on geographic regions including total, urban, rural, and four provinces of Pakistan.

1.3.3 Age at first birth

The first visible outcome of the fertility process is the birth of first child. The timing of this event is measured by the mother's age. The first birth has a significant role in the future reproductive life of each individual woman and has a direct relationship with fertility at individual and aggregative level. Several studies have found evidence of faster subsequent child bearing and an increased chance of unwanted births if the first child is born at an early age (Bumpass et al. 1978, Finnas and Hoem 1980). Few exceptions exist regarding the general relationship between early motherhood and the pace of subsequent fertility in developing countries (Balakrishnan et al. 1988).

This is a most neglected dimension, as far as the fertility research in Pakistan is concerned, even at national level. Previous research have completely ignored the age at first birth in understanding changes and differentials in fertility among Pakistani women (Soomro 1986, Hakim 1994, Hakim 1999). Previous research in Pakistan has shown that rise in female age at marriage as the key factor of fertility decline (Butt and Jamal 1993, Soomro 2000). Age at first birth is closely associated with age at first marriage in Pakistan. This study will focus to explore the determinants of both age at first marriage and birth in Pakistan. In particular, following research question is addressed in this thesis.

What are the correlates of age at first marriage and duration of first childbearing in Pakistan? The question will identify the key factors determining the variation in age at first marriage and waiting time to first pregnancy since 1990s. The analysis will provide the regional variation in age at first marriage and about first form of childbearing in Pakistan.

1.3.4 Determinants of birth interval

Human reproduction is a matter of choice and proceeds in sequential manner over the life course, starting from the biological capacity to reproduce, then the occurrence of the first birth, second birth and so on. Typically, a birth interval consists of four stages: a period of post-partum amenorrhoea, anovulatory cycles, a period of ovulatory exposure, and pregnancy (Potter 1963). Dynamics of fertility behaviour can better be understood through the study of birth intervals. Birth interval dynamics vary from society to society.

Some earlier attempts have been made in Pakistan to examine the effects of different variables (age at marriage and first birth, education, province of residence, ever use of contraception, duration of breast feeding) on birth intervals using 1975 PFS and 1979 PLM surveys data (Kiani and Nazli 1988, Sathar 1988, Khan and Soomro 1993). Apart from the results obtained from these studies regarding birth spacing dynamics of Pakistan, the notable feature was the use of old data particularly at a time when the fertility trend in the Pakistan was indeterminable. In addition the estimates of birth spacing using PFS and PLM data were also reported to be highly biased (Khan 1988). Since the onset of fertility transition in Pakistan starts from 1990s; therefore, the assessment of birth interval dynamics is crucial from 1990s to onwards and it remains a neglected dimension of demographic research in Pakistan which needs to be addressed. The present study presents the analysis of birth intervals since 1990s. In particular, following research question is addressed in this thesis.

What are the correlates of second through sixth pregnancy intervals in Pakistan? The question will identify the key factors determining the variation in pregnancy intervals. The analysis will determine whether the pregnancy intervals are higher using proximate fertility variables than those using socio-economic variables.

1.4 Introducing Pakistan

1.4.1 Location and area

The Islamic Republic of Pakistan[1] achieved independence from the British Empire on 14 August 1947. Pakistan is located in the north west of South Asia between 24° and 37° North latitude, and between 61° and 78° East longitude. Pakistan has three main neighbouring countries: India to the East and Southeast, Afghanistan to the North and Northwest, and the Islamic Republic of Iran in the West (Figure 1.2). Additionally, Tajikistan[2] is separated from Pakistan by a narrow strip of Afghan territory called 'Wakhan'. Currently, Pakistan comprises a total land area of 796,096 square kilometres (sq. km), of which 468,000 sq. km in the North and the West is covered by mountains and plateaus and the remaining 328,000 sq. km comprises a level plain and desert.

1.4.2 Administrative setup

Administratively, Pakistan is divided into six units: four provinces, one Federal area (centre) and tribal areas of the extreme northern frontier region called Federal Administered Tribal Areas (FATA) (Figure 1.2). The four provinces are: Punjab, Sind, and Khyber Pakhtunkhwa (formerly known as North West Frontier Post—NWFP), and Balochistan (Figure 1.2). The central or Federal government headed by the Prime Minister is located in the capital city (Islamabad) of the country. Several ministries and attached divisions lie under the Federal Government. Every ministry is governed by a minister commonly designated as

[1] The official name of Pakistan, named in the 1973 constitution of Pakistan.
[2] Formerly in the Union of Soviet Socialist Republics (USSR)

‘Federal Minister’. A similar level of administrative structure exists at the provincial level. Each province is divided into ‘district’ or ‘thana’, and each district is further divided into sub-districts and wards (‘tehsil’, or ‘taluka). Detailed administrative statistics according to 1998 Population and Housing Census of Pakistan (last census held in Pakistan) are shown in (Table 1.1).

Table 1.1: Distribution of administrative units including division, district and tehsil in provinces, federal and federally administered tribal areas (FATA) of Pakistan

Province/Area	Division	District	Tehsil/Taluka
Balochistan	06	26	116
Khyber Pakhtunkhwa	07	24	60
Punjab	08	34	118
Sind	05	21	88
Federal/Islamabad	-	1	1
FATA	-	07	42
Pakistan	26	113[3]	425

Source: (Population Census Organization 2001)

[3] Presently, Baluchistan consist of 30 districts, Punjab 36 and Sind 23 districts, under the district level Government introduced by ex-president of Pakistan, General Pervez Musharraf

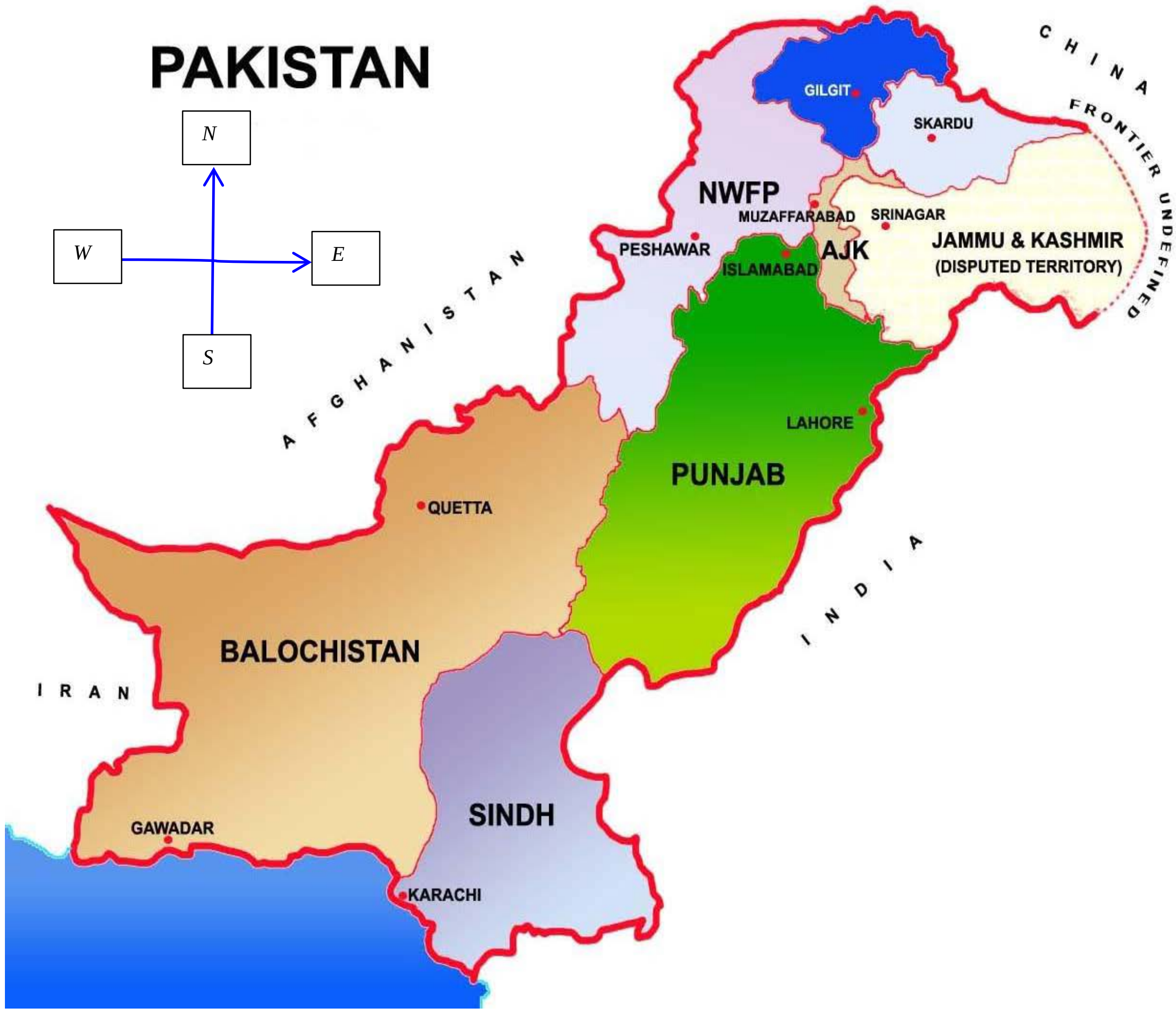

Figure 1.2: Map of the Islamic Republic of Pakistan showing administrative provinces

AJK: Azad Jammu and Kashmir
NWFP: North West Frontier Post (currently known as Khyber Pakhtunkhwa)
Source: http://www.planningcommission.gov.pk/images/map_pakistan (Use).jpg[14/11/2010 20:45:04]

1.4.3 Population Size and growth

The areas which now constitute Pakistan have a long history of census taking. The first census was conducted in 1872, thereafter, decennial censuses were held from 1881 to 1981. Pakistan has conducted five censuses since independence; the first was held in 1951, and subsequent censuses in 1961, 1972, 1981 and 1998. Apart from the censuses, various population surveys from different sources and under different formulations have been conducted in Pakistan since independence to provide data to assist the country's population research and development. In the last five censuses, the population of Pakistan was reported to be 33.81 million (1951 census), 42.98 million (1961 census), 65.32 million, 84.25 million and 130.58 million (1998 census) (Table 1.2). The population of Pakistan has increased around four times over the last 47 years. Pakistan now ranks sixth among the most populous countries of the world (184.8 million) with a total fertility rate (TFR) of 4.0 (Population Reference Bureau 2012). In terms of provincial population size since 1951 census, Punjab is the most populous province of Pakistan (Figure 1.3). Sind followed by Punjab is the second most populous province of Pakistan. Punjab and Sind together are the major centres of industry, trade, finance and education, and attract a large number of peoples from other provinces of Pakistan. Balochistan is the least populous province of Pakistan and shares less than 7 per cent of the total population of Pakistan. In terms of area, Balochistan is the largest province of Pakistan constituting 44 per cent of Pakistan`s total land. Due to mountainous terrain the population density is low in Balochistan and it population grew from 7.5 million in 2003 to 7.8 million in 2008 (The World Bank 2008).

Table 1.2: Population size, density and growth rate during the last five censuses of Pakistan (1951-1998)

Census year (date)	Population	Annual growth rate	Density (per square kilometre)
1951* (28.02.1951)	33,816,555	--	42.5
1961* (31.01.1951)	42,9782,61	2.45	54.0
1972 (16.09.1972)	65,320,941	3.66	82.0
1981 (01.03.1981)	84,253,644	3.05	105.8
1998 (02.03.1998)	130,579,571	2.61	164.0

* Censuses count include East Pakistan
Source: (Population Census Organization 2001)

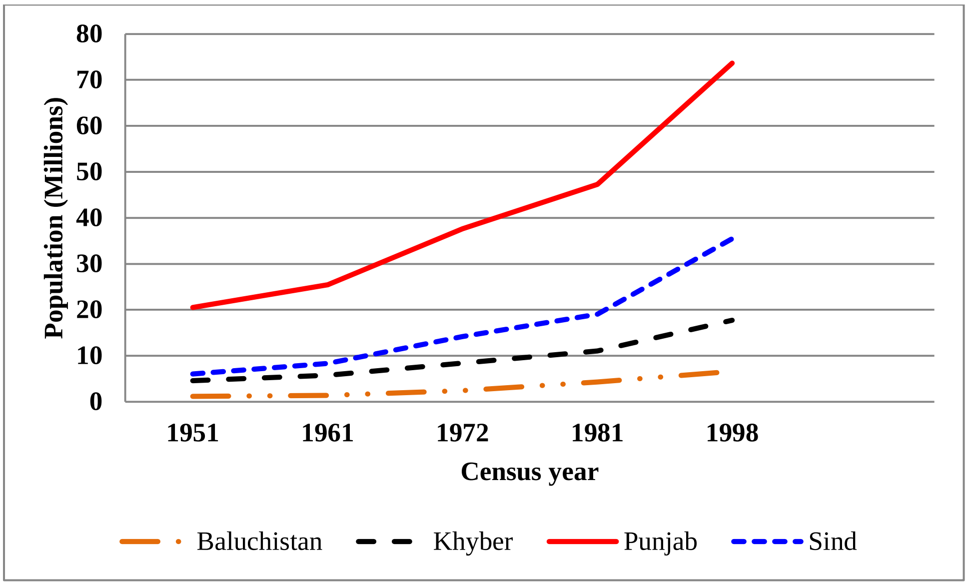

Figure 1.3: Trends in provincial population sizes in Pakistan during 1951-1998

In addition to population size and growth, Table 1.3 laid out the selected indicators of development in Pakistan. Life expectancy, urbanization and literacy levels in Pakistan since

1990s have steadily increased (Table 1.3). Demographic (life expectancy and urban), reproductive health (infant mortality rate and maternal mortality ratio) and social indicators presented in Table 1.3 highlights the improvements in Pakistan since 1990s.

Table 1.3: Selected population and development indicators of Pakistan, 1990-2006

Indicator	1990	1996	2003	2005	2006
IMR (per 1000)	91	92	76	77	78
MMR (per 100,000 live births)	490	375	315	290	275
Life expectancy (years)	60.4	62.4	63.7	64.1	64.3
Urban population (%)	31	32	34	35	35
Literate (%)					
Total	35	43*	n.a	50	55
Female (15 & above)	21	29*		35	40
GDP per capita (2000 US$)	465	515	518	562	595

IMR: infant mortality rate
MMR: maternal mortality ratio
n.a: not available

1.4.4 Culture and social custom

Broadly speaking, culture is the sum or total of the ways of life of people. Geography plays a very important role in the shaping of the culture of an area. It influences the behaviour of the people; through modern science and technology have their own impact on the development of the culture. The culture of Pakistan could be identified according to administratively defined limits as Punjabis from Punjab, Sindhis, Pukhtuns and Balochis. The people in four provinces are further divided into linguistic groups—Punjabi speaking, Sindhi, Pushto and Balochi based on mother language[4]. Urdu is the national language of Pakistan and it occupies a very significant place. Most of people in Pakistan are bi-lingual, speaking their mother (regional) language and Urdu with equal facility. However, Punjab has conspicuous traits—economically more developed, Punjabis are fond of wrestling, love folk tales and songs, enormous 'biradari' (local term) culture is found among Punjabis which literally means brotherhood of people claiming descent from a common ancestor. Table 1.4 presents the selected indicators of development relating culture and custom in four provinces of Pakistan. For example, Punjab is the largest province in terms of area after Balochistan in Pakistan (Table 1.4). More than half of the population of Pakistan lives in Punjab and contributes most of the portion to the national gross domestic product (GDP). Punjab can clearly be marked in differences in literacy predominantly urban Punjab.

[4] There are other languages widely spoken with in the regions or provinces. For example, Saraiki is widely spoken in lower areas of Punjab and interior areas of Sind. Other commonly spoken languages include Hindko, Brauhi, and Kashmiri.

The people of Sindh have developed artistic tradition through crafts, music, exquisite pottery, needle works, embroidery and literature. The inhabitants of NWFP are deeply religious people. They are fond of hunting, shooting and pride and vigour.Balochi people are powerfully built in body and herdling, milking, embroidery making are the traditional arts of Balochi society.

People from all provinces differ in their outlook—Punjabi wear pyjama with long shirts, Sindhi uses trousers and shirts with a distinct Sindhi cap on head, Pathans uses loose shirts and baggy trousers and carry arms and Balochi uses a long loose shirt with bulky trousers and a big turban. The increasing urbanization is Pakistan is leaving a great impact on the dress culture among provinces in Pakistan.

The household is considered as a unit of socialization in Pakistan. Most families in Pakistan live in joint or extended family system—parents of the married male live with their son. Average household size was 7.2 persons according to 2006 Pakistan Demographic and Health Survey. An upward trend is observed in average household size since 1998 Population and Housing Census of Pakistan (6.8 persons). The highest household size is in NWFP (8.0 persons) followed by Sindh and Balochistan (6.7 person). Pakistanis are a deeply religious people to whichever religion they might belong.

Table 1.4: Selected indicators of development relating culture and custom in provinces of Pakistan

Province		Land area (km^2)	Population* (000)	Literacy ratio*	Household size*	%GDP**
Punjab		205,344	73,621.29	46.6	6.9*	54.7
	Urban			64.5	6.3***	
	Rural			38.0	6.4***	
Sindh		140,914	30,439.89	45.3	6.0*	30.0
	Urban			63.7	6.0***	
	Rural			25.7	7.0***	
NWFP		47,521	17,743.64	35.4	8.0*	10.0
	Urban			54.3	7.2***	
	Rural			31.3	7.7***	
Baluchistan		374,190	6,565.88	24.8	6.7*	3.7
	Urban			46.9	8.0	
	Rural			17.5	7.5	

*: 1998 Census of Pakistan
**: values for year 2000
***: 2007 Pakistan Demographic Survey

Marriage is customary and an important social event in Pakistan. Two local terms are important for marriage in Pakistan: ‘nikah’ and ‘rukshsati’. Nikah means a girl is legally married, but that she may or may not have yet started living with her husband—socially acceptable time for starting childbearing. Rukhsati is the ceremony when bride goes to her husband house and she is exposed to the risk of pregnancy only after rushsati. Among provinces there are different customs of marriage institution in Pakistan, for example, bridge exchange (in local terms known as ‘watta satta’) or marriages with cousins in rural areas of Pakistan is quite common. Watta satta literally means give-take, it usually involve the simultaneous marriage of a brother-sister pair from two households. This is one of many customs in Pakistan on which no detailed or summary statistics is available.

Box 1: A brief statement about the study contribution to the field

The work presented in this thesis contributes to an understanding of trends and differentials about the fertility transition in Pakistan since 1990s.
In particular, this study is to mean to contribute to the field in two ways: methodologically and substantively.
Methodologically it includes the development of new demographic index and techniques to explore the issue of age distortions influencing fertility rates.
Substantive applications by focusing on the important neglected demand side dimensions of fertility transition in Pakistan.
The dimensions include, Age distortions, proximate determinants of fertility, age at first marriage and birth and pregnancy intervals in Pakistan.

1.5 Thesis outline

This thesis is organized into eight chapters. Chapter 1 provides the key objectives with rationales of the study followed by a brief account on neglected dimensions of fertility transition in Pakistan. Final section of on-going chapter describes short introduction to Pakistan.

Chapter 2 presents the detailed review of literature on the fertility transition of Pakistan since its independence. The review is arranged into two main parts: first part focuses on the supply side dimensions and then presents a discussion of the family planning program factors in the context of fertility outcome of Pakistan. Second part of the chapter is devoted to provide a detailed review of demand side factors and then presents a discussion of the non-program factors of the fertility transition of Pakistan. At the end of the chapter, the review and discussion of non-program factors highlights the research gaps where are identified as the neglected dimensions in Chapter 1 for the understanding of fertility transition in Pakistan.
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Chapter 3 is concerned with data. The chapter first describes the Pakistan Demographic and Health Surveys (PDHS) and Pakistan Reproductive Health and Family Planning Survey (PRHFPS) data. The approaches used to measure age misreporting are examined next and then a

new index is proposed. This chapter is confined to describe the methods of analysis for age misreporting influencing fertility. For convenience of understanding, other statistical methods are separately presented in each of the Chapter 5, 6 and 7. Chapter 4 is the first analytical chapter and presents the results of the age distortions influencing fertility.

Chapter 5 addresses the second analytical objective of this thesis. It has two parts. The first part of this chapter presents the levels and trends of fertility between 1990s and 2006 as a whole country as well as regional levels. The second part presents the fertility inhibiting indexes of proximate determinants model of fertility.

Third analytical objective of thesis is addressed in Chapter 6. The first part of the chapter presents the descriptive analysis of age at first marriage and birth. The second part of the chapter examines the role of socio-economic, geographic, and demographic factors on age at first marriage. The last part of chapter provides the results of factors affecting age at first marriage on duration of first pregnancy—waiting time to first conception.

Thesis objective IV is addressed in Chapter 7. It is the last analytical chapter and presents the results of the analysis of second through sixth pregnancy intervals in Pakistan. The first part presents conceptual framework including data management, descriptive analysis, and hazard examination for analysing the five pregnancy intervals. The second part of the chapter is devoted to findings of multivariate models using fixed time covariates of five pregnancy intervals. The third part of the chapter shows the regression models with time varying covariates and chapter ends with summary highlights of birth intervals.

Chapter 8 is the last chapter of the thesis. It discusses the concluding remarks of the main findings of each analytical chapter. An overall conclusion with policy implications and directions for future work are presented in the last sections of this chapter.

2 REVIEW OF PROGRAM AND NON-PROGRAM FACTORS

2.1 Introduction and chapter outline

The shift from high to low birth rates in any society is typically termed as fertility transition. Globally, the developed world particularly Europe has led the rest of the world in fertility transition. Many researchers have attempted to identify the factors explaining the European fertility experience. In general terms, the factors explaining the fertility transition vary from country to country. The factors explaining the fertility transition of advanced societies is not necessarily are the same as those for the developing societies. The differences of fertility transition between the developed and developing societies might be due to different societal norms or different cultural traditions.

Both supply and demand factors contribute to the fertility transition. This chapter provides a detailed review on supply and demand factors of fertility transition in Pakistan. The discussions presented throughout the chapter are based on the work of other scholars related to fertility and family issue of Pakistan. There are several sections in this chapter. Section 2.2 presents the supply side factors of fertility transition. Section 2.3 stimulates the discussion of review of programme factors. Section 2.4 explains the demand side factors in understanding the fertility transition of Pakistan. Section 2.5 ends up with the discussion of non-programme factors. Final section of the chapter highlights the research gaps in terms of missing dimension of fertility transition of Pakistan.

2.2 Program factors

Pakistan's population plan has a long history. Pakistan is in the list of those pioneer countries who adopted the population policy in the early 1950s. The 57 year old population programme of the country has passed through various stages. Table 2.1 explains the main features in terms of supply side about the family planning (FP) programme input of Pakistan since 1950s. Various shifts in administrative infrastructure to facilitate country wide FP, and strategies to promote the small family norms among the peoples of Pakistan have been adopted. Every strategy brought over times has its own strength and weaknesses. The administrative mileage of FP starts from the Ministry of Health (MOH) (during the regime of President Ayub Khan) and presently ends up with the joint anarchy of Ministry of Population Welfare (MPW) and MOH. The FP programme of Pakistan has been changed roughly five times in its administrative control from its origin.

Table 2.1: National family planning programme of Pakistan at glance since 1950s

Period	Remarks
1950-55	Informal initiation of family planning (FP) in 1953 under the auspices of FP Association of Pakistan
1955-60	Population researchers showed a concern on high population growth of Pakistan; parliament approved the grant of Rs. 0.5 million to FP association of Pakistan in 1958; National FP board was established in 1959; The Economic Committee of the Government approved the pilot FP projects; foreign aid (US) for clinical activities began in 1960.
1960-65	In 1960 Rs.30.5 million allocated for FP and health services provided on Government outlets; Pilot FP projects were in full swing under foreign assistance via Ministry of Health to develop the formal national FP programme; establishment of FP council; President Ayub Khan voiced an alarming concern over the population growth of Pakistan
1965-70	Government of Pakistan launched National FP programme in 1965; FP programme started one month late due to war with India in 1965; the national programme was governed by the Ministry of Health; FP clinics were established; recruitment of part-time dais; IUCD as the main birth control method; **target**: lower crude birth rate (CBR) from 50 to 40 per thousand populations; Ayub' s Government was over thrown due to religious alliance having anti-FP views in 1969; General Yahya replaced General Ayub in 1969; FP pilot project (Sialkot experience) for efficient delivery system started in 1969
1970-77	Civil war in 1971; East Pakistan became an independent state (Bangladesh); temporarily FP Programme suspension during and immediately after the civil war period, new democratic government took new initiatives; the Continuous Motivation Scheme (CMS) (derived from Sialkot experience) to create demand for FP was initiated in 1973; full time FP workers were employed; Contraceptive Inundation Scheme was added to CMS and remained in effect from 1974-77; Prime Minster Zulfiqar Ali Bhutto's fair interest towards FP; **target**: lower the CBR from 45 to 40 per thousand populations; extraordinary donor's involvement (USAID) during 1974-76; New Federalized Population Welfare Division was established in 1977 which replaced the previous FP council under the Ministry of Health
1977-80	FP Programme activities suspended because of government dissolution by armed forces in 1977, General Zia-ul-Haq opposing views towards FP under the cover of Islamic interpretations; Zia promulgated the Islamic laws ('Hudood ordinances') in 1979; Former prime minister Bhutto was sentenced to death in 1979; Attack of Soviet forces in neighbouring country (Afghanistan) in 1979
1980-88	Ministry of Population and development was established; Population Welfare Division brought under the control of Ministry of Population and Development; staff of FP workers in number was reduced in 1981; Presidential ordinance regarding field activity (field activity act) came in 1983; FP programme is broken into projects; nongovernmental organization council was established; programme namely 'social marketing of contraceptive' (1984) was initiated; ban was lifted on publicity for FP in 1985; **target**: lower the CBR from 40.3 to 37.3 by 1987
1988-90	Benazir Bhutto was elected as first woman prime minister of Pakistan in 1988; she drew more attention on urban areas for population development; the status of Population Welfare Division was upgraded to Ministry of Population Welfare in 1990; health centres were instructed to offer FP services; abortion was declared as an act of murder through 'Qisas and Diyat' ordinance
1990-93	Prime Minister Nawaz Sharif publicly support to FP; intensive media publicity; Government's social action programme in which he drew more attention on rural areas for population development including female education; village based FP workers were recruited (VBFPW); **target:** lower the CBR from 42.3 to 38 per thousand population by 1993
1993-96	Benazir's new Government declared key priority on population development; training for the large number of lady health visitors (330,000) to provide basic health and FP services was announced; financial support for population planning programme from the World Bank.
1996-99	Prime Minister Nawaz Sharif in his second term included a new health programme including mother and child care ; The programme was initiated as an action plan agreed in 1994 International Conference for Population and Development (ICPD); assessment of the PWP; **target**: lower the TFR from 5.9 to 5.4 by 1998
2000-2010	Adoption of National Reproductive Health Programme in 2001 (action plan agreed in 1994 ICPD) ; Pakistan Population Policy was formulated in 2002; National Policy for Development and Women Empowerment in 2002; Five year Population Welfare Plan (2003-08); after 2003, National Finance Commission (NFC) award and Public Sector Development Programme (PSDP) were the key stake holders to approve the financial funding to Population Welfare Departments; decentralization for the contraceptive service delivery (administrative and financial control given to Provincial Population Welfare Departments); Population Sector Perspective Plan 2002-12; In 2010 a new population policy is proposed (2010 proposed population policy); **target**: TFR 3.2 by 2015, 2.1 by 2030
2010-present	Prime Minister Gilani launched a new population policy in 201o—goals include to accelerate completion of fertility transition and increase the birth spacing; Full ownership of Population Welfare Program to provincial governments by 2015; NGOs participation in delivery of contraception at village level through 50,000 Family Health Homes; **target**: TFR 3.1 by 2015

The FP programme is a system of services and organized activities aimed at providing and promoting the acceptance of reproductive health, birth control, sexually transmitted diseases services and outreach and education services to eligible persons (United Nations 1983b). The primary goal of the FP programme is not only to make available the birth control information but also to supply the contraceptives. The review of the FP programme is organized under following main factors: policy environment, organizational set up, field structure, medical programmes, non-medical programmes, non-governmental organizations, and financial cost allocated for the programme implementation.

2.2.1 Policy environment

The key credit for the informal origin of FP activity in Pakistan goes to a well-educated and socio-economically upper class woman working in All Pakistan Women Association (APWA) namely Saeeda Waheed. Notably she decided to favour birth control mediums when her maid died during an attempt to abort pregnancy. Waheed consequently founded the family planning association of Pakistan (FPAP) in Lahore in 1952. Until the 1960s, sporadic efforts to promote FP in the country had been made by voluntary associations with least Government support. It was the President Ayub Khan (a military ruler of the country during 1958-69) who first showed the interest on the population dilemma of Pakistan for economic development. In 1959, Ayub's population fascination came to the audience in the form of a speech which he delivered in the national seminar on population arranged by FPAP. Then he established a centralized FP board to advice the Government on population policy. In the meantime, the results of 1961 National Population Census (a high crude birth rate: 50/1000 population, and a high annual population growth rate: 2.45) signalled to Government the need for a national FP programme. In 1964 FP council suggested to Ayub to launch the independent FP programme. The formal country wide official version of Pakistan FP programme was started on 1 July 1965 during the third five-year plan of the country which was governed by Ministry of Health. By the end of the first year (July 1966), the FP programme was fully operational in 33 districts (10 in East Pakistan and 23 in West Pakistan) (Adil et al. 1968). In 1969, Ayub khan was over thrown. The religious alliance having staunch anti-FP views was mainly responsible for the dismissal of Ayub's Government. Later on, the civil war in 1971 had stalled the FP activities in Pakistan. Bangladesh as an independent state (formerly East Pakistan) and a new Government in West Pakistan (chaired by Zulfiqar Ali Bhutto) were the outcomes of the civil war. The FP commissioner of this time had designed and executed an experiment (the Sialkot experiment) to make available the contraceptive supplies in order to make the re-orientation of the previously stalled FP programme (Osborn 1974). The Sialkot Experiment served as the basis of Continuous Motivation Scheme (CMS) which was launched throughout the country in 1973. The CMS was the product of individual person's policy that had the extraordinary bureaucratic authorities (FP

Commissioner in charge and joint secretary of Ministry of Health). From 1976-77, the population planning programme was completely federalized and population planning council had become a division. Ministry of health was the administrative controller of the division. Industrialists, middle class traders and religious leaders stood against Bhutto's policies of overwhelming modernization. However, in 1977 General Zia ul-Haq (a military ruler: chief of army staff of that time) deposed Bhutto's government and declared the martial law in the country. The FP programme activity was frozen due to martial law environment. Notably this was the critical time when foreign donor agencies (USAID) suspended the financial support to promote FP in Pakistan. Zia keeping in mind the anti-FP religious movements of previous regime and for the support of his government, had officially implemented the 'Hudood ordinances' (laws designated as the Islamic laws, explaining the punishment for theft, sex outside marriage, intoxication, adultery). The undue invasion of Soviet forces in Afghanistan in 1979 strengthened the Zia's government by the extra ordinary interest of the United States. In 1980, Zia appointed an elite lady worker of FPAP (Attiya Inayatullah) as advisor on population. Inayatullah revised the national population programme and a multi-sectoral approach was launched in 1983. The main focus of the multi-sectoral approach was to establish the link between FP and women's development, health and her education.

In 1989, when Benazir Bhutto came into power, she drew her attention to focus FP mainly on urban areas of Pakistan. The ministry of population welfare was created by the combine efforts of newly elected woman prime minister with her federal cabinet of Pakistan. In 1991, Nawaz Sharif (former prime minister) publicly supported the population planning efforts but the official attempts to promote FP in the country were lacking. Unlike the Benazir's regime, Sharif's government focused on the rural areas of Pakistan to cover the outreach services of FP in the country. A village based family planning workers (VBFPW) programme was launched in that era.

In 2000, Pervez Musharraf (a military ruler during 2000-07) brought the concept of modern enlightenment. In 2000, a review committee was constituted for assessment of existing population welfare programmes. However, on the basis of the recommendations suggested by the committee, a national population policy in 2002 was formulated in which the main focus was the decentralization of the programme management. Musharraf was well aware about the anti-FP views of religious alliance in former regimes of Pakistani rulers. Strategically, in 2005, Musharraf invited the religious leaders to support the values of population planning (Population Council 2005). In the meantime, political alliance which was voiced by media stood against Musharraf government. In 2007, as a result Musharraf over throw himself from the government with the decision of retirement. The efforts of inviting religious scholars to promote FP were stalled. Recently, under the new government (elected in 2008 elections), no considerable reforms in terms of policy brought forward besides appointing the federal minister of the ministry of Population welfare. However, in latest, a new population policy 2010 is proposed by the key personal of the ministry of population welfare (Khan 2010). Prime Ministrer Gilani with his team has launched the new Population Policy of Pakistan (PPP) in July, 2010 with a vision to increase the program service delivery in rural and remote areas as well as increasing the birth spacing in Pakistan. In 2010 PPP, Population Welfare Program is decentralised and provincial governments through Population Welfare departments will be the full owner of the program by 2015.

2.2.2 Organizational setup

Formally, the Pakistan's national FP programme started in 1965. The main organizational setup from top to down level of the first national FP programme of Pakistan is shown in Figure 2.1. The central FP council was governed by central minister for health (Ministry of Health) who was designated as the chairman of the council. The council consist of chairman, commissioner and secretaries of other ministries. The commissioner served as the secretary of the council and was assisted by deputy secretary.

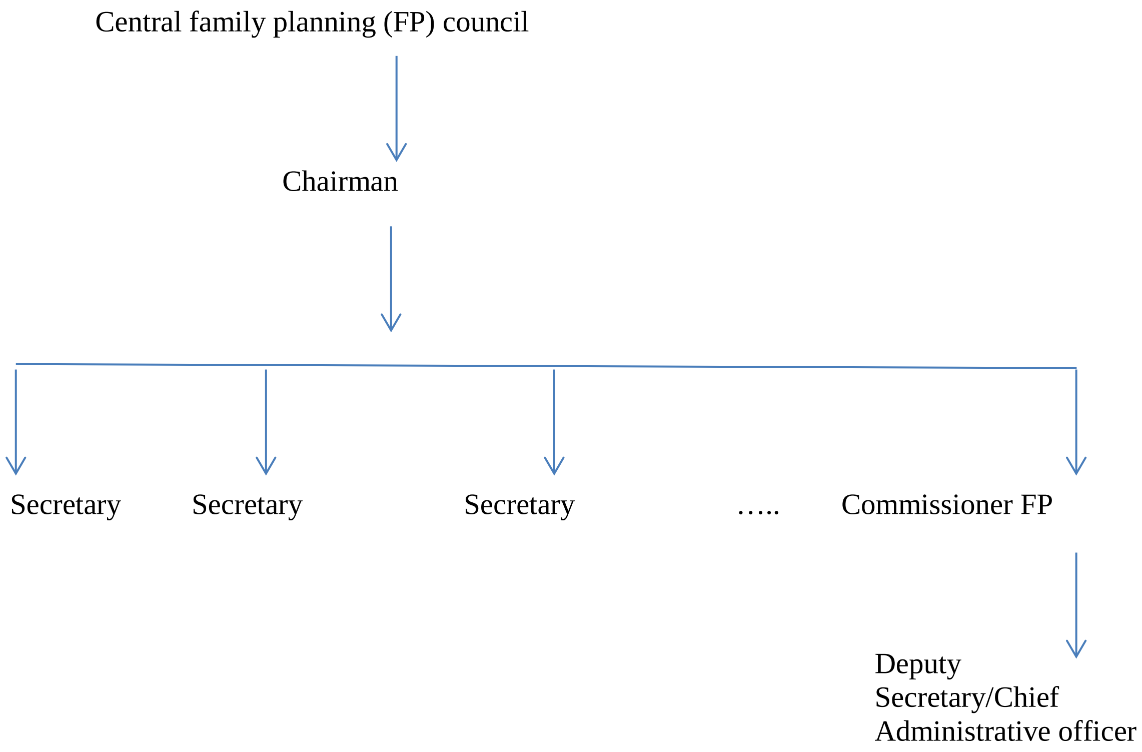
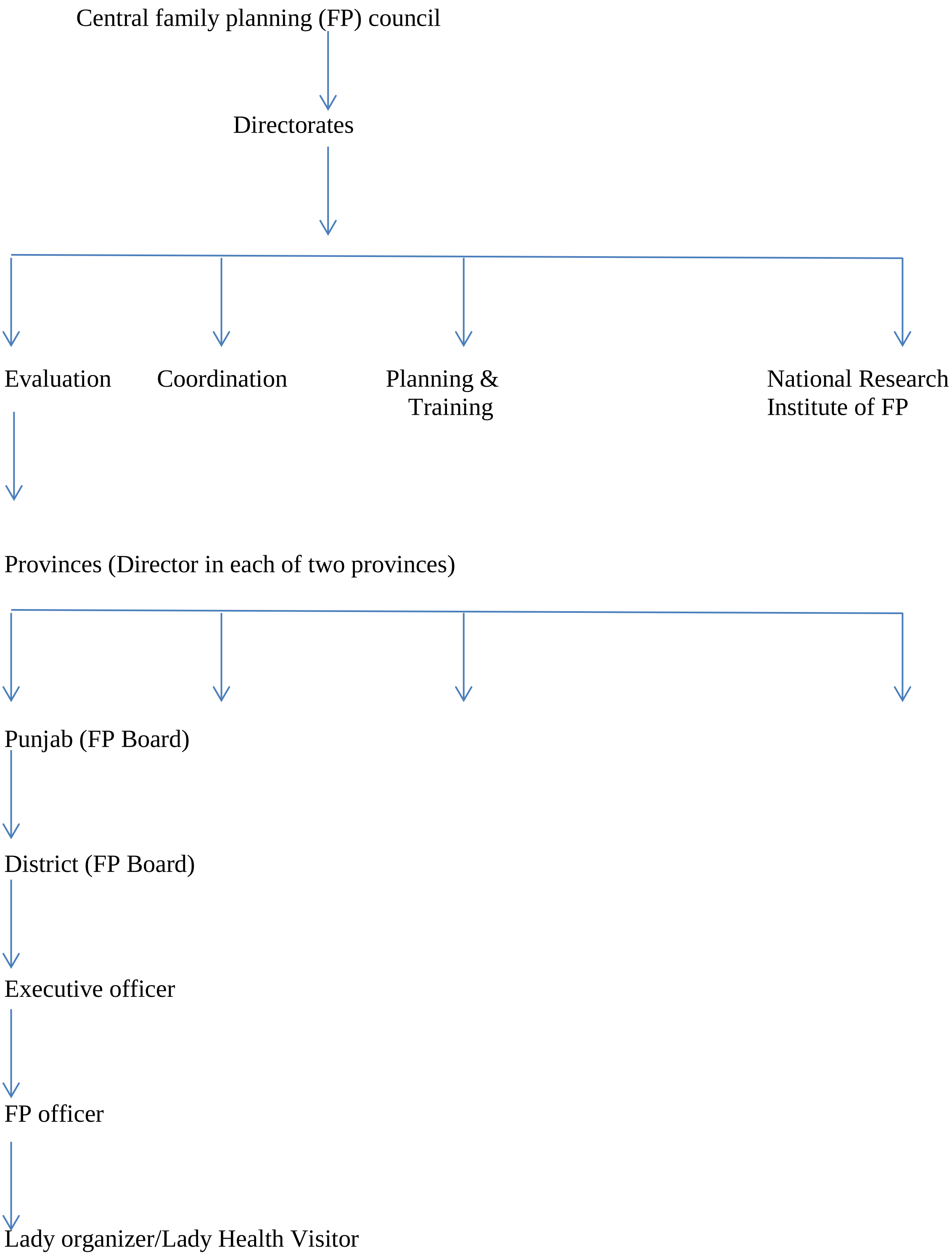


Figure 2.1: Organizational structure of first family planning programme of Pakistan in 1965

Figure 2.2: Top to grass root level personal in organizational setup of first family planning programme of Pakistan in 1965



The council had four directorates namely: directorate of evaluation, coordination, planning and training, and national research institute of FP (Figure 2.2). Provincial FP board works on the direction given by directorate of evaluation. A similar kind of district FP board worked under the provincial FP board. Lady organizers were the main field workers who had the direct orientation with the clients. Further details about roles and responsibilities of the top to grass root level personnel engaged with organizational setup shown in Figures 2.1 and 2.2 can be seen elsewhere (Adil et al. 1968, Bean and Bhatti 1969).

After a political change in 1971, the Population Planning Division (PPD) had replaced the former Central FP Council. The PPD was held under the administrative control of the Ministry of Health, Labour, Social Welfare and Population Planning. The district population planning boards were abolished in 1974 indeed full time district population officers were recruited. The lady organizers were replaced by the two member team including one male and one female (Zaidi et al. 1975).

In 1981, during the Sixth Five-Year Plan of the country, the population programme was administratively shifted to the Ministry of Planning and Development, where it was renamed as the Population Welfare Division and made co-equal with the Economic Planning Division. Further the population welfare programme was decentralized from Federal to district level (Robinson 1987). At Federal level, national population welfare council was created which was chaired by the President of Pakistan. Provincial population councils consisting of provincial ministers, secretaries from civil service and representatives from non-governmental organizations (NGO) were created. The chief minister of the province was the chairman of the provincial population council. A similar kind of district population welfare council was established. The district population welfare officer was the main person to control day to day field work. In 1990, Population welfare programme (PWP) was upgraded and given a separate ministry status designated as the Ministry of Population Welfare (formerly under the Ministry of Planning and Development). Currently, the Ministry of Population Welfare (MPW) of the Government of Pakistan is the key stake holder for the population planning programme of the country. The MPW is governed by the Federal minister of the Federal Government. The Ministry is consisted of its six attached wings namely: program, technical, monitoring and statistics, administration, public private partnership and planning wing. The PWP is de-federalized recently. A similar kind of provincial organizations setup exists presently and the administrative setup is chaired by the provincial chief minister.

2.2.3 Field structure

At the grass root level, lady organizers were the main field workers in the first national population planning programme (Figure 2.2). Employing the part time lady organizers (‘dais’) was a female targeted approach. In assessing the impact of the national FP programme, a number of problems for improvement were suggested. Apart from discussing other problems, one problem was the failure to target the males in the national FP programme (Ahmad 1971). This led to the revised pattern of field structure. As a part of pilot field activity, literate, full time working male and female workers were recruited to offer contraceptive services (Osborn 1974).

This was a door to door kind field work. The model door to door fieldwork both with literate male and female worker were officially implemented through a new system called ‘continuous motivation system’. Tehsil is the fourth level of administrative unit in Pakistan. In the continuous motivation system, a team of two workers (one male and female) were appointed in tehsil area roughly covering the population of 12,000-15,000 residents. The field-team was responsible for the four main tasks: motivating the couple for birth control, providing birth control methods, necessary birth control services and follow-up the couple (Zaidi et al. 1975).

To make more adequate the country wide availability of contraceptives, a ‘contraceptive inundation’ scheme was launched. In this scheme, contraceptives were distributed throughout the country using sale outlets including shopkeepers. Contraceptive inundation scheme was the kind of large scale supply-oriented programme (Robinson et al. 1981). Between 1977 and 1980, field activities were suspended because of the takeover of the military government in Pakistan. In 1981 with the start of new Population Welfare Programme (PWP) through population welfare ordinance 1983 (ordinance regarding field activity), family welfare centres were established. Each centre at grass root level was staffed by a family welfare worker, two assistants (one male, one female) and a helper. Family welfare centres were providing the training to dais (formerly known as lady organizers).

During the eight Five Year Plan of the country (1993-98), the local Lady Health Worker (LHW**)** was employed as the key field workers in the National Programme of Family Planning and Primary Health Care. The minimum education level of LHWs was the eighth grade (traditionally known as the middle pass education). The rural population of Pakistan was the main target of this national programme. Each LHW was available to serve approximately 1000 people in her own community. A village based family planning worker (VBFPW) under the Ministry of Population Welfare was the counterpart to the LHW from Ministry of Health. Currently, the country wide FP services are available for peoples through 3416 outlets including 2853 Family Welfare Centres, 271 Reproductive Health Service Centres and 292 Mobile Service Units (Khan 2010). Under the latest 2010 Population Policy of Pakistan (PPP) broad networking of 500 NGOs is an action plan for implementation of the program. These NGOs will provide family planning and reproductive health information and services in the rural and remote areas through 50,000 new Family Health Homes at the village level in Pakistan.

2.2.4 Medical programmes

Medical programmes section is characterized mainly by the sources of contraceptives supply. First and foremost source of contraceptive supply was the field worker, called Dais. **‘**Dai’ is a local term for midwives in Pakistan. Government of Pakistan during the Third Five-Year Plan (1965-70) had decided to employ Dais in the national FP programme of the country particularly in rural areas. A Dai was designated as village organizer and her status of employment was ‘part-time worker’. An earlier study on the understanding about the characteristics of Dais had suggested the utilization of these midwives in the national FP programme (Croley et al. 1966). Two core reasons were documented for the involvement of village organizers in the national FP programme. Intrauterine contraceptive device (IUCD) was the main birth control technique widely adopted in the national FP programme because of its low price and minimum follow up. The IUCD insertion was not possible without medical services and training. The other reason was the social acceptability of female doctor or nurse by women in Pakistani setting. Therefore, the insertion of IUCD was acceptable to Pakistani women only by female doctor or paramedical staff (Jafarey et al. 1968).

Another source of supply was the establishment of FP clinics or centres in the country. Government of Pakistan during the Second Five-year Plan (1960-65) has decided to establish FP clinics throughout the country (Adil et al. 1968). The utilization of these FP clinics by residential clients brought a notable result: a smaller proportion of the residents with in one mile of the FP clinic had used the clinic as compared to residents of the more distant areas. In other words geographical proximity was observed in utilizing the services of the FP clinics (Green and Krotki 1966).

After the political change in 1971, health centres were established at district headquarters and in metropolitan areas where graduate female motivators were appointed. All the concern of medical programmes up to this stage was to achieve the fertility targets (lowering the CBR from 50 to 40 per thousand populations). After the political crisis period (1971), supply to client based scheme was adopted. Before the formal initiation of this scheme (Contraceptive Inundation Scheme), delivery design was tested through a pilot project (the Sialkot experience). However, formally the continuous motivation and contraceptive Inundation schemes were launched nationwide in 1973. The information regarding scheme targets, objectives and implementation is shown in Table 2.2.

Table 2.2: Continuous Motivation and Contraceptive Inundation Scheme (1970-77)

Targets	Objectives	Implementation
Lower the CBR from 45 to 40/1000	rapidly reduce fertility	emphasis on sterilization and oral pills
Increase contraceptive Use up to 34% by 1975		Replace dais with a motivator team (one male, one female)
Financial cost		Double financial support as Compared to previous Family planning programme

Source: (Khan 1996)

In 1983, the multi-sectoral approach was launched. The scheme was also target oriented (lowering CBR from 40.3 to 37.3/1000 by 1987, increase contraceptive prevalence rage from

9.5% to 18.6% by 1988). The wide availability of contraceptives was the main focus of the multi-sectoral scheme. Under this scheme Family Welfare Centres were increased from 900 to 1250. The commercial marketing of contraceptives was also undertaken.

Two community based schemes to provide door-to-door FP services in rural areas of Pakistan were introduced in the eighth Five-Year Plan (1993-98). One scheme was held under the Ministry of Health and other was controlled by the Ministry of Population Welfare. Formally, this programme was titled as 'the National Programme of Family Planning and Primary Health Care' (Coren 2005, Douthwaite and Ward 2005). This programme is also referred as the Lady Health Worker Programme. The main focus of this program was to increase the health care and FP services in rural areas. LHWs were the main door step supplier of the FP services in this programme. The details regarding evaluation of Lady Health Worker Programme can be seen elsewhere (Douthwaite and Ward 2005). FP clinics other than Population Welfare Centres were opened in 1999-2000 to serve the urban areas of Pakistan (Hennink and Clements 2005). Mainly these FP clinics were setup in Punjab and Sind.
At micro level, a non-official client-oriented approach was tested to train community based workers including LHWs and VBFPWs. This client oriented approach was based on training called SAHR (Sathar et al. 2005). The name SAHR was an acronym: Salutation, Assessment, Help and Reassurance.

In 2002, National Population Policy was formulated in which the Reproductive health programme including mother and child care was initiated (Khan 2010). This was a broad based FP programme including the reproductive health services. The 2002 Population Policy was aimed to achieve the fertility replacement level by year 2010 by providing the universal access of FP and reproductive health in Pakistan.

2.2.5 Non-medical programmes

Different non-medical supply side strategies have been used to induce FP in Pakistan. Non-medical programme ways to promote FP comprise of: women's study groups, movie shows, contraceptives marketing through shopkeepers, FP publicity through local entertainers including singers (Choldin 1966).

Intensive education was thought to be another supply factor to promote the FP in the country. During the Second Five-Year Planning period (1960-65), a pilot project in educational methods relating FP was launched. The project was titles as the Public Health Education Research (PHER) Project (Gustafson et al. 1967). The key objective of the PHER project was to assist the national FP programme which was expected to launch in third Five-Year plan.

After the political change in 1971, the above documented model intensive education was expanded country wide with a new title: information and education. In this campaign FP information was publicised through radio, mobile films, television, group meetings. The FP awareness seminars were conducted in each district headquarters (Zaidi et al. 1975, Syed 1979).

Numerous Non-governmental organizations (the FP association of Pakistan, all Pakistan women association, and mother and child welfare association) were included in information and education campaign to stimulate the FP demand in the Population Welfare Programme in 1980s. Various special groups of the populations (the armed forces, Pakistan International Airways employees, Pakistan Railway employees, Pakistan steel company workers, postal employees, and Water and Power Development Authority employees) were targeted for intensive educational activities promoting small families. Private sector outlets including drugstores were targeted for the contraceptive supplies. This scheme of contraceptive supplies was termed as 'social marketing' or 'the contraceptive distribution' scheme. A trial based joint project between non-governmental organizations coordinating council and United States Agency for International Development (USAID) was undertaken to supply the contraceptives at the community level in 1991-92 (Shelton et al. 1999). The pilot mega project was consisting of six small community based projects.

One another non-medical supply tool for knowledge dissemination was the country wide availability of audio cassette to promote the family planning methods in Pakistan (Collumbien and Douthwaite 2003).

Pakistan being the signatory of the 1994 ICPD proceedings, has agreed on several programs of action. One of the programs was to implement the Population Sector Perspective Plan (PSPP) for the period 2002-12. The PSPP was targeted to achieve Contraceptive Prevalence rate (CPR) at 57 % by 2012 (Khan 2010). In the latest, 2010 Population Policy of Pakistan, 'Contraceptive Commodity Security' is agreed as an action plan to ensure timely procurement and delivery of contraceptives. Through this strategy, inventory control and proper distribution of contraceptive supplies to district outlets will be managed.

2.2.6 Birth control methods

Before the initiation of the first national population programme, President Ayub Khan asked the United States (US) to provide the oral pills for the national FP programme. After the refusal from US on political grounds, Ayub headed to the Population Council New York to assist in a national FP programme of Pakistan. Therefore, the first national FP programme of Pakistan had focused mainly on the use of IUCD. There were four features for the main focus on IUCD: low price, minimum follow up, locally manufactured and no availability of oral pills. IUD was the main available method in FP centres until 1990s (Farooqi and Sheikh 1993). Other than IUCD, conventional birth controls including condoms and foam tablets were also available during the second five year plan period of Pakistan. Later on, low insertion rates of IUCD were found among the women in West Pakistan (Helbig et al. 1970). Condoms, tablets and sterilization remained the main birth control mediums over the time. Then birth control methods are categorized as modern and traditional. Modern methods include female or male sterilization, use of pill, IUD, injectable, implants and condoms. During 1990s, despite the low contraceptive rate, male condom (7.1%: current use) was the main birth control method in Pakistan (PDHS 1990). Comparing 1990 with 2000 revealed female sterilization (6.9%: current use) as the main modern birth control method ((Hakeem et al. 2001). According to 2006 Pakistan Demographic and Health Survey, female sterilization (8%: current use) followed by condoms (7%) are the most widely used mediums of birth control in Pakistan.

2.2.7 Non-Government organizations (NGOs)

The history of population planning in Pakistan shows that the non-state sector informally originated the FP services in Pakistan because first FP association was formed in 1953 in Lahore, Pakistan. It was the first NGO in Pakistan who started to work entirely on its own basis. Then in 1954 another NGO named FP association was founded in Dacca (Former East Pakistan). There was a little role of NGOs in term of numbers and FP services from mid 1960s to 1980 under the three different rulers of Pakistan: president Ayub (1965-69) over thrown by religious wing, President and Prime Minister Bhutto (1970-77) over thrown by business and armed forces and General Zia (1977-80) suspended FP activities under the cover of Islamic laws. Facing the international pressure for population planning program, Zia put Dr Attiya Inayatullah of FP association of Pakistan as advisor on population program. Inayatullah played a key role in involving the NGOs in the national FP program of Pakistan. From mid-1980s to the present times various NGOs and non-state associations are collaborating on population welfare and reproductive health in Pakistan. The most common NGOs presently working for women empowerment and offering FP services are: Rutgers, Rahnuma, The National Institute of Population Studies (NIPS), National Trust for Population Welfare (NATPOW), Marie Stopes Society, Population Association of Pakistan (PAP), Family Welfare Cooperative Society, United Nations Population Fund (UNFPA) and Youth Advocacy Network (YAN). Given the importance of NGOs, the latest 2010 population policy of Pakistan has committed to expand the networking of 500 new NGOs at village level in Pakistan for providing FP and reproductive health services in Pakistan.

2.2.8 Financial cost of the population programme

The FP programme in Pakistan has become 57 years old unofficially and 45 years old officially. The detailed financial cost in Pakistani rupees (PKRs) is shown is Table 2.3. A total of 95102.9 million rupees have been allocated to the FP programmes in past 57 years. Alternatively, the annual allocations of almost 1668.5 million rupees have been invested to lower the population growth rate of Pakistan.

The population planning programme was de-federalized in 2002. The administrative, operational and financial powers were transferred to Provincial Population Welfare Departments. The Federal Government funded the population planning programme through the Public Sector Development Programme (PSDP) until the establishment of National Finance Commission (NFC) to take over the responsibility of provincial population planning programme.

Table 2.3: Budgetary allocation and expenditure (Pakistani rupees) on family planning programme of Pakistan since 1950s

Period	Five Year Plan	Allocation (Millions)	Expenditures (Millions)	Percentage Utilisation
1953-60	First plan (1955-60)	0.5	0.5	100
1960-65	Second	30.5	19	62.3
1965-70	Third	284	356	125.4
1970-78	Fourth (1970-75)	1028.8	833.9	81.1
1977-79	Programme suspended because of government dissolution by armed forces			
1978-83	Fifth	824	617	75.0
1983-93	Sixth	2044	1686.3	83.0
1988-93	Seventh	3535	3172.5	89.7
1993-98	Eight	9000	8400	93.3
1998-02	Ninth	8140	-n.a-	-n.a-
2002-03	-	4200*	3200**	76.2
2003-04	-	4809*	3700**	76.9
2004-2010	-	61207.1*	29680.1**	48.5

n.a: not available
* shows the proposed amount in million rupees
** shows the original allocated amount

2.2.9 Latest population policy of Pakistan

A latest population report published by the Ministry of Population Welfare (MPW) has proposed a Pakistan Population Policy (PPP) 2010. The details of the document can be seen elsewhere (Khan 2010). The key similarities and differences between 2002-PPP and 2010 proposed PPP are shown in Table 2.4. In sum 2002 and 2010 policies seem similar and targets are more realistic in proposed 2010 policy.

Table 2.4: Similarities and differences between 2002 and proposed 2010-Pakistan Population Policy

Feature	PPP 2002	PPP 2010
Poverty Reduction Plan	Included	Included
Reproductive Health Plan	Included	Included
Reducing Maternal Mortality	Included	Included
TFR target	2.1 by 2020	3.2 by 2015 2.1 by 2030
Reduce unmet need	25% Current	from 25 to 5 per cent by 2030
CPR target	57% by 2012	60% by 2030 (30% in 2010)

PPP: Pakistan Population Policy
TFR: Total fertility rate
CPR: Contraceptive Prevalence Rate

2.3 Discussion: review of supply factors

Pakistan FP programme has a long history and limited success. The administrative mileage of FP starts from the MOH (during the regime of President Ayub Khan) and presently ends up with the joint anarchy of MPW and MOH. The FP programme of Pakistan has been changed roughly five times in its administrative control from its origin. Pakistan's FP programme remained a target oriented programme from its inception (Table 2.5).

Table 2.5: Family planning programme targets in Pakistan since 1960s

Period	Crude birth rate/total fertility rate	CPR (%)
1965-70	CBR: reduce annual rate 50 to 40/1000 by 1970	-n.a-
1970-77	CBR: 45 to 40/1000	-n.a-
1977-80	Programme activities suspended	
1980-87	CBR: 40.3 to 37.3/100 by 1987	9.5 to 18.6 by 1988
1987-93	CBR: 42.3 to 38/100	12.9 to 23.5
1993-98	CBR: 39 to 35/1000	14 to 29
1995-2000	TFR: 5.9 to 5.4 by 1998	
2002	TFR: 4.8 to 2.1 by 2020	30 to 57 by 2012
2010*	TFR: 3.2 by 2015 TFR: 2.1 by 2030	30 to 55 by 2015
2010 (latest)	TFR: 3.1 by 2015 TFR: 2.1 by 2030	30 to 60 by 2030

n.a: Not available
CBR: Crude birth rate
TFR: Total fertility rate
CPR: Contraceptive prevalence rate
2010* indicates figures from a proposed 2010 population policy

These targets in literature are termed as the unrealistic targets. The low contraceptive prevalence rates indicate the unrealistic expectation by setting unrealistic targets from the Pakistani nation. The FP programme input has not motivated the minds of Pakistani people. A 30 percentage point rise in contraceptive use over 57 years indicates a rate of increase of only 0.5% per annum. On this least successful FP story of Pakistan, researchers have declared various arguments about the limited success of FP in Pakistan. Some researchers pointed out that the failure to understand the demand side factors as the key elements of unsuccessful FP programme in Pakistan (Robinson 1978). On the other hand, some believed that the FP programme had not worked well administratively (Robinson et al. 1981, Robinson 1987). However, there was a great need over time to understand the reasons of no use of contraception among the non-users. Unlike, different supply side strategies over time have been proposed to meet the population planning challenge of Pakistan (Rukanuddin and Hardee-Cleaveland 1992, Mahmood and Ali 1997, Ali and Zahid 1998). These studies have systematically over the period of time developed a perception that Pakistan population programme is weak and ineffective. These arguments based 60 year FP research of Pakistan left us uninformed to outline a key conclusive statement at a moment.

We highlight some points which should be learnt from the past to draw a conclusive statement. Lessons should be learnt from these highlights for future population planning programmes.

The Pakistan's FP programme is affected by donor influence. The World Bank has provided assistance to Pakistan on various development plans. The World Bank assistance to the Pakistan FP programme regarding decentralization looked to be another obstacle for the Government. Government of Pakistan need to clearly understand the programme implementation is its own personal agenda. The Government with profound understanding of its own nation can well manage and implement the programme to achieve the lower level of fertility.

Historically, it is clear that there have been a more focus on supply side in the FP programme of Pakistan; because increasing the supply infrastructure is easier as compared to motivate the peoples. The FP services can be fruitfully reaped if the sufficient demand exists in a society. Previously, sufficient demand (presently latent demand) of contraception is presumed in Pakistan and the pressure on providing FP services is built for financial aids. First of all, I foresee that a sufficient demand does not exist in the mind set of Pakistani society. This assertion is empirically understandable if we look at the reasons of no use of contraception among the non-users. As quantitative evidence, the findings from the nationally representative survey of Pakistan can be taken for granted. In the latest survey of Pakistan (2006 Pakistan Demographic and Health Survey), the reasons of not using contraception from the married Pakistani women were asked.

A total of twenty one reasons have been reported by currently married women (15-49) who were not using contraception at the time of survey and who do not intend to use in future which are shown in Table 2.6. We categorized these reasons according to programme (supply) and non-programme (demand) factors. The percentage distribution of these reasons since 1990s is shown in Table 2.6. Table 2.6 shows that only seven out of twenty one reasons are attributed towards supply side. The fear of side effects of contraceptive use (5.4 %) in 2006 and no knowledge of contraceptives (10.5 %) in 1990 are at the forefront followed by the health concerns (3.6 %). These two reasons are indirectly related to FP programme input as compared to contraceptive knowledge, source and cost which are directly related to FP programme. Notably, contraceptive knowledge (no knowledge 2.2 % in 2006) has been substantially improved in 2006 as compared to 1990. This improvement highlights the performance of FP input in Pakistan. However, from programme side knowledge of source (know no source 0.8 %) and cost (too much cost 0.8 %) of contraception are smaller in proportions among these non-users.

Table 2.6: Reasons (%) categorized by programme and non-programme factors among non-users for not intending to use contraception in future since 1990s

Factors	Reason	PDHS 2006-07	PDHS 1990-91
Supply	Fear of side effects	5.4	2.8
	Health concerns	3.6	4.6
	Knows no method	2.2	10.5
	Interferes with body's normal process	2.0	n.a
	Costs too much	0.8	0.6
	Knows no source	0.8	0.8
	Inconvenience to use	0.3	0.2
Subtotal		**15.1**	**19.5**
Demand	Up to God	28.4	n.a
	Can't get pregnant (infertile)	14.5	7.3
	Husband oppose	9.9	6.4
	Respondent oppose	7.7	1.6
	Already had menopausal	6.0	4.5
	Religious prohibition	5.0	13.2
	Infrequent or no sex	4.2	1.0
	Wants more children	2.9	42.7
	Don't know	2.2	1.6
	Breastfeeding	1.5	n.a
	No mensuration since birth	0.9	n.a
	Others	0.9	1.9
	Others opposed	0.4	0.2
	Missing	0.4	n.a
Subtotal		**84.9**	**80.5**
Overall Total		**100.0**	**100.0**

PDHS: Pakistan Demographic and Health Survey
n.a: Not available

Overall, in 2006, from the supply side a smaller (15.1) percentage of women (who mentioned no use of contraception in future) thought that they would not use contraception because of supply side issues as compared to issues relating non-programme factors (84.9 %). Notably, proportion of not using contraception due to programme side issues is gently decreased from 19.5 (1990) to 15.1 (2006) over 16 years.

These reasons are quite consistent with the supply side review. The justifications are given below. First, among reasons of supply side, the top priority statement of having the fear of side effects by using contraceptives is quite consistent with the choices made previously in selecting the birth control methods for the national FP programme. Previously IUCD and currently sterilization have been used as permanent birth control methods. These methods look to be inadequate from the society's point of view. Patriarchal male dominated society of Pakistan does not correspond with the concept of male sterilization as a matter of social prestige. Similarly, the female sterilization does not correspond within the joint family household where a senior non-sterilized woman is present. Regarding birth control methods lessons should also be learn in addition by understanding the FP success stories of other Islamic countries, for example Islamic republic of Iran. Iran's and Pakistan's FP programme are contemporary in nature. Iran has mainly focused on the use of pills in his first national FP programme and the Iranian Fertility Survey (as a part of World Fertility Survey) had shown the greater use of pills (85%) in 1976 (Aghajanian 1994).

Another point to note is that the Pakistan FP programme has been religiously discouraged since his glamour period (1965-69). Anti-FP views of religious alliance have created a gap between contraception and Pakistani nation. Ayub Khan's enthusiastic efforts to promote population planning has faced a strong protest from religious parties (Khan 1996). The religious protest against FP played a key role in the dismissal of Ayub's Government. Literature comments about no change in fertility levels of Pakistan during 1970s but it does not highlight the core reason of no change (Shah et al. 1986). The reason of religious prohibition towards contraception is also quite consistent with the 2006 PDHS findings. It is rank sixth (5.0 per cent) from the responses of non-users who has intention not to use contraception in future (Table 2.6). The reason of religious opposition towards FP in Pakistan was rank second (13.2 %). This clearly indicates the aftermaths of previous regime particularly Zia's cover of Islamization to protect his regime. A notable shift (from rank two to fifth) in religious perceptions of not using contraceptives is observed. Lessons should be learnt that Ayub and Bhutto's regimes were mainly suffered from religious wing on the issue of population planning. A workable understanding regarding religious alliance should be developed before proposing new population policies. The supports of religious alliance on FP have shown a remarkable success in other Islamic countries, Iran, Jordon, Egypt and Bangladesh for example. In Iran's FP success, the Islamic directive (fatwa) regarding birth control from 'Khomeini' (Iranian ruler in 1980) given at the time of Islamic revolution in Iran had substantially motivated the nation (Aghajanian 1994). Similarly, in Jordon, religious leader's favouring perceptions regarding contraception provide another guideline to voice the Pakistani religious alliance (Underwood 2000).

Contraceptive knowledge and use is the midst factor which works as an intersection between supplies and demand dimensions of a FP programme. While, on the supply side, it provides the basis by looking at its levels to devise new policies; on the other, it motivates the researchers and policy makers to explore the reasons of its low (or high) levels. Table 2.9 shows the levels of contraceptive knowledge and use in Pakistan since 1960s. There remained a profound gap between knowledge, ever and current use of contraception over the last fifty years. At one side the trend of contraceptive knowledge over time is quite similar to many other countries of the world Kenya, Mozambique and Bolivia for example; while, the trend of contraceptive use is similar to Madagascar and Uganda for example (Khan et al. 2007). In sum, Pakistan resembles with some African countries in terms of contraceptive knowledge and use. However, in first impression, low contraceptive use (29.9 % in 2006) might pinpoint the failure of FP programme of Pakistan. Previously many researchers have perceived this impression and have declared the Pakistani FP programme as unsuccessful. An understandable paradox emerges by re-looking at Table 2.9 and particularly noting the levels of contraceptive knowledge. This shows that Pakistani society keeps very high knowledge of contraception. The immediate question is how this knowledge is conceived? The straightest and simple answer is: Pakistani people have got this knowledge from their surroundings. The next relevant question is; who is disseminating this information? The simple answer is: it is spread by FP programme input. These explanations are consistent if we consider the responses shown in Table 2.6. A smaller proportion (only 2.2 %) among the non-users has no knowledge of any birth control methods. Which indicates the contraception knowledge is high and universal in Pakistan.

From the non-programme factors, the top priority reason of not using contraception was the response that 'it is up to God' (28.4 %) in 2006 followed by the fear of infertility (14.5 %: Table 2.6) in 1990, demand for more children (42.7%) was the main reason of not using contraceptives which is currently at rank 7 (Table 2.6). The possible explanation is: the response 'up to God' was not clearly asked in 1990 Pakistan Demographic and Health Survey women's questionnaire indeed an option of 'others' reason was provided (for details see question numbers 337-338 of women's questionnaire). This shows a firm belief of a Pakistani woman to have more children in 1990s. This firm belief has been translated into 'up to God' in the past sixteen years. In sum, four non-programme reasons for no contraceptive use namely: up to god, fear of infertility, want more children and respondent oppose herself; explains that higher demand for fertility exists in Pakistan indeed the more demand for contraception which was assumed in previous research. All these assertions high light a conclusive statement: FP programme of Pakistan is not unsuccessful indeed it is at more than satisfactory level. Speaking under the strategy of information education and communication (IEC), Pakistan's FP programme has effectively delivered the information, it delivered the education at the above satisfactory level, and communication needs some more strategic input.

Politically speaking, the Zia's regime was the worst one for the population development of Pakistan. During his regime the programme's efforts were conservative and foreign financial supports were suspended. Demographic Health Survey (DHS) are methodologically known as the 'gold standard' for population research as compared to Word Fertility Survey (WFS). In early 1980s DHSs came in population research. Notably, no Demographic Health Survey was held under Zia's regime. The Pakistan's first DHS was held in 1990 under the democratic regime. Age specific fertility rates were thought to be decreased indeed these were increased particularly at younger ages between 1982 and 1988 under the cover of Islamic laws implemented by Zia to support his regime (Table 2.7 and Table 2.8). During Zia's regime until 1985, there was a ban on FP publicity.

Table 2.7: Age specific fertility rates from selected surveys, Pakistan, 1975-2007

Age group	1975 PFS	1979 PLMS	1984 PCPS (1984)	1990 PDHS (1985-90)	1996 PFFPS (1992-96)	2000 PRHFPS (1997-00)	2006 PDHS (2004-06)
15-19	131	99	64	84	83	65	51
20-24	275	283	223	230	249	211	178
25-29	315	313	263	268	278	233	237
30-34	259	263	234	229	215	206	182
35-39	188	188	209	147	148	128	106
40-44	77	101	127	73	75	61	44
45-49	11	48	71	40	24	26	18
TFR	6.3	6.5	6.0	5.4	5.4	4.8	4.1

Years in braces indicates the period of births preceding the survey
Age-specific fertility rates are per 1000 women; total fertility rate is per woman
PFS: Pakistan Fertility Survey
PLMS: Pakistan Labour Force and Migration Survey
PDHS: Pakistan Demographic and Health Survey
PFFPS: Pakistan Fertility and Family Planning Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

It is important to note that the fastest fertility transition happened between 1990 and 2000 (Table 2.8). Notably, this was the period of democratic governments as well as the publicity of FP was uplifted that time. All these statements lead us to draw a conclusive statement regarding programme factors of Pakistan's FP programme. Besides some governance issues in implementing Pakistan's FP programme since its inception, these arguments derive us to conclude that the weakness is not in the performance of the population planning programme of Pakistan. The performance of Pakistan's FP programme from its inception has remained above satisfactory level.

Notably in the Pakistan's FP story, indeed a detailed look on non-programme factors is required. This is quite evident if we re-look at the reasons of not using contraceptives in future (Table 2.6). At one side the non-user women want to be fertile; while, on the other their husbands (rank third among non-programme factors in 2006: Table 2.6) and relatives oppose the use of FP. These remarks further extend the review of this chapter. Therefore, a detailed understanding of non-programme factors is presented in the following section.

Table 2.8: Age specific fertility rates after 1980s from Pakistan Demographic surveys

PDS	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**TFR**
1984	66	268	368	314	226	110	38	6.9
1985	59	273	351	327	235	109	48	7.0
1986	54	266	360	303	226	126	52	6.9
1988	66	264	333	278	203	111	42	6.5
1989	76	266	323	274	197	102	42	6.4
1990	76	275	313	276	176	97	31	6.2
Percentage change in 1980s								**10.1**
1991	69	258	315	259	187	82	27	6.0
1992	73	261	313	255	163	75	28	5.8
1995	59	243	305	242	148	90	30	5.6
1996	55	258	296	255	143	66	23	5.5
1997	52	231	273	211	143	68	31	5.0
1999	36	206	257	204	118	62	26	4.5
2000	33	195	244	204	115	54	23	4.3
Percentage change in 1990s								**28.3**
2001	24	162	243	197	119	58	22	4.1
2003	24	163	230	190	113	49	19	3.9
2005	20	158	226	180	107	50	18	3.8
2006	18	150	226	177	108	54	16	3.7
2007	16	150	225	173	103	53	18	3.7
Percentage change from 2001 to 2007								**9.8**

Age-specific fertility rates are per 1000 women; total fertility rate (TFR) is per woman
Source: 1984-2005, (Nasir et al. 2009a); 2005-2007, Pakistan Demographic Survey (PDS) reports

2.4 Demand factors

Non-programme factors covers many dimensions; however, following are the main: family planning knowledge, approval and use, family structure, children ever born, son preference, communication channels, woman, work and her status, social and cultural constraints, age at first marriage, desired fertility, consanguinity, and proximate determinants of fertility.

2.4.1 Family planning knowledge, approval and use

Earlier FP programmes in Pakistan were pilot projects. The macro level estimates of contraceptive knowledge, approval, or use were scarce. At a micro level, a survey of fertility in five villages of Comilla in East Pakistan had shown that educated and upper-class families were not the first to adopt FP (Khan and Choldin 1965). Another similar micro level study but in urban setting (Dacca) had confirmed that the fertility behaviour of higher educated and less educated couples was almost same (Roberts et al. 1965). Later on, the statistical insignificance was confirmed between contraceptive use and education (Stoeckel 1968). Two points are notable: first, the contraceptive knowledge among males was higher than females in both studies documented above and second, the study areas were in former East Pakistan (current Bangladesh). Under reporting of contraceptive knowledge and use were also identified in the earlier knowledge attitude and practice (KAP) studies (Green 1969, Stoeckel and Choudhury 1969). Contraceptive knowledge among Pakistani women was reported to be high since late 1960s (Sirageldin et al. 1976) (Table 2.9).

The figures showing contraceptive knowledge and use were not the only ways to understand fertility control behaviour of the population. Global pattern of population research started to explore the key factors associated with contraceptive knowledge, approval, or use. The contemporary attempts in Pakistan were also begun to identify quantitatively the important factors explaining the contraceptive knowledge, approval or use. Enormous literature exists in determining the factors explaining the contraceptive use in Pakistan. The unique feature on identifying factors explaining contraceptive use is the usage of different data sets overtime.

Table 2.9: Percentage distribution of family planning (FP) knowledge and use in Pakistan from various population surveys

Source	Respondents	FP Knowledge	Ever (Use of FP)	Current (Use of FP)
1968-69 National Impact Survey	2910, currently married women aged 49 and under	77	12.1	5.5
1975 Pakistan Fertility Survey	4949, ever married women aged 10-50	76	10.5	5.2
1979-80 Population Labour, Force and Migration Survey	10086/9732, ever married women aged 15-49	n.a	6.0/4.6	3.3
1984-85 Pakistan Contraceptive Prevalence Survey	7405, ever married women aged 15-49	61.5	11.8	9.1
1990-91 Population and Demographic Health Survey	6611, ever married women aged 15-49	77.9	20.7	11.9
1994-95 Pakistan Contraceptive Prevalence Survey	7922, ever married women aged 15-49	90.7	28.0	17.8
1996-97 Pakistan Fertility and Family Planning Survey	7584, ever married women aged 15-49	94.3	36.4/35.7	23.9
2000 Pakistan Reproductive Health & FP Survey	6579, ever married women aged 15-49	95.7	40.2	28.0
2006-07 Population and Demographic Health Survey	10023, ever married women aged 12-49	95.7	47.7	29.6

n.a: not available
FP: family planning

Mahmood in 1992 has made this attempt using the data from the 1979-Population, Labour Force and Migration survey for the rural and urban sample of Pakistan (Mahmood 1992). Women's education and her family income were found to be the significant predictors of contraceptive use in urban areas of Pakistan, whereas, women's education was found to be insignificant in rural sample. Nuclear family living was found to be strongly associated with contraceptive use in both rural and urban areas. An inverse relationship between age of women and contraceptive use was noted holding other factors constant in both rural and urban areas. Exposure to the FP programme and contact with FP worker were also found to be positively associated with contraceptive use. Education alternatively literacy levels influences substantially on the contraceptive use. Zaki and Johnson have suggested that the rural-urban fertility differentials gap in Pakistan could be minimized by increasing the literacy levels of women residing in rural areas (Zaki and Johnson 1993).

Women's education, urban residence and FP accessibility were found to be the strong predictors of contraceptive use overtime using three different data sets namely: 1975-Pakistan Fertility Survey, 1979-Pakistan Labour Force and Migration survey and 1984-Population Contraceptive Prevalence survey (Mahmood and Zahid 1993). Women education has been termed as the key predictor of contraceptive use. If the women education is combined with employment, then both education and employment would lead to the remarkable uplift of contraceptive use in Pakistan (Hakim 2000, Hamid and Stephenson 2006).

Previously, desire of no more children has been used as an indicator for the demand of FP services in Pakistan. Hakim has examined the use of contraception in relation to desire for no more children using the data from the Pakistan Contraceptive Prevalence Survey (PCPS 1984) (Hakim 1995). He suggested that desire for no more children has a direct influence on the contraceptive use. The low level of contraceptive use is mostly attributed to the slow paced fertility transition of Pakistan. In an earlier study, lack of spousal communication, less female autonomy, religious beliefs and preferences for sons were noted to be key factors affecting level of contraceptive use (Mahmood and Ringheim 1996).

The use of more formal or official data sets was not the only source in explaining the factors affecting contraceptive use, but some informal or micro level data sets were also used. At a micro level a comparative study of users and non-users of modern contraception from two cities of Pakistan was conducted (Zafar et al. 1995). Women's education, fatalism (index based on: no involvement of women in politics, destiny believe indicating no advance planning, firm believe on God for basic needs in a family), familism (index based on: woman can have only two children if she wants two, natural purpose of life incomplete with few children, woman could have an abortion because of many children) and sex preference were found to be the most significant predictors of contraceptive use in urban slum of Pakistan. Using the same data, further analysis under different formulation was carried out. The impact of socio-economic and demographic (husband and wife education, husband occupation, family income, age at marriage and number of dead children) and role relationship (index based on: help in cleaning the house, food and children's preparation, labour participation for women, husband domination and exposure to mass media) variables on contraceptive use were statistically found. Women education and husband domination and his help were identified to be the key predictors of contraceptive use (Zafar 1996).

The question asked about contraceptive use is generally shown in the dichotomous way (yes and no format) in any official or non-official survey reports. More explicitly, yes and no answer or the user and non-users of contraceptives are the typical ways to show the responses on contraceptive use. The natures of respondent response on the contraceptive use question vary from environment to environment in which interviews were held. The answer might be different if the interview is undertaken in a one to one scene (respondent and interviewer only) for example, than one to many environments (respondent and other women of the household). The answer on contraceptive use is further divulged in the presence of the male member of the household. The presence of household women other than respondent or the presence of male member is quite common in the patriarchal society of Pakistan. Among the study sample selected in the three national surveys (1984 and 1994-Pakistan Contraceptive Prevalence Survey, and 1990-Pakistan Demographic and Health Survey) of Pakistan, a special group of respondents who at the time of survey did not divulge themselves as contraceptive users, was identified. This special group of respondents did not answer contraceptive use question due to cultural reasons and the group was designated as the 'shy/silent' users of contraceptives (Hashmi 1996).

The previous studies conducted on contraceptive knowledge, approval or uses were mostly based on the interviews with married women only. It was presumed that women's attitudes towards FP were the reflections of their husbands' preferences. This proxy approach might not truly reflect the FP attitudes of husbands. For the true representation of husband views towards family, a couple based interviews were conducted in 1990 Pakistan Demographic and Health Survey of Pakistan. Couples desire of additional children, their contraceptive approval, their pre-decided family size, husband-wife communication on FP and their education were found to be the significant predictors of their contraceptive use (Mahmood 1998).

In the traditional Pakistani family system not only the husband's attitudes influenced the contraceptive use of their spouses, the impact of other family members was also identified. The discussion of woman with her mother in law or the fertility preferences imposed by mother in laws were found to have a strong influence on the contraceptive use of the spouses (Fikree et al. 2001). Additionally, the significant differentials were found on opinions about desired fertility among the husbands, wives and mother in laws (Masood Kadir et al. 2003).

2.4.2 Family structure

One of the basic social institutions of human society is the type of family. The prevailing family system in a society has an effect on fertility behaviours particularly in traditional societies where extended or joint family system is deep rooted. The fertility differentials of Pakistani women living in joint and nuclear families of both rural and urban areas were made. The early study was based on the information collected from the 1968-69 National Impact Survey (NIS) of Pakistan. No statistical difference was found between the fertility levels of joint and nuclear families (Karim 1974)

2.4.3 Children ever born

The estimates of mean number of children ever born (CEB) per woman are based on a straight question: how many children have been born alive? This question was directly asked to woman at the time of interview during the survey or census. The estimates of average CEB provides a measure of cumulative fertility of the sample of women. Previously direct and indirect approaches using CEB were employed to describe the fertility differentials in Pakistan (Hakim 1994, Afzal and Kiani 1995). However, age wise mean number of children ever born from multiple surveys to Pakistani women has been shown in Figure 2.3.

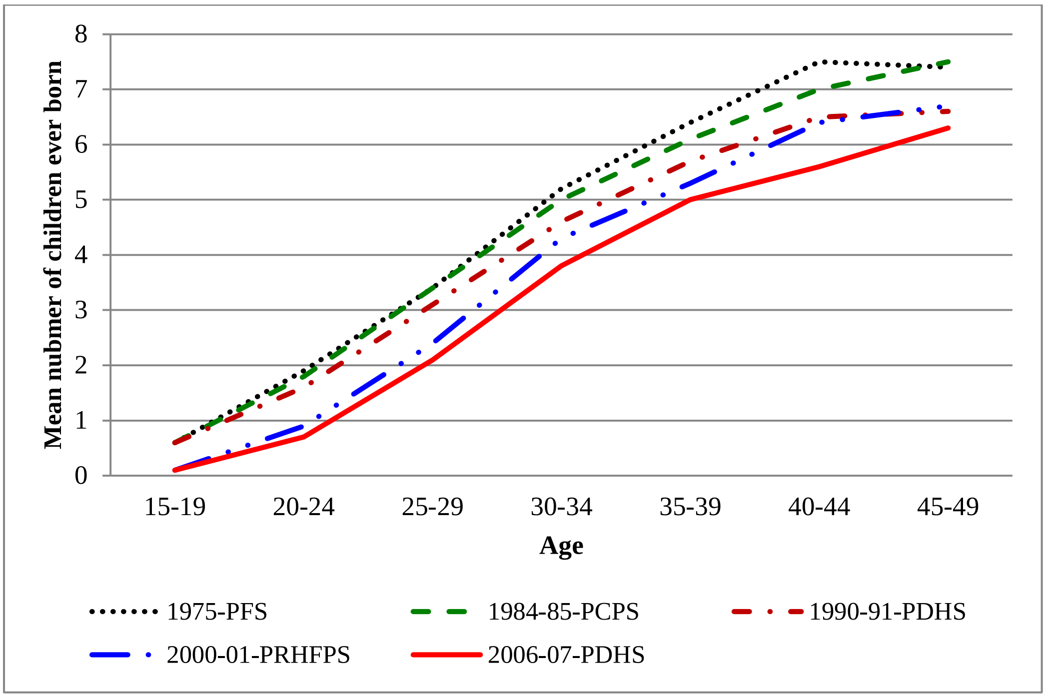


Figure 2.3: Mean number of children ever born through various sources in Pakistan since 1975

PFS: Pakistan Fertility Survey
PDHS: Pakistan Demographic and Health Survey
PCPS: Pakistan Contraceptive Prevalence Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

2.4.4 Son preference

Son preference is categorized as the sequential element in fertility decisions. The desire for sons affects fertility attitudes and behaviour. There are more values by having sons in agrarian societies as compared to non-agrarian societies. In agrarian societies, sons are viewed as the social and economic security for their parents during old age. Globally, most studies about son preference came in demographic research in 1970s (Repetto 1972, Stinner and Mader 1975, Ben-Porath and Welch 1976). Son preference both from the husband and wife point of views was ascertained using 1968 NIS information (Khan and Sirageldin 1977). A similar kind of study to explore the son preference was conducted using the information from the 1984 Population, Labour Force and Migration survey (Ali 1989). The study revealed that son preference had a strong influence on fertility in Pakistan in 1970s. Some recent studies have highlighted the preferences for sons in determining the reproductive behaviour of Pakistani women (Winkvist and Akhtar 2000).

2.4.5 Communication channels

There are two main channels through which FP messages are conveyed: mass media and interpersonal communication. The mass media communication channels are viewed on three major forms. These forms are reading newspaper including posters, listening radio and watching television. The other communication channels might include community leaders or personals, husbands, friends, relatives, doctor, hakim, singing and drama, cinema, non-governmental organizations. The studies at two levels are conducted in Pakistan to assess the effectiveness of communication channels used for FP information: micro or experimental level and at national level (Shah and Kazi 1977). Regarding interpersonal communication, previous studies have shown a high rate of contraceptive acceptance which was mainly attributed to husband-wife, friends, neighbours and relatives communication of motivation to adopt FP (Farooqi 1994). However, husband attitude and his exposure to FP messages through media with his wife's level of education were reported to be the main determinants of interpersonal communication.

2.4.6 Women work participation and fertility

Among the plethora of dimensions in understanding the demand factors for FP, one of the factors was known as 'women employment status'. Globally, status of women and FP has received attention quite earlier (United Nations 1973). Education plays the key role in working status of women. Demographic research has clearly explored a relationship between education and fertility. Mostly the inverse type relationship exists between education and level of fertility. The study of education and fertility can be used as an indirect approach to understand the relationship between women work and fertility. Using this indirect approach, Syed has found that education influenced fertility behaviour of Pakistani women in three ways (Syed 1978). First, increasing the level of education tends to rise the age at first marriage. Second, more educated women have more knowledge and use of contraception. Lastly, family size tends to reduce with the increasing level of education.

There were least opportunities for Pakistani women to work outside home after the independence. This remained largely an unfilled area after 50 years of independence. Because of the scarcity of the information on women work participation, earlier studies have found no effect of women employment on fertility in Pakistan (Shah 1975, Syed 1978). The general information regarding female work participation at national level was available through The Population, Labour Force and Migration (PLM) surveys. In deed the detailed information regarding fertility behaviour including household productive and reproductive choices with a women role in decision making were scarce. To bridge this gap, a pilot survey was undertaken in Karachi to gain the detailed information on reproductive histories of working women. The findings from this survey noted that women who work in professional and clerical occupations have much lower fertility as compared to house wives (Kazi and Sathar 1986). Other characteristics of working women including career and non-career oriented workers, work history before and after marriage, reasons for work participation and their age at marriage can be seen in Kazi and Sather (1986). These micro level studies continued to determine the influence of work on women reproduction in Pakistan. Women's fertility under the two broad categories of employment (formal and informal) was assessed (Sathar and Kazi 1990). It found that women who had formal employment (more committed towards their career targeting higher salaries) desire for fewer children as compared to women involved in informal sector.

In sum, the findings of 1990 and 2007 Pakistan Demographic and Health Surveys suggest that the labour force participation of young age women (20-34) years has gently risen from 16 per cent in late 1990s to approximately 22 per cent in 2007. Notably, the women involvement in work particularly in mature ages (35 and above) has no substantial effect on their fertility.

2.4.7 Women status and fertility

Status of women in each society may be interpreted differently. Women status can be broadly viewed in two spheres: internal (inside home) and external (outside home) status. The internal sphere consist of many dimensions, deciding what food has to be bought for example, who decide to buy things, who decide to admit the child in which school and so on. The external sphere mainly includes the outside mobility for any purpose. Pakistan is a typical patriarchal society in which mostly men are the main decision makers in both spheres. Pakistani women would make internal decisions autonomously subject to mature in age, having a nuclear family setup, highly educated and be a resident of modern locality (Sathar and Kazi 2000, Hakim et al. 2003). The inside home empowerment of Pakistani women is largely dependent on her outside work. The working women residing in urban areas were found to be more empowered in household decision making as compared to those living in rural areas (Mahmood 2002). Moreover, in Pakistan low educational attainment and less labour force participation of women indicate the weak empowerment of her outside home decision making. Education and employment are the conventional measures to denote the women status. Weak empowerment of women leads to their low status as compared to men in the society. This assertion is quite true in Pakistani society where mostly the male members are the head of households. However, apart from discussing male's patriarchy in Pakistani setting, it has been statistically argued that change in education level would not only rise the age at marriage of Pakistani women but also improve her status in all spheres in the society (Sathar et al. 1988). This change would ultimately play a key role in fertility decline of Pakistan. The women's enhanced role in household decision making would lead to fertility reduction outcomes. Increasing the level of women education is declared to be the key determinant for her cultural and reproductive autonomy (Saleem and Pasha 2007). Alternatively, to aid our assertion, Pakistani women with no education were found to have higher number of children ever born as compared to those women with some education (Hakim 1994).

2.4.8 Proximate determinants of fertility

The proximate determinants model of fertility proposed by Bongaarts is widely used tool in understanding the pattern of fertility transition (Bongaarts 1978). Bongaarts work was based on the scheme introduced by Davis and Blake in mid-1950s. Davis and Blake have set a scheme in which social, economic, cultural, political, and environmental factors were mediated by other factors called 'intermediate factors' or variables (Davis and Blake 1956). This section first provides a discussion from literature on effect of the social and cultural variables over the fertility transition in Pakistan.

2.4.8.1 Social and cultural constraints

Social and cultural constraints cover many different aspects prevailing in the society. These constraints vary in importance like from thin streams to thick rivers. Previously, Purdah (the Muslim custom of veiling) was thought to be one of social constraint which impede FP acceptance in the Pakistani society. However, the purdah observance found to be an insignificant constraint on the acceptance of FP in Pakistan (Shah and Bulatao 1981). In addition to social constraints, culturally, religious anti-family planning views are readily set in the society. Recently, six key barriers to contraceptive use are identified namely: "strength of the motivation to avoid pregnancy, social and cultural acceptability of contraception, perceptions of husband's preferences and attitudes, health concerns, knowledge of contraception and perceived access to services" (Casterline et al. 2001) (p.95). The characteristics of household including husband and household members including mother-in-law of Pakistani women are the other obstacles to use FP services (Stephenson and Hennink 2004). Preference for son is the other obstacle for contraceptive use in Pakistan (Muhammad 2009). Keeping the rural-urban differentials in mind, various implications including 'doorstep delivery' are suggested to increase the use of contraception (Coren 2005, Hollander 2005).

2.4.8.2 Age at first marriage

In almost all societies male and female are supposed to fulfil their sexual and procreative needs within marriage. Female age at marriage marks the formal entry into sexual union particularly in the Muslim societies. If age at marriage is early, a woman will have longer exposure of child bearing period and is expected to end up with higher fertility, while the opposite has an effect on fertility (Coale 1975). In demographic transition theory, delayed age at marriage is the major determinant of fertility decline. Researchers have documented the rise in female age at marriage as the main factor in the decline observed in fertility levels of Pakistan. The legal age at marriage in Pakistan is 18 years for males and 16 years for females. The males and females pattern of age at first marriage since 1950s is shown in Table 2.10. In 1961, the female singulate age at marriage was just 18 years; which according to the recent estimates has increased to 23 years (Table 2.10). The female age at marriage was found to be the significant determinant of fertility at the national level using district as the unit of analysis (Soomro 1986). A wide gap in fertility levels was noted between younger and older groups of age at marriage. In sum, any hints of a fertility transition until the 1990s appeared, was attributed towards the rise in age at marriage.

Table 2.10: Pattern of singulate mean age at marriage (years) in Pakistan from multiple sources since 1950s

Source	Period	Male	Female	TFR
Census	1951	22.3	16.9	-
Census /PGE	1961	23.3	16.7	7.9
Census /PLM	1972	25.7	19.7	7.1
Census/PCPS	1981	25.1	20.2	6.0
Census	1998	25.8	21.7	4.8
PDS	2003	26.4	22.3	3.9
PDS	2005	26.4	22.3	3.8
PDS	2006	26.5	22.7	3.7
PDS	2007	26.4	22.8	3.7
PDHS	2006-07	27	23	4.1

TFR: Total fertility rate
PDS: Pakistan Demographic Survey
PGE: Population Growth Estimation Survey (1962-65)
PLM: Pakistan Labour Force and Migration Survey (1970-74)
PCPS: Pakistan Contraceptive Prevalence Survey (1984-85)

2.4.8.3 Desired fertility

Desired fertility is generally measured by the couple's statement of additional children to complete family size. Measuring and analysing the demand for additional children provide the future prospect of fertility outcome. An element of extra security by having large families exists in agrarian societies. On the one hand, desired large family size provides the extraordinary security for the family; on the other, sons provide the strong basis for economic values of the family especially in rural areas of Pakistan. Further, in Pakistan, the demand for additional children is mostly attributed to husband's or husband's family demand for additional children. The wives` desires for additional children are largely shaped or influenced by husband's fertility preferences. Previous research has shown that the desire to have no more children is greater among women than among men in Pakistan (Mahmood and Ringheim 1997).

The husband-wife communications about FP and family size have turned out as the significant predictors of desired fertility.

2.4.8.4 Consanguinity and fertility

The marriage between close biological kin falls under consanguinity. One of the social norms in marriages of Pakistani society is consanguinity. At the national level, officially, the reproductive information including consanguineous unions was first collected in 1990-91 Pakistan Demographic and Health Survey of Pakistan. Micro level attempts in understanding the reproductive behaviour of consanguineous couples were also held. Both national and micro level studies under consanguinity have shown that Pakistani women marry at younger ages and less likely users of contraceptives (Shami et al. 1994, Hussain and Bittles 1999).

2.4.8.5 Model of proximate determinants of fertility

Turning now to the Davis and Blake work they categorized the intermediate variables into three main groups namely: intercourse-related, conception-related and gestation related variables. Later on, Bongaarts re-expressed intermediate variables for empirical purposes. Bongaart`s intermediate variables are referred to the proximate determinants` of fertility (Bongaarts 1978). Moreover, from eight proximate determinants of fertility, Bongaarts critically noted the four variables largely responsible for the observed level of fertility, namely: the proportion of women married, contraceptive use, duration of postpartum amenorrhea and induced abortion. To quantify the effects of these four major determinants of fertility on total fecundity, Bongaarts developed the following model:

$$\mathrm{TFR} = \mathrm{C_m} \times \mathrm{C_c} \times \mathrm{C_i} \times \mathrm{C_a} \times \mathrm{TF} \qquad (1)$$

Where Cm, Ci, Ca, and Cc denote the indices of proportion married, lactational infecundability, abortion and contraception, respectively. The theoretical maximum fertility of a woman is 35 births, not counting multiple births. This theoretical maximum is based on the maximum reproductive life span of age (generally 15 to 50 years) and the absence of all biological and behavioural constraints. If the constraints waiting time to conception, risk of intrauterine mortality and onset of permanent sterility are taken into account, the average potential fertility is about 15.3 children per woman with minor variations in human sub-populations (Bongaarts and Potter 1983). This potential fertility is referred to as the total fecundity (TF) (simply defined as the expected number of average live births among women within their reproductive age). These indices range in value from 0 to 1. A variable has no fertility inhibiting effect if the index is 1 and zero if the fertility inhibition is complete by the given intermediate variable. The computational details of these indices are given in Chapter 5. Table 2.11shows the indices of proximate determinants model from various sources since 1975. The index of marriage Cm is designed to express the reduction in fertility caused by women sexual inactivity. Pakistan is a society where it can be assumed that: married women are almost all sexually active and unmarried women are all sexually inactive. Under this assumption, the index takes the value of 1 when all women in the reproductive age categories are married and zero when no Pakistani women are married. Thus in 1975 the value of $C_m = 0.79$ indicates that 21% of women in their reproductive period were not sexually active. The value of index decreased in last 25 years which gives that 32% of women in their reproductive period were not active sexually in 2000. The index of contraception, C_c, depends on the prevalence, extent of use and effectiveness of contraception. The index takes the value of 1 in the absence of contraception and 0 if all fecund women use 100% effective contraception. The values of this index over 25 years confirm that Pakistan is low contraception society.

Table 2.11: Indices of proximate determinants model in Pakistan since 1975

Indices/measures	1975 PFS	1984-85 PCPS	1990-91 PDHS	1993 PFPI	1996-97 PFFPS	2000-01 PRHFPS
C_m	0.79	0.78	0.67	0.70	0.68	0.68
C_c	0.95	0.92	0.87	0.80	0.78	0.83
C_i	0.69	0.65	0.63	0.63	0.67	0.65
C_a	1.0	1.0	1.0	1.0	n.a	0.99
Total fecundity	15.3	15.3	15.3	15.3	14.5	13.2
TFR (estimate)	7.9	7.1	5.7	5.4	n.a	4.8

PFS: Pakistan Fertility Survey; Indices are estimated by (Aziz 1994)
PCPS: Pakistan Contraceptive Prevalence Survey; Indices are estimated by (Aziz 1994)
PDHS: Pakistan Demographic and Health Survey; Indices are estimated by (Aziz 1994)
PFPI: Population and Family Planning Indicators Survey; Indices are estimated by (Aziz 1994)
PFFPS: Pakistan Fertility and Family Planning Survey; Indices are estimated by (Soomro 2000)
PRHFPS: Pakistan Reproductive Health and Family Planning Survey; Indices estimated by (Nasir et al. 2009b)

The index Ci shows post-partum infecundability that is designed to describe the effects on fertility of extended periods of post-partum amenorrhea. The value of this index varies between 0.69 (PFS 1975) and 0.65 (PRHFPS 2000) which indicates that post-partum amenorrhea and post-partum abstinence suppress maximum potential fertility by 31% and 35% respectively. Regarding induced abortion; it is illegal in Pakistan unless undertaken to save the life of the mother. However, the medical professionals of Pakistan recognized that induced abortion has long been occurring in Pakistan. To date, the reliable, compact and direct national level estimates of induced abortions in Pakistan are scarce, indeed some micro level and indirectly estimated national figures relating induce abortions are available (Sathar et al. 2007, Naghma-e-Rehan 2011). In general, two measures namely abortion rate and ratio were used to measure the incidence of abortion at national level (Sathar et al. 2007). A national abortion rate of 29 per 1000 (abortion ratio: 14 per 1000 pregnancies) Pakistani women was estimated in

2002 using indirect estimation procedures. In simple words, one in seven pregnancies was terminated by induced abortion in Pakistan.

However, regarding provincial differentials in abortion rates, Khyber (37 per 1000 women) and Baluchistan (38 per 1000 women) were found to have higher than average national abortion rate.

2.5 Discussion: review of demand factors

Regarding demand side the understandings emerge from the literature are given below. These understandings further highlight the research gaps. First of all, Pakistan should not be considered as the homogenous society indeed it is a collection of many heterogeneous societies. Pakistan is a country where the construction designs of two houses in the same street for example, or the political views of two persons living in the same household are quite different from each other. The reader may find it a humorous argument but it explains an existing reality which has substantially prevailed in the Pakistani society. On which the social or on the cultural basis is the Pakistani society considered to be homogeneous? The partial answer to consider the Pakistani society as homogeneous can be only viewed on the religion basis. Islam is the official religion of the country. Only religiously at surface level, Pakistan can be declared as a homogenous state. Notably, if the insights of religion basis would be understood, then a heterogeneous pattern of religious obligations can be observed in the population of Pakistan. Conservatively speaking, the Muslims of Pakistan follows in their religious norms to one of the three main schools of Islamic thought. The names of these schools are: Hanafi including Dewbandi and Baralvi, Hanbali including Ahal-e-hadish and Ahal-e-Taseeh. The attitudes regarding FP of religious scholars belonging to these schools are dissimilar (Nasir and Hinde 2011). It can be concluded in a more narrow sense even on religious grounds that the Pakistani society is not homogenous.

Secondly, another key point conceived from the demand side literature is that: the increases in woman's education and upgrading her economic status have been vigorously suggested to lower the fertility levels of Pakistan. These are long term investments which only are not enough to make a substantial population development of Pakistan. Logically, with these long terms inputs some gentle short time policies are the need of time, however, few short time interventions have already been proposed, involvement of religious or community leaders, focusing on mother-in-laws for example, to effectively increase the contraceptive use. Should these long or short time inputs be equally provoked in action all over the country in which there exist many heterogeneous regions which are quite apart with each other in cultural and social norms? This assertion can gently be supported if we look at the fertility patterns of Pakistan under different regional characteristics (Table 2.12). In general urban areas precede the rural ones in terms of population development. As expected, the fertility levels of urban areas (TFR:

4.9 to 3.3) in Pakistan are at the forefront Table 2.12). Regarding provincial fertility differentials, Punjab has the lowest TFR as compared to other provinces. Notably, TFR has fallen so rapidly in Baluchistan between the 2000-01 PRHFPS (5.4) and the 2006-07 PDHS (4.1).

Table 2.12: Total fertility rates by background characteristics from selected surveys, Pakistan, 1990-2007

Characteristics		1990-91 PDHS (1985-90)	2000-01 PRHFPS (1997-00)	2006-07 PDHS (2004-06)
Residence	Urban	4.9	3.7	3.3
	Rural	5.6	5.4	4.5
Province	Punjab	5.4	4.7	3.9
	Sind	5.1	4.7	4.3
	Khyber	5.5	5.1	4.3
	Baluchistan	5.8	5.4	4.1

PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

Finally, the documented literature clearly depicts the 'adoption approach' of research which literally means that: as the International or global demographic or population research has changed or shaped towards different dimensions since 1950s, the same dimensions have been replicated in population research of Pakistan, but the essence of the real fertility situation is not focused. This can be termed as the 'adoption approach of research' in our view. The replicated population research as a global fashion or manner in Pakistan has not only neglected the true essence of fertility situation but there remains a wide gap between the creation of new knowledge along with true understanding and the reliable replication of existing knowledge.

2.6 Chapter review: critical remarks

Pakistan FP programme has a long history. The chapter was started for making fruitful review as well as highlighting the research gaps in the fertility transition of Pakistan. Mechanically, the FP programme of any country includes or deals the two key components: provision of FP services on the supply side and Information, Education and Communication (IEC) on the demand side. This chapter has provided an overview of these two components since 1950s with a particular focus on Pakistan. A controversy existed in the literature whether the supply as compared to demand or demand as compared to supply is more important in modifying the contraceptive behaviour of the couples (Kar and Talbot 1980). At least in our view, the nature of controversies over the issue along with the importance of supply-demand dimensions varies from society to society. Apart from discussing the importance of supply or demand side of FP of other societies as empirical evidence, I have confined the discussion regarding the situation in Pakistan. Further the main focus of this study is confined to demand side understanding of fertility transition in Pakistan. Supply factors precede the demand factors in a typical FP programme. Section 2.2 was started as a framework and pre-requisite of the fertility transition in Pakistan. Pakistan's FP programme has been documented as unsuccessful in previous research. This study has re-investigated the programme's inputs.

From the programme side factors, the choice and availability of birth control methods need careful attention from policy makers. How the FP programme factors have dealt with the deep rooted fear of side effects from the people's mind? The strategies are required to minimize this fear.

Every nation keeps its own absorption level to accept small family norms. The problem is not target setting of fertility but the key challenge was its implementation to achieve the targets. Within the contraceptive users of Pakistan (whether male or female), a wide gap between ever and current use is identified. Before setting the target(s) to increase the contraceptive use in Pakistani society, why did not the reasons of dropouts understand? A clear research and evaluation to understand the reasoning's of dropouts is utmost required. The political disruption under Islamic cover has adversely affected its inputs which were voiced by religious alliance. At one side, the conservative political leadership has stalled the programme; while, on the other a typical Pakistani woman want to keep her fertile as a societal mind set which is also inadvertently influenced by her spouse perceptions. These two main factors have caused the fertility transition to be in slow pace. The momentum created by these factors has pushed the Pakistani nation to wait for a couple of decades to reach on below replacement level. These arguments drive us to conclude that the more weakness is not in the population planning programme of Pakistan but it is in the ways was implemented administratively and forcefully were problematic by ignoring the nation's real demand. In sum, Pakistan's FP programme is not unsuccessful indeed it is at above satisfactory level.

Supply side literature of Pakistan's FP programme has served as a framework for demand side understandings. The supply side literature concludes to focus on demand side in Pakistan. Therefore, a timely study of demand side factors is the need of time having two main aims. Demand side overview at one side, might contribute to save a couple of years or a half decade early to reach a replacement level; while, on the other it might highlight the previously neglected or stalled dimensions of research. The study of demand side factors has identified that Pakistani society should be considered as the heterogeneous one on its social, regional, cultural or even religious backgrounds before devising any population policies. Demand factors have explained that the fastest fertility transition in Pakistan occurred between 1988 and 2000. The fertility differentials in terms of regions of this fastest time are presented in Table 2.12.

2.7 Research gaps and conceptual framework

The documented literature regarding demand side allow us to high light few research gaps or dimensions which would improve our understanding about slow paced fertility transition of Pakistan. Doing so definitely yield important lessons for other countries in African or Asian regions for example and it also lead to further improvement in the Pakistan's national FP and health programme. In the demand side literature, what is missing or neglected? Age is noted as the highly significant variable influencing almost its every dimension. The real significance of accurate age on fertility was initiated previously but the issue is stalled particularly in the last twenty years. The problem of accurate age reporting was identified quite early but its impact on fertility has not been widely or narrowly examined in Pakistan hitherto. This remained an ignored dimension which this study addresses. This is an issue of great relevance. The native or non-native research community has termed this issue as 'age reporting: a familiar problem in Pakistan'. This familiar population research problem is identified yet ignored.

Globally, the proximate determinant model is widely used to examine the typical change in fertility levels (transition from natural to controlled fertility) of a country, society or region. Previously, proximate determinant model has been in vogue only at aggregative level by assuming the homogeneous population in Pakistan. As research gaps three dimensions in applying the proximate determinants model are highlighted here. First, keeping the regional differentials and heterogeneous society in mind, the provincial as well as rural-urban proximate determinant model is focused in this study. Secondly, the age specific proximate determinants model is strongly lacking in previous research which is also identified as a research gap in this Chapter. Accurate age reporting is an issue with age variable. Lastly, age-specific proximate determinants model adjusted for age reporting is further identified as a research gap in this review.

In demographic research, several studies have found evidence of faster subsequent child bearing and an increased chance of unwanted births if the first child is born at an early age. This event is measured by mother's age. The empirical evidence on age at first birth particularly in the fastest fertility transition period is lacking in the demand side literature which is focused in this study at regional as well as provincial levels in Pakistan.

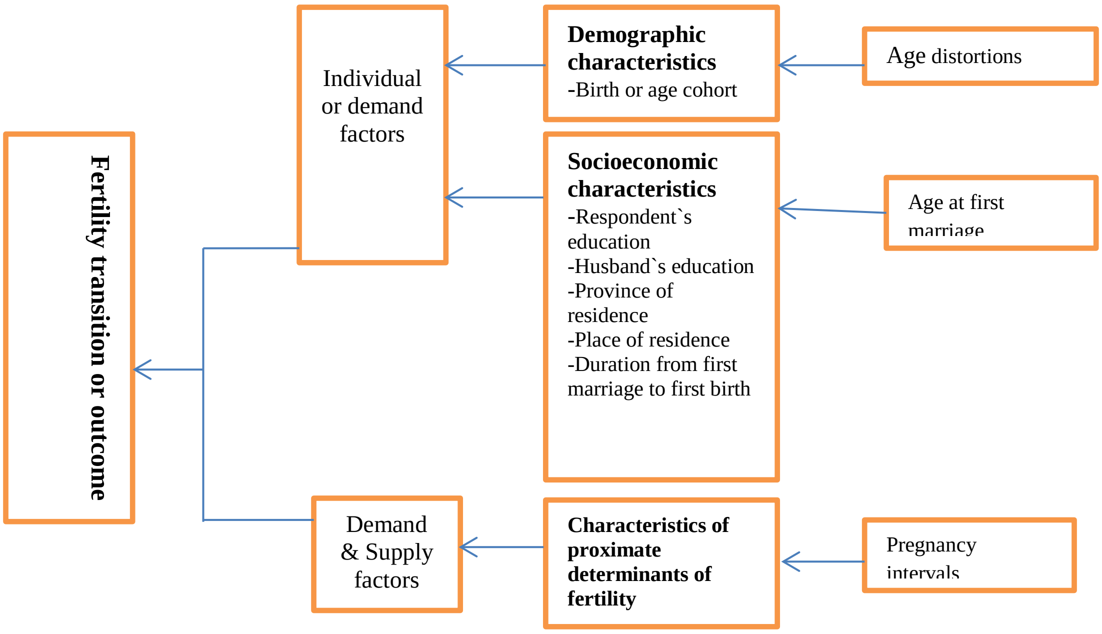
The documented demand side literature highlights an important argument: Pakistani woman want to be fertile when she is sexually active under union norms. Under this scenario, bringing the nation to stop child bearing might not be acceptable to the societal built in norms, while; on the other hand, motivating the Pakistani women to widen the gaps between births would be greatly acceptable to society. Hence the study of birth intervals (pregnancy intervals) of Pakistani women is another dimension of research with great importance. Previously some novel attempts regarding birth interval dynamics have been made in Pakistan. The new attempts with advanced quantitative methodologies and using new data sets in this dimension are strongly lacking. This study provides the new insights of birth interval dynamics at regional and provincial levels of Pakistan.

The one core out of many rationales to focus on these dimensions of research in this study is given below.

Recently the views of fertility stagnation are in view in the literature (Sathar 2007, Khan 2010). The robustness of these views should be answered by answering the following questions. Are the fertility estimates robust enough over the past twenty five years population research of Pakistan? Is there anything ignored in measuring the fertility estimates, which after a sufficient time in accumulation behaviour, now exhibiting a stagnant situation, but actually the fertility transition of the Pakistani nation is not stagnant or it is on its right slow paced way? The empirical answer to these questions perhaps clear the way for future population planning of Pakistan. The discussion presented throughout the chapter strengthen the remarks that supply and demand factors both play equal role for the better understanding of the fertility transition or change in a region. Figure 2.4 presents a simple conceptual framework connecting supply and demand factors under the context of fertility transition in Pakistan. The framework maps the pathways starting from neglected dimensions of fertility transition in Pakistan. This dissertation will focus on four dimensions, mentioned in Chapter 1 (section 1.3) age misreporting (categorized as demographic characteristics), age at first marriage with waiting time to first pregnancy (socio-economic characteristics) and pregnancy intervals from characteristics of proximate determinants of fertility. Supply factors played an important role on the characteristics of proximate determinants of fertility.

In concluding this section, some dimensions of the demand side literature of Pakistan's FP programme has been highlighted here still many dimensions; family structure and fertility transition in Pakistan for example, are left which are beyond the scope of this study.

Figure 2.4: A conceptual framework relating supply and demand factors to study fertility transition in Pakistan, 1990-2006



3 DATA AND METHODS

3.1 Introduction and chapter outline

The aim of this chapter is to state the sources of data and the methods of analysis applied in this study. This study uses the information collected in three cross sectional nationally representative surveys. Section 3.2 states the sources of these three surveys. The details about surveys including coverage are provided in subsections (3.2.1-3.2.3) of section 3.2. Section 3.3 explains the sample design of these surveys including universe and sampling frame, stratification, sampling plan and sample sizes. It is interesting to note that all three surveys share the same sample design. Questionnaires are the standard instruments in the quantitative surveys. Section 3.4 describes the questionnaires used in the surveys. This chapter is confined to describe the methods of analysis for Chapter 4 (sections 3.5 to 3.7). For convenience of understanding, other statistical methods are separately presented in each of the Chapter 5, 6 and 7.

However, this Chapter also outline few proposed methods with an algorithm for accuracy of age reporting. A Further modified Whipple index (section 3.6.4) and method of digit shifts to adjust for digital preference are proposed in section 3.6.9. Section 3.7 describes the proposed procedure for estimating the fertility rates adjusted for age reporting bias.

3.2 Sources of data

Two main sources of data have been used in this study namely: Pakistan Demographic Health Survey (PDHS) and Population Reproductive Health and Family Planning Survey. Both surveys are coordinated by National Institute of Population Studies (NIPS), Islamabad, Pakistan (National Institute of Population Studies [Pakistan] and Macro International Inc 2008, National Institute of Population Studies [Pakistan] and Macro International Inc 1992, Hakeem et al. 2001).

3.2.1 Pakistan Demographic and Health Surveys

Globally, worldwide FP programmes in most countries of the world were launched in 1950s or in early 1960s. Have the FP programmes made an effect to decline the fertility particularly in developing areas? To answer this, a series of internationally compatible and nationally representative surveys (WFS: World Fertility Surveys) were launched in 1970s for evaluating the FP inputs. The WFS were particularly designed for developing countries where vital registration information was scarce. However, early 1980s was the time of origin for Demographic Health Surveys (DHS) as compared to WFS. DHS are known as the ‘Gold standard’ for population research for a variety of good reasons. Historically, two DHS have been conducted in Pakistan since its inception namely Pakistan Demographic and Health Survey (PDHS) first in 1990-91 during the second phase of DHS surveys and second PDHS in 2006-07. The aim of PDHS is to provide reliable information for policy makers in the Ministries of

Population Welfare and Health, planners and researchers to improve programmatic interventions by devising new strategies for population and health policies for the country.

PDHS-2006 has collected information from ever-married women of age 12-49 years who was a usual resident of the household (who stayed there the night before the survey). Woman's questionnaire was used to elicit the information regarding her background characteristics, reproductive history, knowledge and use of FP methods, child immunization including health and immunization, fertility preferences, breastfeeding practices, her work status, and awareness about sexually transmitted diseases including HIV/AIDS.

PDHS-1990 has collected information from ever-married women of age 15-49 years who was a usual resident of the household (who stayed there the night before the survey). Woman's questionnaire was used to elicit the information regarding her background characteristics, reproductive history, knowledge and use of FP methods, pregnancy and breast feeding, vaccinations and health of children, marriage, and family size preferences.

3.2.2 Pakistan Reproductive Health and Family Planning Survey

Pakistan's first national FP programme was launched in 1965. To evaluate the FP inputs, Pakistan had started series of population surveys from time to time. Mostly Ministries of Population Welfare (formerly Population and Development) and Health has remained the administrative controller of these surveys from time to time. National Impact Survey (NIS) in 1968 was the first in this series. However, apart from discussing the long history, the discussion is confined to action plans agreed by Government of Pakistan in 1994 International Conference on Population and Development (ICPD). Pakistan being the signatory of 1994-ICPD proceedings has included the component of reproductive health in its Population Welfare Programme.

At national level, Pakistan Reproductive Health and Family Planning Survey (PRHFPS) in 2000-01 was the pioneer survey which in addition included the reproductive health of women. The aim of PRHFPS is to provide information on reproductive health, fertility and FP for policy makers in the Ministries of Population Welfare and Health, planners and researchers to improve programmatic interventions by devising new strategies for population and health policies.

PRHFPS-2000 has collected information from ever-married women of age 15-49 years who was a usual resident of the household (who stayed there the night before the survey: de jure member).

3.2.3 Coverage

The PDHS and PRHFPS are nationally representative surveys in scope. Both surveys (PDHS, PRHDFP) have covered the four provinces (Punjab, Sind, Khyber and Baluchistan) of the country. The universe consists of all urban and rural areas of the four provinces of Pakistan. Federally Administered Tribal Areas (FATA) and military restricted areas were excluded in both surveys. However, in conducting PDHS-2006, Federally Administered Northern Areas (FANA) was further excluded from the survey due to security and political concerns. The population of excluded area constitutes about (3-4) % of the total population.

3.3 Sample design

3.3.1 Universe and sampling frame

The sample for each survey (PDHS and PRHFPS) was drawn from the National Master Sample Frame prepared and maintained by Federal Bureau of Statistics (FBS) (formerly Central Statistical Office), Islamabad, and Pakistan. In master sampling frame for urban areas prepared by FBS, each city / town has been divided into a number of enumeration blocks. Each enumeration block consists of 200-250 households on average with well-defined boundaries and maps. The lists of enumeration blocks have been updated over time. Before the initiation of PDHS-1990 for example, the updating of frame/lists was done on the basis of information obtained from the 1988 Census of Establishments. Similarly, before the initiation of PRHFPS-2000, the updating of lists was made on the basis of information obtained from the 1998 population and housing census of Pakistan.

The lists of villages/mouzas/dehats (mouza/dehat is a local term referred to area consisting of 75-100 houses roughly) has been taken as the sampling frame for rural areas of Pakistan. Both enumeration blocks in urban domains and villages in rural domains make a master sampling frame and have been considered as the primary sampling units (PSUs).

3.3.2 Stratification

The master sampling frame is consist of two frames (one urban and one rural). All major cities of urban areas have been stratified according to low, middle and high income groups based on information collected at the time of updating of urban sampling frame for each enumeration block. In rural domain, each district in the Punjab, Sindh and Khyber has been considered as independent and explicit stratum, whereas in Baluchistan each administrative division constitutes a stratum.

3.3.3 Sampling

The three household surveys used in this study have adopted a two-stage, stratified, random sample design. Enumeration blocks in urban domain and villages in rural domain have been taken as primary sampling units (PSUs).

The first stage involved selecting the PSUs from each stratum. The PSUs have been selected with probability proportional to size method of sampling. The summary information of successfully covered PSUs for the three surveys is shown in Table 3.1.

Table 3.1: Coverage of sample areas, primary sampling units (PSUs) in three population surveys of Pakistan

Sample area/PSU	PDHS-1990	PRHFPS-2000	PDHS-2006
Total	407	367	1000
Urban	225	180	390
Rural	182	187	610

PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

The second stage of sampling involved selecting households (SSUs: secondary sampling units). Alternatively, households with sampled PSU have been taken as SSU. The selection of SSU was made with equal probability using systematic sampling technique with a random start. Table 3.2 presents the total selected households with response rates of successfully completed interviews of the three surveys. In terms of household selection as SSU (102037 household sampled), PDHS-2006 is the largest-ever household survey conducted in Pakistan. At the time of fieldwork, 97687 households out of 102037 were occupied by residents. Of the occupied households, 95441 (97.7 per cent) were successfully interviewed (Table 3.2). Out of 95441 occupied households, 9255 households were successfully interviewed using long household questionnaire and the remaining (86186 households) were interviewed using short household questionnaire. The study sample (ever married women) was taken from 9255 households. PDHS and PRHFPS did not allow the substitution of households in the case of non-response.

Table 3.2: Summary distribution of households selected in three population surveys of Pakistan

Households/SSUs	PDHS-1990	PRHFPS-2000	PDHS-2006
Total (selected)	8019	7332	97687
Interviews completed	7193	6857	95441
Response rate	89.7	93.5	97.7
Urban (selected)	4050	3240	39060
Interviews completed	3602	3013	37909
Response rate	88.9	93.0	97.1
Rural (selected)	3969	4092	58627
Interviews completed	3591	3844	57532
Response rate	90.5	93.9	98.1

PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey
SSU: Secondary Sampling Unit
Source: (National Institute of Population Studies [Pakistan] and Macro International Inc 1992, Hakeem et al. 2001, National Institute of Population Studies [Pakistan] and Macro International Inc 2008)

3.3.4 Sample size

In the selected household (SSU), the ever-married woman was the target for interview. To meet this target, the eligible women (PDHS-1990: ever-married 15-49; PRHFPS-2000: ever-married 15-49; PDHS-2006: ever-married 12-49) were identified using short questionnaire in PDHS-2006 for example. However, the sample sizes (based on long household questionnaires) for successfully completed interviews in three surveys are shown in Table 3.3.

Table 3.3: Sample sizes of ever-married women in Pakistan Demographic and Health and Population Reproductive Health and Family Planning Surveys of Pakistan

Sample characteristics	PDHS-1990	PRHFPS-2000	PDHS-2006
Total			
Eligible	6904	7411	10601
Successfully interviewed	6611	6579	10023
% successfully interviewed	95.8	88.8	94.5
Urban			
Eligible	3567	3200	4104
Successfully interviewed	3384	2826	3830
% successfully interviewed	94.9	88.3	93.3
Rural			
Eligible	3337	4211	6497
Successfully interviewed	3227	3753	6193
% successfully interviewed	96.7	89.1	95.3

PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

3.4 Questionnaire

Questionnaires were used as the main instrument for data collection in all three surveys from eligible women. In general, PDHS and PRHFPS have used different sets of questionnaire. Three types of questionnaire were used in PDHS-1990: the household questionnaire, the woman's questionnaire and the husband's questionnaire. The household questionnaire listed all usual residents of a sampled household, plus all visitors who slept in the household the night before the interview. Some basic information was collected on the characteristics of each person listed, including their age, sex, marital status, education, relationship to the head of the household. The main purpose of this section of the household questionnaire was to identify women and men who were eligible for the women's and the husband's questionnaire. The woman's questionnaire was used to collect information from eligible women (ever-married: age 15-49) who slept in the household the night before the household interview.

The PRHFPS-2000 has used a questionnaire having two parts: a household schedule and a woman questionnaire. The household schedule collected information on background characteristics of the household and demographic characteristics of all usual household

members. The main purpose of the household schedule was to identify ever-married women, age 15-49, who were eligible for detailed interview using the woman's questionnaire.
The PDHS-2006 has used six types of questionnaires: community questionnaire, short household questionnaire, long household questionnaire, women's, maternal verbal autopsy questionnaire, and child verbal autopsy questionnaire. However, the discussion is confined to women questionnaire. The discussion besides household and women questionnaire is beyond the scope of this study. The short household questionnaire listed the information of all the usual members and visitors of the household. The main purpose of the short household questionnaire was to twofold: first to identify ever-married women, age 12-49, who were eligible for detailed interview using the woman's questionnaire and to record detailed demographic information about usual members of the household. The long household questionnaire not only collected the basic information (age, sex, marital status, education, relationship to the head of household of each person listed) but also collected information regarding births, deaths that occurred since January 2003, death of child under age 5 since January 2005, any death to a woman age 12-48 since January 2003, children school attendance, survivorship status of parents of children under age 18, and registration status of each person.

The contents of household's and women's questionnaire used in PDHS-1990 were based on DHS model B questionnaire, which was designed for use in countries with low contraceptive prevalence. Most of the contents of questionnaire used in PRHFPS-2000 were based on standard PDHS contents. The contents of household's and women's questionnaire used in PDHS-2006 were based on model questionnaires developed by the Measure DHS programme. All questionnaires were translated into national (Urdu) and major regional languages (Punjabi, Sindhi, Pashto, Baluchi, Sariaki).

3.5 Methods

When people do not know their correct ages, they tend to report their ages either in round numbers or instead they ask the enumerators to write down whatever age they think proper, is referred as age heaping or age preference or digit preference (avoidance). To evaluate the erroneous age reporting (first objective of the study), there are several methods available depending on the type of age statistics used. More explicitly, for single year age-sex distributions, conventionally, Whipple and Whipple type, Myers' and Bachi index are available, whereas, age ratio score are generally used on five year age distribution. A number of other general indexes of digit preference have been proposed: Carrier (1959) index, Ramachandran (1967) index for example (Carrier 1959, Ramachandran 1967). These indexes have some theoretical advantages over the Whipple and Myers indexes, but as indicators of the general index of heaping differ little from each other (Siegel and Swanson 2004). Hence, the use of Carrier or Ramachandran index is beyond the scope of this study. The five year group based age structure is further examined using age ratio analysis (United Nations 1955). Age ratio analysis includes the estimation of age ratio scores and age accuracy index.

3.6 Overview of age misreporting indexes

Whipple, Whipple-type, modified Whipple, further modified Whipple, Myer`s, Bachi`s, and age accuracy index with age ratio scores are used to test the accuracy of single as well as five year group age returns. The summary statistics of each of the index with pros and cons is shown in Table 3.4. The Indexes shown in Table 3.4 are applicable on single year (Whipple, Whipple-type, modified Whipple, further modified Whipple, Myer`s, Bachi`s) and five year age categories (age ratio scores and age accuracy index) and all Indexes are applied in this study. Each index has certain merits over the other. For example, a standard Whipple index measures the effect of digital preference on terminal digits 0 and 5 only, Whipple-type on terminal digit 3 only, Modified and Further Modified on all (0 through 9) terminal digits. Though these are different indexes gives similar results in understanding age misreporting. The detailed descriptions of these indexes are available from sections 3.6.1 through 3.6.7.

Table 3.4: Summary information of various age misreporting indexes

Index	***Construct***	***Pros***	***Cons***
Myer`s	Rectangular distribution assumption	Use of entire age distribution	Blended population
Bachi	Similar to Myer`s		
Whipple	Rectangular distribution assumption (RDA), single year age returns (SA)	Preference (avoidance) on terminal digits 0 and 5	Lack of preference (avoidance) on terminal digits 1-4 or 6-9, RDA assumption on 10 year age range—crude assumption,
Whipple-type	RDA, SA	Preference (avoidance) on terminal digit 3, Practical for geographic spatial comparisons	Crude assumption of age range in linearity
Modified Whipple	RDA, SA	Preference (avoidance) on all terminal digit 1-9, RDA assumption on 5-year age range, easy to compute	RDA assumption on 5-year age range
Further modified (proposed)	RDA, SA	Preference (avoidance) on all terminal digit 1-9, RDA assumption on 3-year age range, Practical for geographic spatial comparisons, east to compute	
Age ratio score (ARS)	Single & 5-year age returns	Advantage over Whipple	Net age misreporting
Age accuracy	Depends on ARS	Overall measure of accuracy	

3.6.1 Whipple`s index

The Whipple's index depends on the assumption on the form of the true distribution (rectangular distribution) of the population by age. The rectangular distribution assumption assumes that there are an equal number of persons in each age (age group) in the true population.

For example, in a 10-year range, we may measure heaping on terminal digit "0" in the range 23 to 62 very roughly by comparing the sum of the populations at the ages ending in "0" in this range with one-tenth of the total population in the range (WI_0^{10}):

$$WI_0^{10} = \frac{P_{30} + P_{40} + P_{50} + P_{60}}{\frac{1}{10}(P_{23} + P_{24} + P_{25} \dots P_{60} + P_{61} + P_{62})} \times 100 \qquad (1)$$

Similarly, a Whipple index for preference of terminal digit "5" would be as follows:

$$WI_5^{10} = \frac{P_{25} + P_{35} + P_{45} + P_{55}}{\frac{1}{10}(P_{23} + P_{24} + P_{25} \dots P_{60} + P_{61} + P_{62})} \times 100 \qquad (2)$$

In general, an expression of preference for any terminal digit i (o to 9) in a 10-year range would be as follows:

$$WI_i^{10} = \frac{P_{2i} + P_{3i} + P_{4i} + P_{5i} + P_{6i}}{\frac{1}{10}(P_{23} + P_{24} + P_{25} \dots P_{60} + P_{61} + P_{62})} \times 100 \qquad (3)$$

Whipple's index (WI) for a 5-year age range gives the relative preference of terminal digit '0' and '5' while reporting age in the age interval 23 to 62. The choice of the range 23 to 62 is largely arbitrary. It is defined as follows in equation (4):

$$WI_{0 \text{ or } 5}^{5} = \frac{P_{25} + P_{30} + P_{35} + P_{40} + P_{45} + P_{50} + P_{55} + P_{60}}{\frac{1}{5}(P_{23} + P_{24} + P_{25} \dots P_{60} + P_{61} + P_{62})} \times 100 \qquad (4)$$

In equations (1) to (4), P_x is the number of persons reporting their age in completed years. Whipple's index varies from 100 to 500. A value of 100 represents no preference for terminal digits '0' and '5' and a value of 500 indicate that only digits '0' and '5' are reported. However, the United Nations (UN) recommends a standard for measuring the age heaping using Whipple's Index as follows (Table 3.5) (United Nations 1990):

Table 3.5: United Nation standard description of quality of reporting using Whipple index

Whipple's Index value	Quality of age reporting	Deviation from perfect
<105	Very/highly accurate	< 5%
105-110	Relatively/fairly accurate	(5–9.99) %
110-125	Approximate	(10-24.99) %
125-175	Bad/rough	(25-74.99) %
>175	Very bad/very rough	≥ 75%

3.6.2 Whipple-type index

Poston and his students have developed a Whipple type index to reflect only the degree of heaping on age 3 for the ages between 23 and 53. They referred the index as Whipple-type or Whipple-3 (W-3) (Poston and Micklin 2005, Poston and Yuan 2000, Poston and Yuan 2003). The index according to Poston notation is given below:

$$W-3=\frac{P_{23}+P_{33}+P_{43}+P_{53}}{\frac{1}{10}(P_{23}+P_{24}+P_{25}\ldots P_{60}+P_{61}+P_{62})} \tag{5}$$

The multiplier (100) is omitted from equation (5) to onwards for ease of presentation. The general formula for Whipple-type index would be:

$$W-i=\frac{P_{29}+P_{39}+P_{49}+P_{59}}{\frac{1}{10}\sum_{2i-j}^{5i+10-j-1}P_x} \tag{6}$$

The index is capable to allow for different age ranges and spatial divide. Keeping in view of these capabilities; Talib and his colleagues proposed the following formula to evaluate the age reporting behaviour in Malaysian Censuses (Talib et al. 2007):

$$Wi_t^{j,k}=\frac{P2i_t^{j,k}+P3i_t^{j,k}+P4i_t^{j,k}+P5i_t^{j,k}+P6i_t^{j,k}+P7i_t^{j,k}}{\frac{1}{10}\sum_{n=20}^{79}P_{nt}^{j,k}} \tag{7}$$

Taking age range 20 to 79 years, i's values refer to the terminal digits and varies from 0 to 9; j values refer to urban (value of 1) and rural (value of 2) stratum; k values refer to ethnicity (Malay =1, Chinese=2, Indian=3) and t refer to two time periods of Malaysian Censuses (1991, 2000).

Applying the same mechanism a Whipple-type index for each terminal digit is constructed for the present study by confining the age range 13 to 52 years (this age range best suits the survey sample age range 15-49 years). The proposed index for each terminal digit (0 to 9) is shown below in equations (8) to (9):

$$W0_t^{j,k}=\frac{P20_t^{j,k}+P30_t^{j,k}+P40_t^{j,k}+P50_t^{j,k}}{\frac{1}{10}\sum_{n=13}^{52}P_{nt}^{j,k}} \tag{8}$$

The generic expression for digits i (0 to 9) would be:

$$Wi_t^{j,k} = \frac{P2i_t^{j,k} + P3i_t^{j,k} + P4i_t^{j,k} + P5i_t^{j,k}}{\frac{1}{10}\sum_{n=13}^{52} P_{nt}^{j,k}}$$

(9)

Where j values refer to provincial stratum (Punjab=1, Sind=2, Khyber=3, Baluchistan=4); k values refer to rural-urban stratum (urban =1, rural=2) and t refer to three time periods of cross-sectional surveys conducted in Pakistan (1990, 2000, 2006).

3.6.3 Modified Whipple index

The original Whipple index, Whipple type or extended formula proposed in this study (equation 14 to 17) are all based on assumption of linearity over a ten-year age range. A modification in Whipple index was proposed by Noumbissi (Noumbissi 1992). Noumbissi termed the ten-year assumption as crude assumption. However, Noumbissi's modification was based on more reasonable assumption of linearity by taking an age range of five years. Noumbissi proposed the following two indexes to measure the age heaping (taking age range 23 to 62) at terminal digit '0'and '5':

$$W_0 = \frac{5(P_{30} + P_{40} + P_{50} + P_{60})}{({}_5P_{28} + {}_5P_{38} + {}_5P_{48} + {}_5P_{58})}$$

(10)

$$W_5 = \frac{5(P_{25} + P_{35} + P_{45} + P_{55})}{({}_5P_{23} + {}_5P_{33} + {}_5P_{43} + {}_5P_{53})}$$

(11)

In equations (10) to (11), ${}_5P_x$ is the population of the age range$(x, x + 4)$. The value of $'W_0$ or W_5' in equation (10) and (11) is equal to 1 if no age heaping is observed. Following equation (10) and (11), one could easily devise the modified Whipple index for terminal digits 1-4 and 6-9.

However, recently, Noumbissi's version of Whipple index is noted to be impractical for spatial comparison purposes (Spoorenberg and Dutreuilh 2007). Spoorenberg and Dutreuilh have proposed a total modified Whipple's index (W_{tot}) as an overall summary measure of age reporting which is shown below:

$$W_{tot} = \sum_{i=0}^{9} (|W_i - 1|)$$

(12)

Where W_i is the digit-specific modified Whipple's index for each of the ten digits (0-9) developed by Noumbissi.

If no preference is observed, then

$W_0 = W_1 = \cdots = W_9$ and $W_{tot} = \sum_{i=0}^{9}(|1-1|) = 0$

3.6.4 Further modified Whipple index: proposed index

By following Noumbissi and Spoorenberg, the modification developed in this study is based on a more reasonable assumption of linearity over an age range of three years rather than five or ten. This assumption is more reasonable in a sense that: say for example a typical Pakistani woman of 31 (or 32) year of age is more probable to answer 30 as compared to woman aged 29. However, mechanically, the proposed index is based on the principles of original Whipple's index. The index is specifically developed by keeping the reproductive age range of the study sample (13-52). This index has an advantage in terms of application for any DHS survey sample of women (reproductive ages). The formula to measure the age heaping on terminal digit 0 is shown below:

$$W0 = \frac{3(P_{20} + P_{30} + P_{40} + P_{50})}{\left({}_3P_{20} + {}_3P_{30} + {}_3P_{40} + {}_3P_{50}\right)} \tag{13}$$

Where in equation (13) ${}_3P_x$ is the population of the age range$(x, x+2)$.

The generic expression would be as follows:

$$FMWi = \frac{3(P_{1i} + P_{2i} + P_{3i} + P_{4i} + P_{5i})}{\left({}_3P_{1i} + {}_3P_{2i} + {}_3P_{3i} + {}_3P_{4i} + {}_3P_{5i}\right)}$$

i =0, 1, 2…9 (14)

The index is capable to allow for provincial, urban-rural and time stratums. Hence the more compact generic expressions would be as follows:

$$FMWi_t^{j,k} = \frac{3\left(P1i_t^{j,k} + P2i_t^{j,k} + P3i_t^{j,k} + P4i_t^{j,k} + P5i_t^{j,k}\right)}{\left({}_3P1i_t^{j,k} + {}_3P2i_t^{j,k} + {}_3P3i_t^{j,k} + {}_3P4i_t^{j,k} + {}_3P5i_t^{j,k}\right)} \tag{15}$$

Where j values refer to provincial stratum (Punjab=1, Sind=2, Khyber=3, Baluchistan=4); k values refer to rural-urban stratum (urban =1, rural=2) and t refer to three time periods of cross-sectional surveys conducted in Pakistan (1991, 2000, 2006).

For more practical utilization of this index to allow for spatial comparison purposes, the expression for total further modified Whipple index would be as follows:

$$W_{tot}^{*} = \sum_{i=0}^{9} (FMWi) \tag{16}$$

$$FMW_{tot}^{*} = \sum_{i=0}^{9} (0.1FMWi) \tag{17}$$

The index would take value of '1'; if no digit preference (or avoidance) is observed then $W1 = W2 = \cdots = W9$ and $FMW_{tot}^{*} = \sum_{i=0}^{9}(0.1FMWi) = 1$

In addition to the formula development shown in equation (17), the following expression could be constructed for FMW index by directly following Spoorenberg and Dutreuilh (2007) work:

$$FMW_{tot}^{*} = \sum_{i=0}^{9} |FMWi - 1|$$

3.6.5 Myer`s index

Myers has developed and applied a procedure to study the extent of digital preference to avoid the bias due to the fact that numbers ending is '0' would normally be larger than numbers ending in '1-9' because of the effect of mortality (Myers 1940, Myers 1954). Myer`s approach is to derive a "blended population" to overcome the decreasing nature of the population curve and to calculate heaping at each age using the entire age span. The Myer`s index range is from 0 to 180. The small value of index shows high accuracy of age reporting. A value of '0' represents no heaping whereas a value of 180 indicates that all ages are reported at single digit. However, the brief computational details of Myers index are given below, further details can be seen elsewhere (Pollard et al. 1990, Siegel and Swanson 2004). In addition to these details, an example for calculating Myer`s index is provided in appendix A.

Computational Details

i. The first step in calculating the Myer`s index is to derive the blended population. For this one has to decide the age range over which the extent of digital preference has to be measured, say 10-49.

ii. This chosen range is divided into two partially overlapping sub-range with a lag of 10 years, say 10-39 and 20-49

iii. Allot co-efficient to each digit for both the sub-ranges such that the sum of co-efficient for both sub-ranges corresponding to the same terminal digit must be 10.

iv. Population total for ages ending with corresponding terminal digit, for each digit in both the sub-ranges is calculated.

v. These population totals are then multiplied with the respective co-efficient for both sub-ranges. The multiplication by the co-efficient ensures that each digit is given equal weight.

vi. Blended population is then calculated by adding these products for each terminal digit in both the sub-ranges.

vii. Percentage for each digit from the total of blended population is then calculated.

Finally, the sum of absolute deviation of these percentages from 10% gives us the value of Myer's index.

3.6.6 Bachi`s index

Bachi's index is another method that is used to test the accuracy in reported single year age returns (Bachi 1951). This is similar to Myer`s index (computational details step i-vii). In step viii, the sum of positive deviations only gives the value of Bachi's index.

3.6.7 Age ratio score and age-accuracy index

According to United Nations (United Nations 1955), the age ratio score (ARS) has an "advantage over the methods of Whipple, Myers and [others because] the index which is obtained is affected by differential omission of persons in various age groups from the census count and by tendentious age misstatement as well as by digit-preference and is therefore more truly a reflection of the general accuracy of the age statistics'' (p. 42). However, ARS for a five year age group say P_x^5 is defined as follows:

$$\mathrm{ARS} = \frac{P_x^5}{\frac{1}{3}(P_{x-5}^5 + P_x^5 + P_{x+5}^5)} \times 100 \tag{18}$$

ARS is the ratio of population in the given age group (P_x^5) to one-third of the sum of the populations in the age group itself and the preceding (P_{x-5}^5) and following (P_{x+5}^5) groups times 100. One could easily devise the expression for a single year age which is given below:

$$\mathrm{ARS} = \frac{P_x}{\frac{1}{3}(P_{x-1} + P_x + P_{x+1})} \times 100 \tag{19}$$

The deviation (positive or negative) from 100 on particular age groups would indicate the extent of age heaping. ARSs serve as the measures of net age misreporting and should not be taken as the valid indicators of errors of particular age groups (Hobbs 2004). An age-accuracy index for overall measure of the accuracy of an age distribution can be calculated by taking the average deviation (without regard to sign) from 100 of the age ratio scores over all ages. The lower value of the age-accuracy index indicated the more accurate the age reporting. In addition to this general interpretation of age accuracy index; Smith (Smith 1992) writes about age-accuracy index: "measures accuracy of age reporting only to the extent that the irregularities it identifies are not present in the true age distribution'' (p.34).

3.6.7.1 Proposed age ratio score

The formula for ARS for single year age as shown in equation (19) reserves a notable drawback: it completely misses the wider variety of age miss-statement just by allowing the one year forward $(x + 1)$ in age and one year backward $(x - 1)$ shift in age reporting. The expression (19) is readily available to capture the wider shifting of age miss reporting (either forward or backward). Hence to accommodate the wider shifting of age misstatement, the following expression is proposed:

$$\mathrm{ARS}^{k} = \frac{P_x}{\frac{1}{k}(P_{x-k} + P_x + P_{x+k})} \times 100 \tag{20}$$

Where $k = 1, 2, 3, 4$.

3.6.8 Statistical model of digit preference

Among statistical models, logistic regression model has many versions for applications particularly depending on the type of outcome (dependent) variable used for analysis. For digit preference in age reporting multinomial logistic regression approach is recently suggested (Pullum 2008). A multinomial logistic regression is used to model the pattern of digit preference in this study. Multinomial logistic model is the extension of binary logistic model in which the outcome variable more than two categories. Generally, in mathematical numeral system age is understood as a combination of two numerical digits (units and ones). Taking unit digit (0-9) of age as an outcome variable for each respondent, multinomial logistic regression is used. Let Y_i denote the outcome variable (having ten categories: 0-9) for i^{th} respondent which can take any value between 0 and 9. Consider a collection of P independent variables (predictors) say denoted by vector: $\underline{X} = (x_1, x_2, x_3, \cdots, x_p)$, with a vector of respective coefficients: $\underline{\beta} =$

$(\beta_1, \beta_2, \beta_3, \cdots, \beta_p)$. Let $\pi = (\pi_0, \pi_1, \pi_2, \pi_3, \cdots, \pi_9)$ is the probability of preferring (avoiding) a digit; then the odds for preferring a digit of multinomial logistic regression model would be:

$$\frac{\pi_i}{\pi_0} = \mathrm{Exp}\ (\alpha_i + X\underline{\beta_i}\ ) \tag{21}$$

Where α_i in equation (21) is the intercept term of the model. The log-odds for multinomial logistic regression model would be:

$$\mathrm{Log}\left(\frac{\pi_i}{\pi_0}\right) = \alpha_i + \sum_{k=1}^{p} \beta_{ik} X_k \tag{22}$$

The estimated probabilities $(\hat{\pi}_0, \hat{\pi}_1, \hat{\pi}_2, \hat{\pi}_3\ \ , \cdots, \hat{\pi}_9)$ for digit preference (taking digit zero as reference category) would be as follows:

$$\hat{\pi}_0 = \left[\frac{1}{1+e^{\alpha_1+X\,\underline{\beta_1}}+e^{\alpha_2+X\,\underline{\beta_2}}+e^{\alpha_3+X\,\underline{\beta_3}}+e^{\alpha_4+X\,\underline{\beta_4}}+e^{\alpha_5+X\,\underline{\beta_5}}+e^{\alpha_6+X\,\underline{\beta_6}}+e^{\alpha_7+X\,\underline{\beta_7}}+e^{\alpha_8+X\,\underline{\beta_8}}+e^{\alpha_9+X\,\underline{\beta_9}}}\right]$$

$$\hat{\pi}_i = \left[\frac{e^{\alpha_i+X\,\underline{\beta_i}}}{1+E}\right] \tag{23}$$

Where $i = 1,2,3,4,5,6,7,8,9$, and

$$E = e^{\alpha_1+X\,\underline{\beta_1}} + e^{\alpha_2+X\,\underline{\beta_2}} + e^{\alpha_3+X\,\underline{\beta_3}} + e^{\alpha_4+X\,\underline{\beta_4}} + e^{\alpha_5+X\,\underline{\beta_5}} + e^{\alpha_6+X\,\underline{\beta_6}} + e^{\alpha_7+X\,\underline{\beta_7}} + e^{\alpha_8+X\,\underline{\beta_8}} + e^{\alpha_9+X\,\underline{\beta_9}} \tag{24}$$

It is important to note that, the proportions of digit preference or avoidance (π`s) can be obtained (using conventional approaches) without using the multinomial model (with no covariates); however, the key advantage of multinomial model is that it allows making an assessment about the impact of covariates on digit preference.

3.6.9 Method of digit shifts: proposed method

The method of digit shifts is proposed here which is used to estimate the true age distribution of the respondents. The method is explained in the following four steps.

Step 1: Total imaginary number of women at terminal digit

Let $\widehat{P_i}$ be the estimated probabilities using multinomial logistic regression model with no covariates for unit digit preference or avoidance, $i = 0,1,2,3 \dots 9$. The total number of women $\left(W_i^R\right)$reporting each terminal digit using estimated probabilities would be calculated as:

$$W_i^R = \widehat{P_i} \times N$$

(25)

Where N is fixed, usually $N = 100$, or 1000, or $10{,}000$ and same for each age.

Step 2: Matrix of digits

This step involves the construction of (10×10) matrix of digits D. The column sums of D represents the constant (say 1000) number of women assuming their true terminal digits and the row sums represent the total number of women reporting each digit estimated in step 1 using equation (26). In terms of notation, d_{ij} indicates the assigned number of women reporting digit i but with true digitj; $(i, j = 0,1,2, \dots 9)$. The algorithm for assigning d_{ij} is based on shifting the least distance digit and details are given in appendix of thesis (see Appendix B). However, the matrix of digits is given below:

$$D = \begin{pmatrix} d_{00} \; d_{01} & \cdots & d_{09} \\ \vdots & \ddots & \vdots \\ d_{90} \; d_{91} & \cdots & d_{99} \end{pmatrix}$$

(26)

$$D = [d_{ij}]$$

(27)

Where , i (rows) refer to the terminal digit reported, j refers to the true terminal digit of the age of the women.

$$\sum_{j=0}^{9} d_{ij} = W_i^R \quad \text{for } i = 0,1,2 \dots 9$$

(28)

Step 3: Matrix of digit weight

This step involves the construction of (10×10) matrix of digit weights A.

$$A = [\alpha_{ij}]$$

Where

$$\alpha_{ij} = \frac{d_{ij}}{W_i^R}$$

Such that the rows of this matrix all sum to 1.0;

$$\sum_{j=0}^{9} \alpha_{ij} = 1 \ \forall_j$$

Step 4: Matrix of true age distribution

For true age distribution, we apply the relevant $\alpha_{ij}{}'s$ to the observed reported age distribution to generate a matrix of true age distribution (W_{ij}) with elements

$$W_{xy} = \alpha_{xy} W_x^{obs} \tag{29}$$

Where W_x^{obs} in equation (29) is the observed number of women at each age and W_{xy} is the number of women with reported age x and true age y, α_{xy} is the probability that a woman reporting age x had a true age y. The representation of matrix of true distribution would be as follows:

$$\begin{pmatrix} \alpha_{15,15} W_{15}^{obs} & \cdots & \alpha_{15,49} W_{15}^{obs} \\ \vdots & \ddots & \vdots \\ \alpha_{49,15} W_{49}^{obs} & \cdots & \alpha_{49,49} W_{49}^{obs} \end{pmatrix}$$

Finally, the true age distribution of women adjusting for digit preference or avoidance is obtained by summing each column of $(35 \times 35 + \delta)$ matrix; where 35 rows is the range of reproductive ages (15 to 49) and δ is arbitrary shifting year(s). Mathematically speaking, the following expression could be used for true age distribution:

$$W_y^T = \sum_{k=15}^{49} \alpha_{xy} W_x^{obs}$$

(30)

In addition to expression (30), the following check could be observed:

$$\sum_{x=15-l}^{49+u} W_y^T = \sum_{x=15}^{49} W_x^{obs}$$

(31)

3.7 Fertility rates adjusted for age misreporting

Fertility is a major counteracting force to population attrition from mortality. It is an expansionary force in population dynamics and may be defined as the actual reproductive performance of a woman or a group of women. The reproduction process in human being typically occurs during teens of life with the variation in the age at Menarche (Riley et al. 1993). The fertility behaviour process is changing over time (Vanderpost 1992). In short, fertility is the actual reproductive performance of a woman which is generally measured by live births. However, keeping the scientific standards of fertility reporting and comparison purposes, the fertility is reported in terms of fertility rates. Many direct and indirect techniques are available for estimating fertility rates (United Nations 1983a). The most common and directly estimable type of rates is the age specific fertility rates using the birth history analysis. However, the following approach is adopted in this thesis to estimate age specific fertility rates (unadjusted and adjusted for age misreporting).

Let f_x is the observed age specific fertility rate (ASFR) of Pakistani women at their reported ages and is defined as follows:

$$f_x = \frac{\text{Reported births at age x in year t}}{\text{Women at age x in year t}}$$

(32)

The age specific fertility rates adjusted for digit preference or avoidance (f_y^T) would be as follows (equation 33):

$$f_y^T = \frac{\sum_x f_x W_{xy}}{\sum_x W_{xy}}$$

The derivation of equation (33) is shown in Appendix C. The age specific fertility rate of equation (33) is the weighted average of the observed fertility rates with the W_{xy}'s as weights.

4 AGE MISREPORTING AND FERTILITY

4.1 Introduction and chapter outline

The aim of this chapter is to examine the accuracy of age reporting and its influence on fertility levels. The place of residence (urban, rural) and province (Punjab, Sindh, NWFP and Baluchistan) is a separate geographic entity. A separate analysis for each of the above mentioned geographic entities is presented throughout the chapter. The pattern of age misstatement can be presented in a graph or table through indices. Section 4.2 provides graphically and numerically the trends and differentials of age misstatement using single year age statistics of ever married women. Section 4.2 advances with the pattern of specific digit preference through ranking. For the 5-year age categories data, age ratio analysis is demonstrated in section 4.3 which ends up by looking at the age accuracy index for seven entities on three dates. Section 4.4 presents theoretical perspectives of age misreporting influencing fertility. Single year age specific fertility rates (as well as five year age group fertility rates) for both reported and adjusted for age reporting were estimated using methodology developed in Chapter 3 (section 4.5). Finally, the chapter ends with the summary highlights.

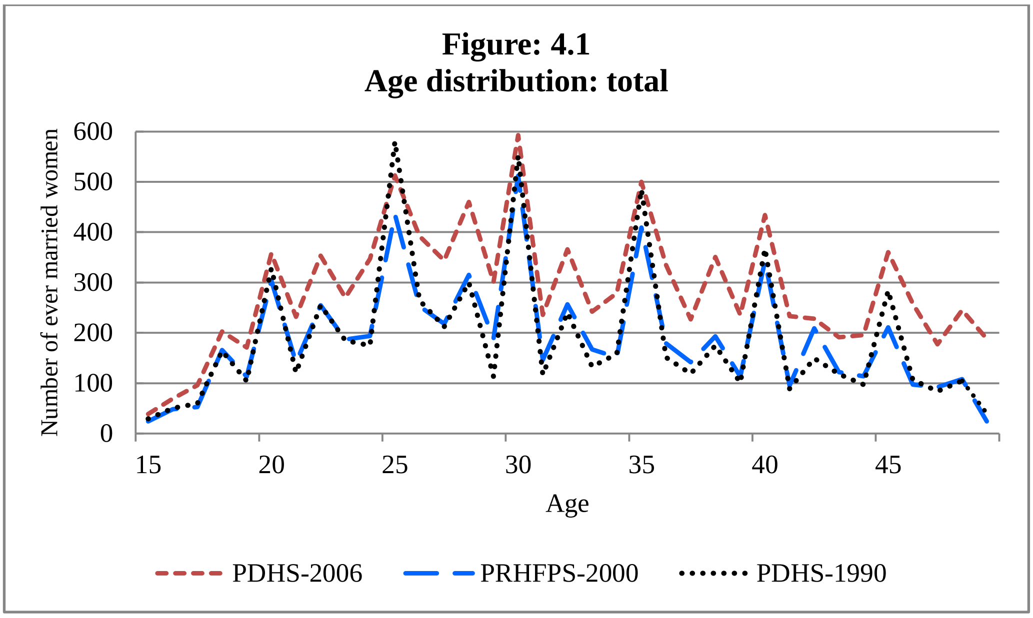
4.2 Single year of age data

Single year of age returns (completed in years) from three surveys were used. For analytical purposes, a glance at the single year of age data might reveals the peculiar irregularities.

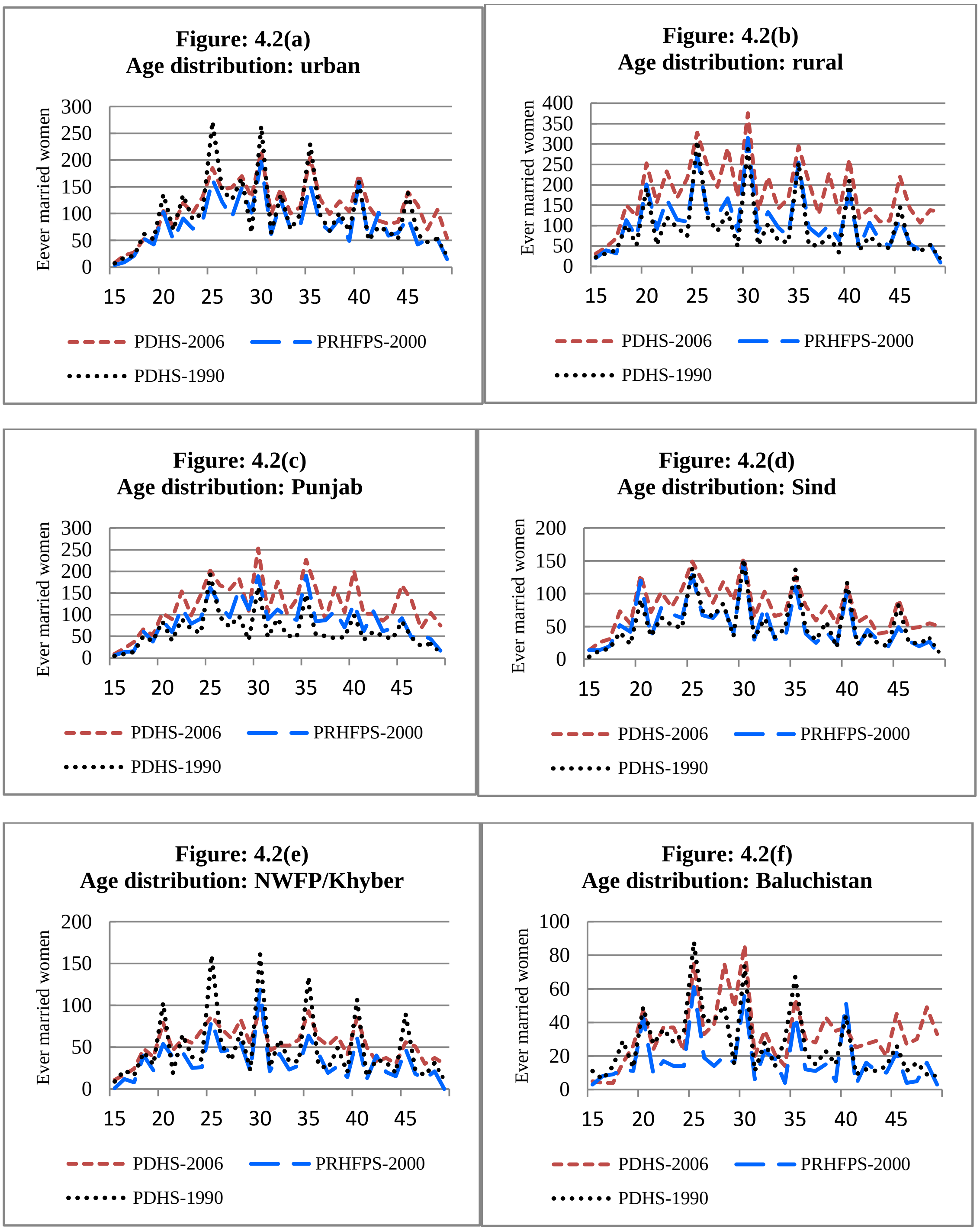
4.2.1 Age distribution: graphical look

In general, heaping (the tendency of reporting certain ages at expense of the others: digit preference or avoidance) is the key error in single year of age data. Figure 4.1 and 4.2 are the graphical displays of single years of age for the females of reproductive age for seven geographic entities namely: total survey sample, urban, rural, Punjab, Sindh, NWFP, and Baluchistan. Each of these figures provides the displays for three time periods of surveys: 1990-91, 2000-01, and 2006-07. When most of the people (women) do not know their correct ages, they might tend to report their ages in round numbers ending in certain digits or instead ask the enumerator to write down whatever age the latter thinks proper. This assertion is true in Pakistani society. As a result of this reporting, the single year age distributions if sketched graphically might show distinct peaks and roughs at ages ending with certain digits. At first glance, the key conclusive remark regarding the age distribution for all seven entities is that it is irregular. The clear fluctuations (peaks and roughs) observed in Figure 4.1 - 4.2 show the substantial faulty age reporting among women. It is also observed that age misstatement among women living in rural areas of Pakistan is somewhat more pronounced than their urban counterparts (Figure 4.2 (a) and (b)). Through the intra-regional comparisons by considering the peaks only, the highest heaping is noticed on ages ending in terminal digit '0': 20, 30, and 40 (Figure 4.2). The second highest heaping (digit preference) is noticed on ages ending in digit '5': 25, 35 and 45. The third highest peaks (digit preference) are noticed on ages ending in '8': 18, 28, 38 and 48. The fourth highest heaping is noticed on ages ending in '2': 22, 32, and 42. By considering the roughs only, most avoided ages are those ending in '9': 19, 29, 39 and 49 followed by those ending in '1': 21, 31, and 41 (Figure 4.2). As a whole, the general pattern of digit preference within entities is similar over the three time periods.

Figure 4.1: Single year age distribution for total ever married women in three surveys, Pakistan, 1990, 2000 and 2006



PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey



PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

Figure 4.2: Single year age distribution for ever married women in different geographic areas of Pakistan, 1990, 2000 and 2006

4.2.2 Age heaping indices

Age heaping and digit preference or avoidance might be measured more precisely with indices. The use of indices might also help to study the extent of digit preference (avoidance). The indices estimated in this chapter are based on the assumption that true ages are rectangularly distributed over an n-year age range that is centred on the specific age being examined. For measuring age heaping using Whipple`s method, United Nations (UN) recommendations have been followed: the index value of 100 shows no sign of age heaping at all (for details see Chapter 3; Table 3.5). Whipple`s index only measures preference for ages ending in digits 0 and 5; while, the modified Whipple`s index and further total modified Whipple`s formula takes account of preference and avoidance of all ten digits using all the information obtained via the specific indices for each digit (0 to 9).

Myer`s method avoids the bias of Whipple`s approach (it is likely that numbers ending in '0'are larger than the following numbers '1 to 9' because of the effect of mortality) (Siegel and Swanson 2004). The theoretical range of Myer`s index (0-180) has been used for measuring age heaping using Myer`s blended method: the value of 0 represents no age heaping. In addition to Myer`s method, the Bachi index is also used. It has a theoretical range from 0 to 90: the value of 0 represents no age heaping. In short, Myer`s and Bachi`s methods are based on the principle that in the absence of age heaping, the aggregate population of each age ending in one of the digits 0 to 9 should represent 10% of the total population.

The key conclusion regarding age heaping indices is: although the age heaping assessments are made using different methods, the five indices reveal identical patterns in the quality of age reporting. Table 4.1 presents the calculated values of the five indices based on three surveys for each geographic entity. Table 4.2 presents the improvements in the quality of age reporting (variation in percentages) among women compared to the previous survey. The negative sign attached to the values shown in the table indicates improvement, while, a positive sign (Sind and Baluchistan) would indicate deterioration in the accuracy of age reporting.

4.2.2.1 Total sample

Whipple`s index is designed to reflect the preference for the terminal digits of 0 and 5. Table 4.1 shows the calculated values of Whipple`s index at three different dates. Whipple`s figure of 199 for 1990 means that age heaping at terminal digits of 0 and 5 is substantial. The population tabulated at these terminal digits might be said to overstate the corresponding unbiased population by 99%.

According to UN standards, Whipple`s index at total level for 1990 falls under the 'very rough' category. The quality of age reporting according to Whipple`s method steadily improves (14.57%) in 2000 from 1990 (Table 4.2). The corresponding figures for modified Whipple`s (429) and further modified Whipple`s (345) shown in Table 4.1 confirms the quality of age reporting as very rough for the year 1990. Both the modified and further modified Whipple`s indices show nearly the same level of improvement (21%, 20% respectively) in age reporting in 2000 when compared to 1990 (Table 4.2). Collectively, the three different applications of Whipple`s approach reveal the same patterns of age reporting for the total ever married women selected in the three surveys.

The summary values of Myer`s index for three survey dates are presented in Table 4.1. It appears from the table that the quality of age-reporting for total women interviewed in the 2006-07 PDHS (Myer`s index: 23) was substantially better as compared to the other two surveys. The magnitude of improvement in correct age reporting from 2000 to 2006 (37.84%) was higher when compared to 1990 to 2000 (21.28%) value (Table 4.2). Overall, the values of summary indices indicate substantial evidence of age misreporting but an improvement over time.

Table 4.1: Comparison of age misreporting indices, Pakistan, 1990, 2000 and 2006

Time	Whipple`s index	Modified Whipple`s index	Further modified Whipple`s index	Myer`s index	Bachi`s index
Total					
1990	199	429	345	47	23.7
2000	170	338	277	37	18.7
2006	140	207	172	23	11.5
Place of residence					
Urban					
1990	178	362	284	39	19.3
2000	155	289	237	31	15.5
2006	135	173	145	19	9.5
Rural					
1990	220	504	409	57	28.6
2000	182	375	309	43	21.3
2006	143	228	192	26	13.0
Region/province					
Punjab					
1990	176	348	283	40	20.2
2000	142	247	203	25	12.6
2006	136	212	181	24	12.0
Sindh					
1990	201	442	352	46	23.2
2000	189	395	341	48	24.0
2006	143	216	177	26	13.0
NWFP/Khyber					
1990	229	554	458	62	31.0
2000	184	391	321	44	22.0
2006	137	181	137	21	10.3
Baluchistan					
1990	191	393	303	43	21.3
2000	231	540	460	63	31.5
2006	148	302	178	33	16.3

Table 4.2: Comparison of variation (%) of age misreporting indices with respect to previous years, Pakistan

Time	Whipple`s index	Modified Whipple`s index	Further modified Whipple`s index	Myer`s index	Bachi`s index
Total					
1990	-	-	-	-	-
2000	-14.57	-21.21	-19.71	-21.28	-21.10
2006	-17.65	-38.76	-37.91	-37.84	-38.50
Place of residence					
Urban					
1990	-	-	-	-	-
2000	-12.92	-20.17	-16.55	-20.51	-19.69
2006	-12.90	-40.14	-38.82	-38.71	-38.71
Rural					
1990	-	-	-	-	-
2000	-17.27	-25.60	-24.45	-24.56	-25.52
2006	-21.43	-39.20	-37.86	-39.53	-38.97
Region/province					
Punjab					
1990	-	-	-	-	-
2000	-19.32	-29.02	-28.27	-37.50	-37.62
2006	-4.23	-14.17	-10.84	-4.00	-4.76
Sindh					
1990	-	-	-	-	-
2000	-5.97	-10.63	-3.13	4.35	3.45
2006	-24.34	-45.32	-48.09	-45.83	-45.83
NWFP/Khyber					
1990	-	-	-	-	-
2000	-19.65	-29.42	-29.91	-29.03	-29.03
2006	-25.54	-53.71	-57.32	-52.27	-53.18
Baluchistan					
1990	-	-	-	-	-
2000	20.94	37.40	51.82	46.51	47.89
2006	-35.93	-44.07	-61.30	-47.62	-32.38

4.2.2.2 Urban and rural women

In case of PDHS-1990, the urban population tabulated at terminal digits 0 and 5 might be said to overstate the corresponding unbiased population by 78% using Whipple`s formula. Whipple`s index falls under the 'very rough' category following UN standards. The quality of age reporting according to Whipple`s method steadily improves (12.92%) in 2000 from 1990 (Table 4.2). The levels of improvement in age reporting according to both the modified and further modified Whipple index are 20.17%, and 16.55% respectively in 2000 when compared to age reporting in 1990 (Table 4.2). The Myer`s index displays a similar pattern: the quality of age-reporting in the 2006-07 PDHS (Myer`s index: 19) was substantially better than in the other two surveys. Overall, the values of summary indices indicate substantial evidence of age misreporting though better when compared to national and their rural counterparts.

According to UN standards, Whipple`s index for 1990 fall under the 'very rough' category. The level of improvement in age reporting according to the modified and further modified Whipple`s indices are 25.60%, and 24.45% respectively in 2000 when compared to age reporting in 1990 (Table 4.2). Overall, age reporting is poorer in rural areas than in urban areas.

4.2.2.3 Age heaping among provinces

Whipple`s index for 1990 for women living in Punjab fall under the 'very rough' category when following the UN standards. The modified (348) and further modified Whipple`s index (283) shown in Table 4.1 also confirms the quality of age reporting as 'very rough' for year 1990. The figure of Myer`s index for 2006 (24) is very close to the national figure (23). Whipple`s index for 1990 for women living in Sindh fall under the 'very rough' category when following the UN standards. According to Whipple`s index, the quality of age reporting only marginally improved by six per cent between 1990 and 2000 (Table 4.2). Table 4.1 presents the summary values of Myer`s index for three survey dates. It appears from the table that the quality of age-reporting for Sindi women interviewed in the 2006-07 PDHS (Myer`s index: 26) was better when compared to the other two dates. The most notable result is the deterioration (4 %) in the quality of age reporting from 1990 (46) to 2000 (48). The same deterioration is confirmed using Bachi`s method.

The Whipple`s index value of 229 for 1990 indicates that the population tabulated at terminal digits of 0 and 5 might be said to overstate the corresponding unbiased population by 129% (very rough age reporting: UN standards). Two points are interesting to note: at provincial level in 1990, the quality of age reporting was worst in NWFP when compared to other provinces; while the other point is: NWFP has shown a second highest level of improvement in age reporting (25.54%) in 2006 when compared to other provinces. Regarding Myer`s approach, the most notable result is the biggest change (52.27 %) in the quality of age reporting from year 2000 (44) to 2006 (21). The same pattern is confirmed using Bachi`s method (53.18%).

Whipple`s index for 1990 falls under the 'very rough' category when following the UN standards. The case of Baluchistan is much interesting: this is the only province where the quality of age reporting was seen to be much worse in 2000 than in 1990. According to Whipple`s index for example, the quality of age reporting deteriorated by 21% between 1990 and 2000 (Table 4.2). Another notable feature of age reporting in Baluchistan is: when comparing other provinces for year 2006, the quality of age reporting is the worst of any region in Pakistan.

4.2.3 Pattern of digit preference through ranking

The use of summary indices is a traditional approach adopted by researchers to identify the accuracy for single year age returns obtained through census enumeration or survey responses. The indices help to identify whether there is preference or avoidance of certain digits (between 0 and 9 inclusive) over the others. The simplest method to determine the preference or avoidance is to take the sums of the number of persons at reported ages (say 10: sum of 10, 20, 30, 40, 50, 60, 70, 80) which end in each of the terminal digits 0 to 9; the deviation from 10% (of the total) of any sum would indicate the digit preference (Mba 2003). This methodology would not be appropriate since, with advancing terminal digits of age, the sum would tend to increase. The Myer`s approach circumvents this problem by blending the population in such a way that totals for each of the ten digits are expected to be nearly 10 per cent of the overall total. Therefore, together the Myer`s blended method and digit specified Whipple`s, modified Whipple`s, and further modified Whipple`s indices determine the over selection or avoidance of a particular digit showing up in the deviation from the 10 per cent. The magnitudes of this deviation for each digit determine the pattern of preference or avoidance. Turner suggested the standards for determining the pattern of digit preference or avoidance in a population where age heaping does occur (Turner 1958). Turner`s suggested patterns of digit preference or avoidance were verified by Stockwell in different applications (Stockwell 1966, Stockwell and Wicks 1974).

Turner devised the following rank order (most heaping occur at ages ending in multiples of 10) to determine the pattern of terminal digit preference or avoidance:

Digit	Preference/avoidance status
5	most preferred
2, 8	
4, 6	
3, 7	
1, 9	most avoided

The patterns of digit preference and avoidance were judged by following the Turner`s guidelines in the present study for each entity of interest. The general pattern of digit preference and avoidance depicted in Tables 4.3 and 4.4 confirms reasonably well with the pattern suggested by Turner. The ranking was obtained from the estimated digit specific indices of age heaping for each geographic entity and are produced in Appendix D (Tables D1 through D7).

4.2.3.1 Total sample

According to the data presented in Table 4.3, 8 of the 12 figures (4 indices at three survey times) examined the greatest (rank first) heaping occurred at digit 0, and in 4 of these figures at digit 5. The opposite of this is true for second greatest heaping which occurred at digit

5. The third and fourth greatest heaping occurred on two digits 8 and 2 (each occurred six times) besides the order of importance (if digit 2 was ranked third then digit 8 would usually be ranked fourth and vice versa). As expected, the four digits 0, 5, 8 and 2 are the most preferred digits among the total ever married women in three surveys.

The remaining digits fall in the category of avoided digits, of these, 6 is the least avoided digit. The second least avoided digits are 3, and 7 (or 7, and 3). Following in a similar manner, however, the most avoided digit is observed to be 9. In sum, the pattern of digit preference and avoidance for the total ever married women in this study is found to be quite consistent with Turner`s suggested patterns of digit preference or avoidance documented in section 4.2.3. The only exception seen in this study is digit 4 (when comparing with Turner`s suggested pattern) which is found as the third most avoided digit.

Table 4.3: Terminal digit preference (avoidance) of total ever married women in three surveys, Pakistan, 1990, 2000 and 2006

		Total									
Index and time		**Rank of digits**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
		Digits									
Whipple`s	2006	0	5	8	6	2	9	7	4	3	1
	2000	0	5	8	2	6	7	3	4	9	1
	1990	5	0	8	2	6	7	3	4	9	1
Modified Whipple`s	2006	0	5	8	2	6	9	4	1	3	7
	2000	5	0	8	2	6	3	7	4	9	1
	1990	5	0	8	2	6	3	7	4	1	9
Further modified Whipple`s	2006	0	5	2	8	6	9	1	7	4	3
	2000	0	5	2	8	6	7	1	3	4	9
	1990	5	0	2	6	8	7	1	3	4	9
Myer`s	2006	0	5	2	8	6	4	1	3	7	9
	2000	0	5	2	8	6	3	4	7	1	9
	1990	0	5	2	8	6	3	4	7	1	9

4.2.3.2 Urban-rural and provinces

In case of urban women, an equal and greatest heaping is noticed on digits 0 and 5 (6 of the 12 figures shows either digit 0 or 5) (Table 4.4). The third and fourth greatest heaping occurred on two digits 2 and 8. Four digits 0, 5, 2 and 8 are the most to the least preferred digits. The pattern of digit preference and avoided is found to be quite consistent with Turner`s suggested patterns. The only exception seen in this study is digit 7 (when comparing with Turner`s suggested pattern) which is found as the fifth most avoided digit.

As expected four digits 0, 5, 8 and 2 are the most preferred digits among the rural ever married women in three surveys (Table 4.4). It is interesting to note that the pattern of digit avoidance based on Turner`s criteria among rural women is more variable, however the most avoided digit is identified to be 1.

As expected four digits 0, 5, 2 and 8 are the most preferred digits among the ever married women from Punjab in three surveys (Table 4.4). It is interesting to note that the pattern of digit avoidance based on Turner`s criteria women is more variable, however the digits other then 0, 5, 2 and 8 are categorised as the avoided digits.

The digits 0, 5, 2 and 8 are the most preferred digits among the ever married women from Sindh in three surveys. The remaining digits fall in the category of avoided digits. Digit 6 is the least avoided digit. The second least avoided digit is 7. Following in a similar manner, however, the most avoided digit is observed to be 9.

Table 4.4 presents the ranked distribution of terminal digits using four indices of age heaping on three dates. Overall, the four digits 0, 5, 8 and 6 are the most preferred digits among the ever married women from NWFP in three surveys. The remaining digits fall in the category of avoided digits. A clear pattern of digit avoidance is lacking, however the most avoided digit is observed to be 9.

In eight out of the twelve figures examined the greatest (rank first) heaping occurred at digit 5, and in two of these figures at digit 0 (Table 4.4). As expected the third and fourth greatest heaping occurred on digits 2 and 8 respectively. Notably, the fifth greatest heaping (preference) occurred on digit 6 (unusual when compared to Turner criteria). Overall, four digits 0, 5, 8 and 2 are the most preferred digits among the ever married women from Baluchistan in three surveys. The remaining digits fall in the category of avoided digits. A clear pattern of digit avoidance is lacking.

Table 4.4: Terminal digit preference (avoidance) of ever married women in three surveys in different geographic areas of Pakistan, 1990, 2000 and 2006

Index and time		Digits									
		Rank of digits									
		1	2	3	4	5	6	7	8	9	10
		Urban									
Whipple`s	2006	5	0	8	6	2	7	9	4	1	3
	2000	0	5	8	2	6	7	4	9	3	1
	1990	5	0	8	2	6	7	4	3	9	1
Modified Whipple`s	2006	5	0	8	2	6	9	4	1	7	3
	2000	0	5	2	8	6	4	7	3	9	1
	1990	5	0	8	2	6	7	4	3	9	1
Further modified Whipple`s	2006	0	5	2	8	6	1	7	9	4	3
	2000	0	5	2	8	6	7	4	9	3	1
	1990	5	0	2	8	6	7	1	4	9	3
Myer`s	2006	0	5	2	6	8	4	1	7	3	9
	2000	0	5	2	8	6	4	3	7	1	9
	1990	5	0	2	8	6	4	7	3	1	9
		Rural									
Whipple`s	2006	0	5	8	6	2	9	7	4	3	1
	2000	0	5	8	2	6	3	7	4	9	1
	1990	5	0	8	2	6	7	3	4	9	1
Modified Whipple`s	2006	5	0	8	2	6	9	4	3	1	7
	2000	5	0	8	2	6	3	7	4	9	1
	1990	5	0	8	2	6	3	7	4	9	1
Further modified Whipple`s	2006	0	5	2	8	6	9	1	7	4	3
	2000	0	5	2	8	6	7	1	3	9	4
	1990	5	0	2	6	8	7	1	3	4	9
Myer`s	2006	0	5	2	8	6	4	1	3	7	9
	2000	0	5	2	8	3	6	1	7	4	9
	1990	0	5	2	8	3	6	4	7	1	9
		Punjab									
Whipple`s	2006	5	0	8	6	2	4	7	9	1	3
	2000	5	0	8	2	6	7	4	9	3	1
	1990	5	0	2	8	6	3	7	4	9	1
Modified Whipple`s	2006	5	0	8	2	6	4	9	1	7	3
	2000	5	0	8	2	6	4	9	3	7	1
	1990	5	0	2	8	6	3	7	9	1	4
Further modified Whipple`s	2006	0	5	2	8	6	1	7	9	4	3
	2000	5	0	2	8	6	7	9	1	4	3
	1990	5	0	2	6	8	7	1	3	9	4
Myer`s	2006	0	5	2	6	8	4	1	7	3	9
	2000	5	0	2	8	6	4	3	1	7	9
	1990	5	0	2	6	3	8	7	4	1	9

Table 4.4: continued

Index and time		Digits									
		Rank of digits									
		1	2	3	4	5	6	7	8	9	10
		Sindh									
Whipple`s	2006	0	5	8	6	2	9	7	4	1	3
	2000	0	5	2	8	6	3	7	4	9	1
	1990	5	0	8	2	6	7	4	3	1	9
Modified Whipple`s	2006	0	5	8	2	6	9	4	7	1	3
	2000	0	5	2	8	6	3	7	4	9	1
	1990	5	0	8	2	6	7	3	4	1	9
Further modified Whipple`s	2006	0	5	2	8	6	9	1	7	4	3
	2000	0	5	2	6	8	7	3	4	1	9
	1990	0	5	2	8	6	7	1	3	4	9
Myer`s	2006	0	5	2	6	8	4	1	3	7	9
	2000	0	5	2	8	3	6	4	7	1	9
	1990	0	5	2	8	6	4	3	7	1	9
		NWFP									
Whipple`s	2006	0	5	8	6	7	9	4	2	3	1
	2000	0	5	8	2	6	7	1	4	3	9
	1990	5	0	8	2	6	3	7	4	9	1
Modified Whipple`s	2006	0	5	8	6	4	3	1	2	9	7
	2000	0	5	8	2	6	7	3	1	4	9
	1990	5	0	8	2	6	3	4	9	7	1
Further modified Whipple`s	2006	0	5	8	6	1	2	7	9	4	3
	2000	0	5	2	6	8	7	1	3	4	9
	1990	5	0	2	6	8	7	1	3	9	4
Myer`s	2006	0	5	8	6	4	2	1	3	7	9
	2000	0	5	2	6	8	7	1	3	4	9
	1990	0	5	2	8	3	6	4	7	1	9
		Baluchistan									
Whipple`s	2006	5	0	8	6	2	4	7	9	1	3
	2000	5	0	8	2	6	7	4	9	3	1
	1990	5	0	2	8	6	3	7	4	9	1
Modified Whipple`s	2006	5	0	8	2	6	4	9	1	7	3
	2000	5	0	8	2	6	4	9	3	7	1
	1990	5	0	2	8	6	3	7	9	1	4
Further modified Whipple`s	2006	0	5	2	8	6	1	7	9	4	3
	2000	5	0	2	8	6	7	9	1	4	3
	1990	5	0	2	6	8	7	1	3	9	4
Myer`s	2006	0	5	2	6	8	4	1	7	3	9
	2000	5	0	2	8	6	4	3	1	7	9
	1990	5	0	2	6	3	8	7	4	1	9

4.3 Age misreporting using five year age data

4.3.1 Age ratio score

The analysis presented in section 4.2 using the indices to determine the preference or avoidance of specific terminal digits provides the overall extent of digit preference or avoidance. Our point in this line of argument is that use of indices for digit preference (avoidance) might not take account or inform us that 'heaping' at particular digit may be due to strong preference for a single age or age group. Therefore, age ratio analysis could be used to circumvent this problem. In general, the quality of census or survey returns (reported) for age groups may be examined by calculating age ratios for 5-year age groups with expected or standard values or configuration (United Nations 1955). Age ratios could be defined in several ways; however, the definition documented in section 3.5.6 (equation no. 18) of Chapter 3 is used for the present analysis. Hobbs in Siegel and Swanson (Siegel and Swanson 2004) noted that 'barring extreme fluctuations in past births, deaths, or migration, the three age groups should form a nearly linear series. Age ratios should then approximate 100, even though actual historical variations in these factors would produce deviations from 100 in the age ratio for most ages' (p. 147). According to the definition of age ratio provided in Chapter 3 and the quote presented above, might define the three age groups as: the age group of interest, one preceding and the one following age group to the group of interest. The age ratios estimated in this study would be compared with standard value of 100 (when there is no pronounced preference or avoidance). The general pattern of age heaping for 5-year age groups has been depicted in Figure 4.3 and Figure 4.4.

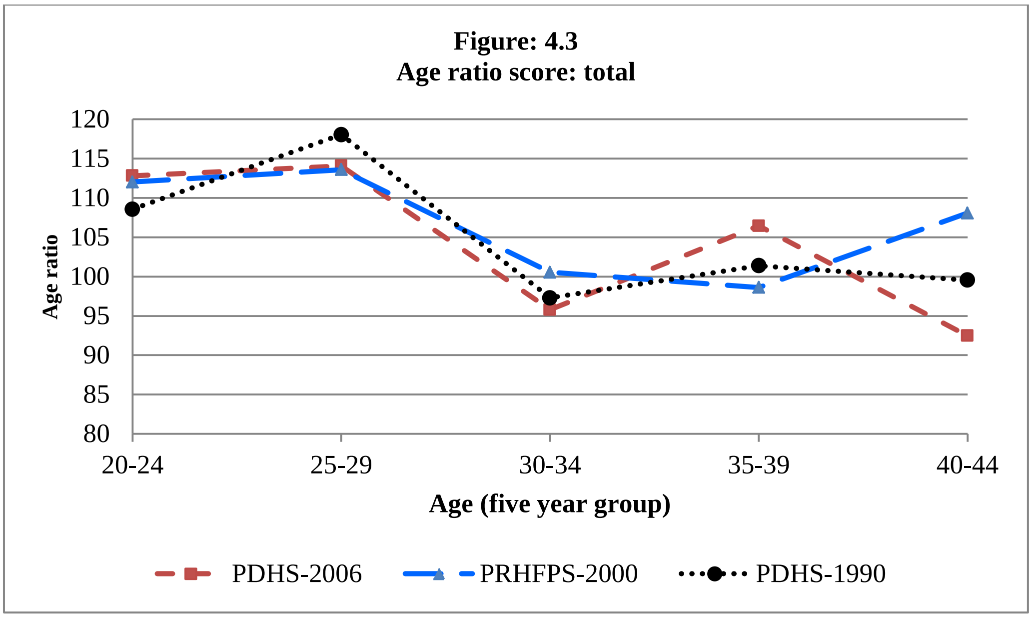
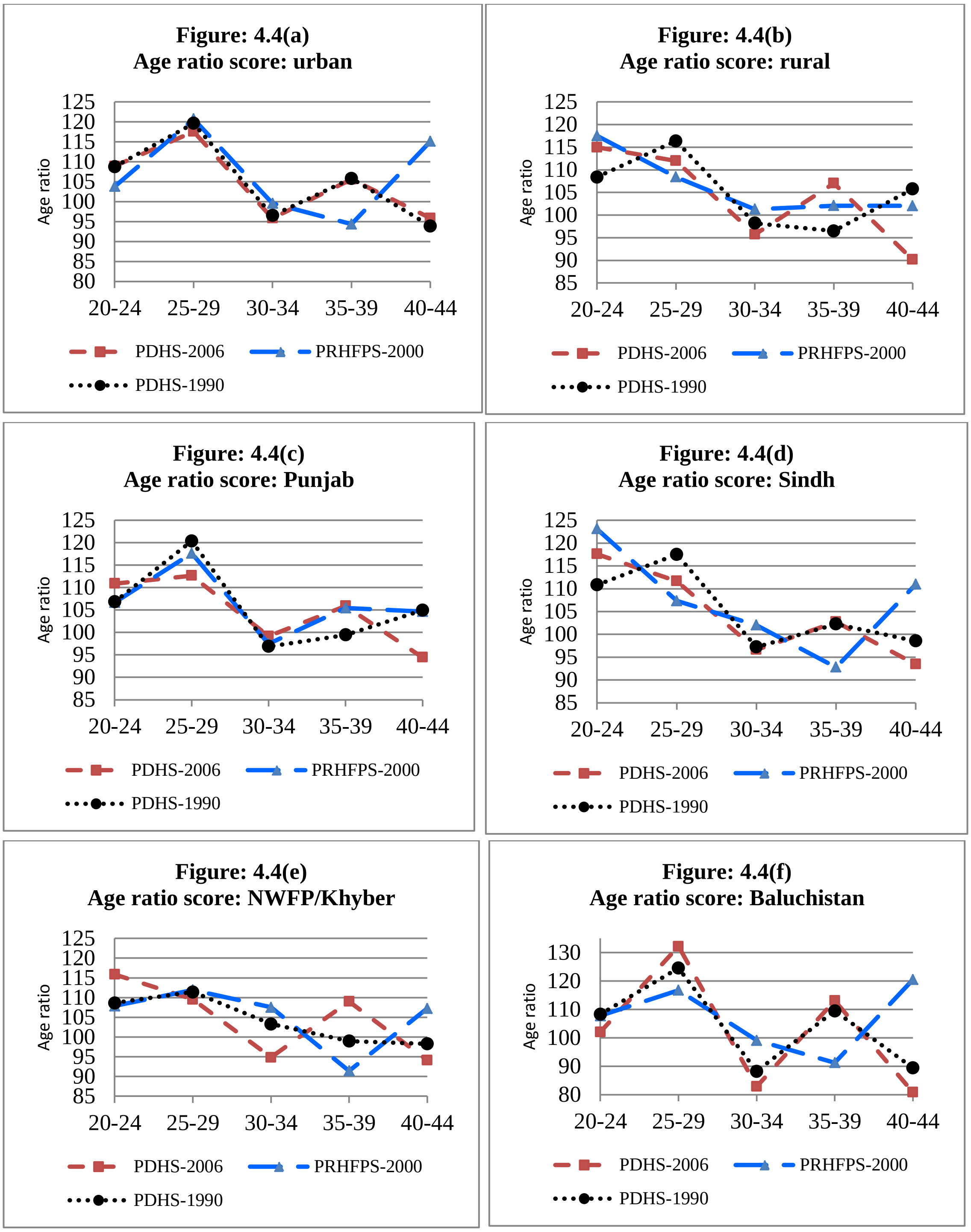


Figure 4.3: Age ratios by 5-year age groups for total ever married women showing preference for specific ages, Pakistan, 1990, 2000 and 2006



PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

Figure 4.4: Age ratios by 5-year age groups for ever married women showing preference for specific ages in different geographic areas of Pakistan, 1990, 2000 and 2006

Figure 4.3 displays the calculated age ratio scores for all ever married women on the three survey dates. The age ratios in the age group 20-24 years for three surveys are 108.57, 112.02 and 112.83 (PDHS-1990, PRHFPS-2000 and PDHS-2006 respectively). However, the meanings of largest positive and negative age ratios have been given below for illustration. The highest age ratio shown is 118.06 (PDHS-1990) in age group 25-29 years (Figure 4.3). This means that there are 18.06 per cent more women in the age group 25-29 than the average of the numbers of women in the two age groups that are adjacent to age group 25-29. The largest negative (deviation from 100) age ratio is 92.47 in age group 40-44 in 2006. This means that there are 7.53 per cent fewer women in the age group 40-44 than the average of the numbers of women in the two age groups that are adjacent to age group 40-44. Figure 4.4 display the calculated age ratio scores of ever married women in different geographic areas of Pakistan in three surveys.

4.3.2 Age accuracy index

Age Ratio Scores (ARSs) serve as the measures of net age misreporting and should not be taken as the valid indicators of errors of particular age groups (Hobbs 2004). An age-accuracy index for the overall measure of the accuracy of an age distribution can be calculated by taking the average deviation (without regard to sign) from 100 of the age ratio scores over all ages. The lower value of the age-accuracy index, the more accurate the age reporting. The values of the age accuracy index for the seven entities on three survey dates are presented in first half of Table 4.5. The second half of shows the improvements on the age accuracy index (variation in percentages) among women compared to the previous survey date (Table 4.5). Negative values shown in the table indicate accuracy, while, the positive values indicate deterioration.

The age accuracy index has an average of 7.78 in 1990 to 9.72 in 2006. The index ranges from a low value of 5.22 for NWFP in 1990 to a high of 16.71 for Baluchistan in 2006. Baluchistan ranks first with high index values on three dates. Notably, this indicates that the inaccuracy of age distribution of Baluchistan increased by 52.60 per cent in 2006 compared to 2000.

According to index variation with respect to previous year, urban region (-11.60%) and Punjab are declared to be fair enough in their accurate age distribution. Overall, in three time periods, in most of the geographic entities, age accuracy index differ in their values.

Table 4.5: Comparison of age accuracy index with respect to previous surveys, Pakistan, 1990, 2000 and 2006

Time	1990-91PDHS	2000-01 PRHFPS	2006-07 PDHS
Total	6.23	7.13	9.02
Place of residence			
Urban	8.77	9.14	8.08
Rural	7.16	6.27	9.61
Region/province			
Punjab	7.17	7.39	7.17
Sindh	6.97	10.13	8.38
NWFP/Khyber	5.22	8.64	9.05
Baluchistan	12.95	10.95	16.71
Mean	7.78	8.52	9.72
Standard deviation			
	2.52	1.69	3.18
Variation (%) with respect to previous survey			
Total	-	14.45	26.51
Place of residence			
Urban	-	4.22	-11.60
Rural	-	-12.43	53.27
Region/province			
Punjab	-	3.07	-2.98
Sindh	-	45.34	-17.28
NWFP/Khyber	-	65.52	4.75
Baluchistan	-	-15.44	52.60

PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

4.4 Theoretical development of age misreporting affecting fertility

A key question for our analysis is whether there is any effect of substantial age misreporting on the fertility levels. No standard theory of fertility decline accounted the effect of age misreporting on fertility measurements exists for instance socioeconomic, demand, or adjustment theories of fertility decline mainly focus on changes in social and economic indicators (Bryant 2007). Some empirical findings do exist where age misreporting found to have a substantial impact on the fertility estimates. The main idea for theoretical development originates from the understanding of stalls in fertility estimates of many developing countries where age reporting effect is ignored (Bongaarts 2006). For example in sub-Saharan African region, various studies have reported the fertility stalls (Bongaarts 2008, Sneeringer 2009). These fertility stalls are recently questioned for to be real. The fertility stalls are re-examined to presume that they might be overstated due to limitation, quality and nature of DHS data sets. This time re-examination of fertility was made with an account on the effect of age and date misreporting using nine sub-Saharan African countries as case studies (Machiyama 2010). For example, the fertility stalls found to be spurious in Benin, Cameroon and Ghana. The obvious explanation provided for spurious fertility stalls were due to digital preference, age displacement, and underestimation of births. Theoretically it could be inferred that errors of age reporting do have an effect on estimated fertility rates based on empirical findings but the next important question needs an explanation: what would be the magnitude and direction of error? In early 1970s, Rindfuss presented a mixed view where he hypothesised that if ages of children are misreported then estimated fertility rates for some years will be artificially inflated and all the estimates for other years will be depressed, and if the ages of women are misstated then age-specific fertility estimates for every year will be over or underestimated (Rindfuss 1974). Rindfuss' s mixed hypothesis does not quantify years forward in time will inflate the fertility rates or fertility rates will be depressed for years back in time. In addition Rindfuss has not supported his hypothesis empirically.

For our point of view based on empirical assessment on countries from sub-Saharan Africa, it could be hypothesising that fertility rates will be underestimated in case of substantial age misreporting—stall could be perceived from depressed fertility rates. These depressed fertility rates might generate the theory of completed fertility transition. We assume this theory for the re-examination of fertility transition in Pakistan.

The misreporting of age could lead to misreporting of fertility. Particularly, the possible effect of female age misreporting produces a distorted age distributions of women and their reported births. The distortions occur because of the transfer of women and births from one particular age category to the next (either forward or backward). For example, the missing women of age 22 will be found in age 20 and so on. The extreme biological age limits of fertility which are ignored are an addendum to age distortions. The fertility of the missing women and those who are on extreme biological age limits could be different from those who are found on certain age categories. The notion is to adjust the missing ones in the relevant age categories.

4.5 Adjusted fertility rates

Table 4.6 shows the estimated probabilities $(\hat{\pi}_0, \hat{\pi}_1, \hat{\pi}_2, \hat{\pi}_3 \ \ , \cdots, \hat{\pi}_9)$ of digit preference or avoidance using no covariate multinomial logistic regression model. The proportions greater than 0.1 exhibits the digit preference, while, the probabilities less than 0.1 shows the digit avoidance. Digits 0 and 5 are the most preferred terminal digits across all entities.

The same digit preference could easily be observed in first instance by looking at the blank boxes in Table 4.7. However, digit 6 (PDHS-2006) and digit 2 (PRHFPS-2000) are found to be next most preferred terminal digits (Table 4.6 and Table 4.7).

Using the estimated probabilities of digit preference (avoidance), total numbers of women at terminal ages have been assigned in matrix of digits. The algorithm based on least distance digit shifts technique was used to assign the number of women to adjust their inaccurate age reporting. The mechanical principle behind the algorithm was to adjust for the number of women at avoided terminal digits. Therefore the algorithm starts to assign women from the least avoided digit (of those with $\hat{\pi}_i$ less than 0.1 it is the largest). As an explanation, digit 2 (estimated probability: 0.0945) of urban sample in 2006-07 PDHS is the least avoided digit (Table 4.6). The shortfall of 55 respondents could be adjusted from the first least distance (either from backward digit 1 or from forward digit 3). Digit 1 and 3 with their estimated probabilities of 0.0831 and 0.0761 respectively are avoided themselves and hence the both digits are not capable to support in adjusting digit 2. Proceeding in a similar manner, the second backward digit (0) is available at the least distance to adjust the avoidance of digit 2. This adjustment is shown through a digit shift [2, -] which is depicted in Table 4.7. In short, the complete set(s) of least distance digit shift(s) for every entity are shown in Table 4.7.

However, contrary to the least distance shift algorithm starts with the least avoided digit, one assign women starts from the most avoided digit. For example, digit 3 (estimated probability: 0.0761) of urban sample in 2006-07 PDHS is the most avoided digit (Table 4.6). The short fall of 239 (1000-761) respondents would be adjusted from the least distance shift (either from backward digit 2 or from forward digit 4). There are good reasons for adopting the algorithm starts from the least avoided digit in this study: for example adjusting the women from the least avoided digit is not as crude assumption as starting to adjust from most avoided digit. A typical Pakistani woman is more inclined to report her true terminal digit therefore she least avoided, whereas another woman who mostly avoided her terminal digit of age is less inclined to report her true age. The magnitude of error for those who most avoided their terminal digits of age could be high compared to those least avoided. The other reason for preferring the least avoided algorithm is: the distance (either forward or backward) between the digits would be minimum (Digit 0 has the minimum distance to digit 2 compared to digit 3).

Table 4.6: Estimated probabilities of terminal digit preference, 1990 and 2006, Pakistan

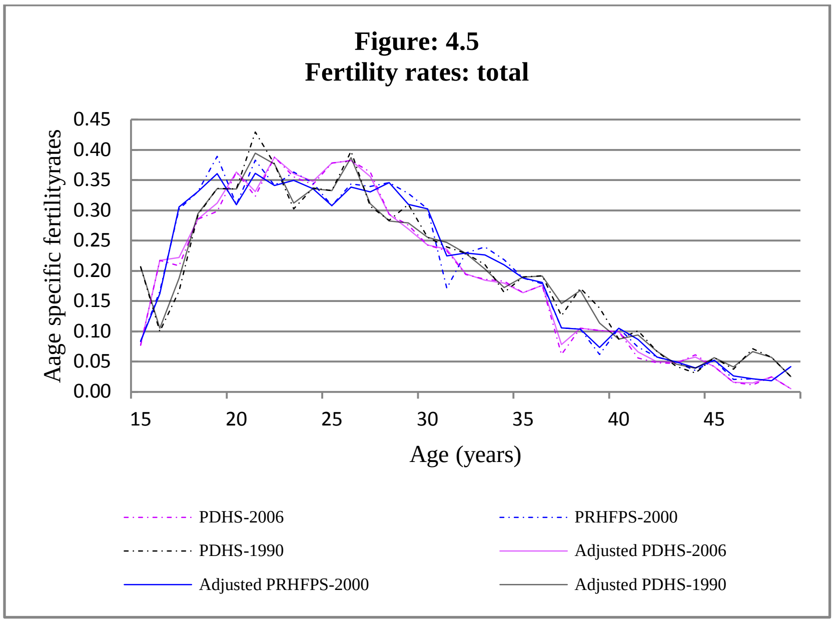
Entity	Digits									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	2006-07 Pakistan Demographic and Health Survey									
Total	0.1519	0.0755	0.0975	0.0729	0.0831	0.1438	0.1038	0.0780	0.1133	0.0802
Urban	0.1423	0.0831	0.0945	0.0761	0.0858	0.1427	0.1066	0.0829	0.1093	0.0768
Rural	0.1581	0.0707	0.0994	0.0708	0.0814	0.1445	0.1020	0.0749	0.1159	0.0823
Punjab	0.1456	0.0746	0.1024	0.0699	0.0919	0.1454	0.1135	0.0732	0.1102	0.0732
Sindh	0.1597	0.0766	0.1064	0.0704	0.0810	0.1443	0.0951	0.0788	0.1061	0.0816
NWFP	0.1564	0.0846	0.0803	0.0815	0.0864	0.1354	0.1078	0.0830	0.1084	0.0762
Baluchistan	0.1506	0.0627	0.0865	0.0762	0.0506	0.1497	0.0807	0.0862	0.1479	0.1088
	2000-01 Pakistan Reproductive Health and Family Planning Survey									
Total	0.1969	0.0616	0.1186	0.0763	0.0726	0.1661	0.0828	0.0719	0.1012	0.0519
Urban	0.1824	0.0617	0.1221	0.0756	0.0838	0.1480	0.0850	0.0782	0.1058	0.0575
Rural	0.2085	0.0616	0.1158	0.0769	0.0639	0.1804	0.0811	0.0669	0.0976	0.0474
Punjab	0.1487	0.0758	0.1194	0.0825	0.0862	0.1517	0.0837	0.0818	0.1052	0.0649
Sindh	0.2346	0.0491	0.1229	0.0740	0.0638	0.1709	0.0804	0.0642	0.0960	0.0442
NWFP	0.2254	0.0595	0.1189	0.0633	0.0623	0.1746	0.0963	0.0658	0.1002	0.0337
Baluchistan	0.2805	0.0291	0.1014	0.0765	0.0486	0.2095	0.0595	0.0546	0.0978	0.0425
	1990-91 Pakistan Demographic and Health Survey									
Total	0.2109	0.0529	0.1019	0.0692	0.0676	0.2109	0.0814	0.0657	0.0953	0.0442
Urban	0.1833	0.0576	0.1061	0.0705	0.0768	0.1938	0.0912	0.0719	0.0986	0.0503
Rural	0.2403	0.0480	0.0973	0.0679	0.0578	0.2291	0.0709	0.0590	0.0919	0.0378
Punjab	0.1748	0.0648	0.1152	0.0816	0.0721	0.1937	0.0912	0.0699	0.0849	0.0517
Sindh	0.2258	0.0525	0.0973	0.0615	0.0645	0.2087	0.0814	0.0670	0.1038	0.0373
NWFP	0.2463	0.0388	0.0985	0.0668	0.0540	0.2405	0.0681	0.0485	0.0994	0.0390
Baluchistan	0.2043	0.0507	0.0840	0.0585	0.0881	0.2026	0.0815	0.0844	0.0964	0.0494

Table 4.7: Set of least distance shifts used to adjust for digit avoidance

Entity	Digits									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	Digit shift(s)									
	2006-07 Pakistan Demographic and Health Survey									
Total	-	[1, -]	[2, -]	[-, 2] +[3,-]	[-, 1]	-	-	[1, 1] + [2, -]	-	[-, 1]
Urban	-	[1, -]	[2, -]	[-, 2] + [3, -]	[-, 1]	-	-	[1, 1] + [2, -]	-	[-, 1] + [4, -]
Rural	-	[1, -]	[2, -]	[-, 2] + [3, -]	[-, 1]	-	-	[1, -] + [2, -]	-	[1, 1]
Punjab	-	[1, -]	-	[1, -] + [-, 2]	[-, 1]	-	-	[1, 1] + [2, -]	-	[-, 1] + [4, -]
Sindh	-	[1, -]	-	[1, -] + [-, 2] + [3, -]	[-, 1]	-	[1, -]	[-, 1] + [2, -]	-	[-, 1]
NWFP	-	[1, -]	[2, -]	[-, 2]	[-, 1]	-	-	[1, 1] + [2, -]	-	[-, 1] + [4, -]
Baluchistan	-	[1, -] + [-, 4]	[2, -]	[-, 2]	[-, 1] + [-, 4] + [-, 5]	-	[1, -]	[-, 1]	-	-
	2000-01 Pakistan Reproductive Health and Family Planning Survey									
Total	-	[1, -]	-	[-, 2]	[-, 1] + [2, -]	-	[1, -]	[-, 1] + [-, 3]	-	[-, 1] + [-, 3]
Urban	-	[1, -]	-	[1, -] + [-, 2] + [3, -]	[-, 1]	-	[1, -]	[-, 1] + [2, -]	-	[-, 1]
Rural	-	[1, -]	-	[1, -] + [-, 2]	[-, 1] + [4, -]	-	[1, -]	[2, -]	[-, 2]	[-, 1]
Punjab	-	[1, -]	-	[1, -]	[-, 1]	-	[1, -]	[-, 1] + [2, -]	-	[-, 1] + [-, 3] + [4, -]
Sindh	-	[1, -]	-	[1, -] + [-, 2]	[-, 1] + [4, -]	-	[1, -]	[2, -]	[-, 2]	[-, 1]
NWFP	-	[1, -]	-	[1, -] + [-, 2]	[-, 1] + [4, -]	-	[1, -]	[-, 1] + [2, -]	-	[-, 1]
Baluchistan	-	[1, -]	-	[1, -] + [-, 2]	[-, 1] + [4, -]	-	[1, -]	[2, -]	[-, 2]	[-, 1]
	1990-91 Pakistan Demographic and Health Survey									
Total	-	[1, 1]	-	[-, 2]	[-, 1]	-	[1, -]	[2, -] + [-, 3]	[-, 2]	[-, 1]
Urban	-	[1, 1]	-	[-, 2]	[-, 1]	-	[1, -]	[2, -]	[-, 2]	[-, 1] + [4, -]
Rural	-	[1, -]	[2, -]	[-, 2]	[-, 1] + [4, -]	-	[1, -]	[2, -]	[-, 2]	[-, 1]
Punjab	-	[1, -]	-	[1, -] + [-, 2]	[-, 1]	-	[1, -]	[2, -]	[-, 2]	[1, -] + [4, -]
Sindh	-	[1, -]	[2, -]	[-, 2] + [3, -]	[-, 1]	-	[1, -]	[-, 1] + [2, -]	-	[-, 1]
NWFP	-	[1, -]	[2, -]	[-, 2]	[-, 1]	-	[1, -]	[2, -] + [-, 3]	[-, 2]	[-, 1]
Baluchistan	-	[1, -]	[2, -]	[-, 2]	[-, 1]	-	[1, -]	[2, -]	[-, 2]	[-, 1] + [4, -]

By following algorithm starts from least avoided digit, the matrix of digit shifts has been used to construct the digit weights for each entity. Finally, for estimating the age specific fertility rates, the true age distributions (age distribution adjusted for digit preference or avoidance) of ever married women with a number of true births (age and birth distribution adjusted for terminal digit preference or avoidance) in past one year have been constructed. Both the age distribution of ever married women and total number of births in last one year prior to survey were estimated using digit weights. The number of births in past one year prior to survey date of interview was collected from the birth history information of ever married women selected in the survey. The fertility rates were estimated in two ways: one, using the number of ever married women at their reported ages with reported number of births (conventional approach for estimating fertility rates assuming no age misreporting); while, in second way, using the adjusted number of ever married women at their true ages with the number of births at adjusted ages of women. Both the set of unadjusted and fertility rates adjusted for age misreporting haven been presented in Figure 4.5 to Figure 4.6 for seven geographic entities.

Figure 4.5: Unadjusted and adjusted for age misreporting the age specific fertility schedules for total ever married women in Pakistan, 1990, 2000 and 2006



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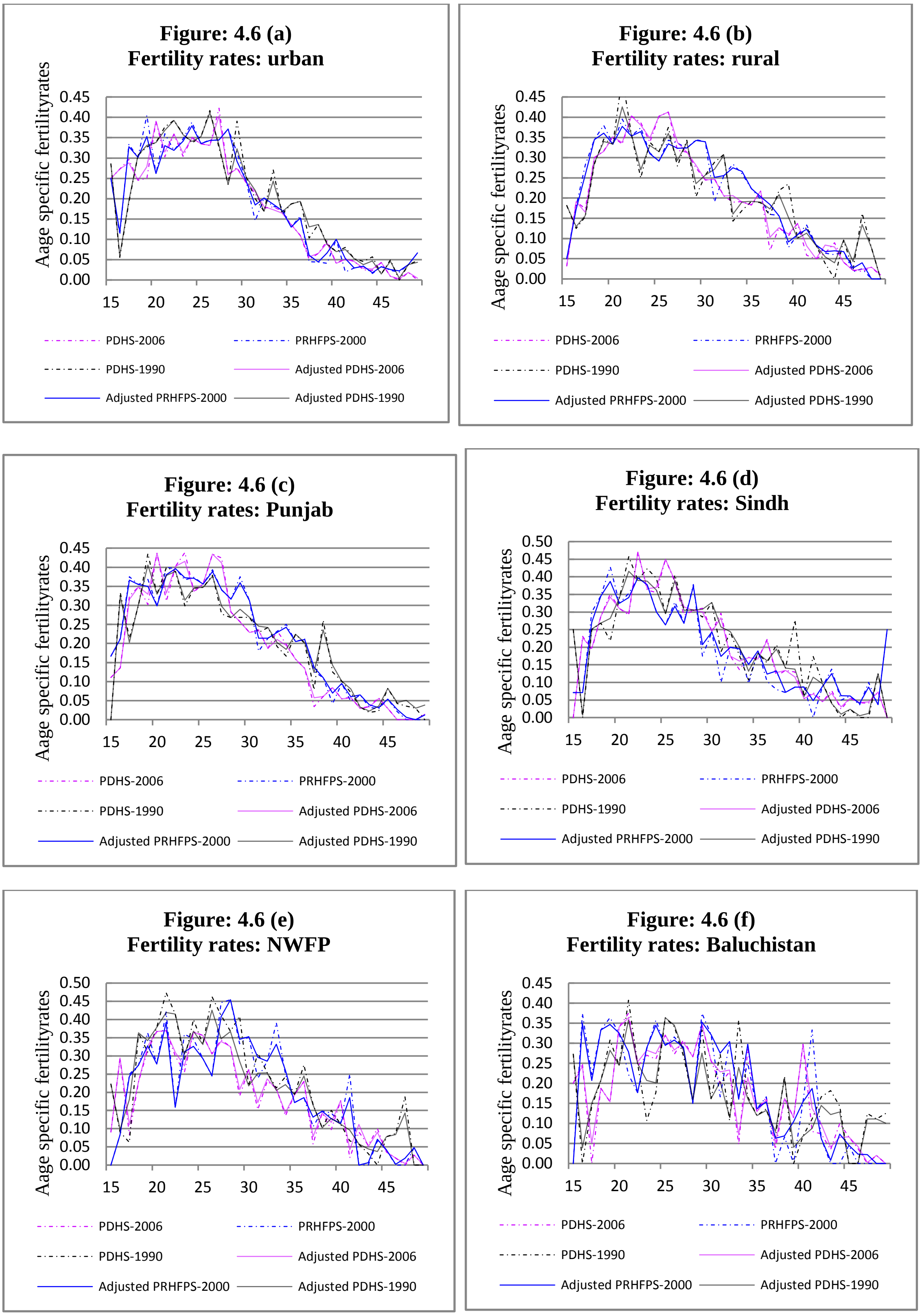
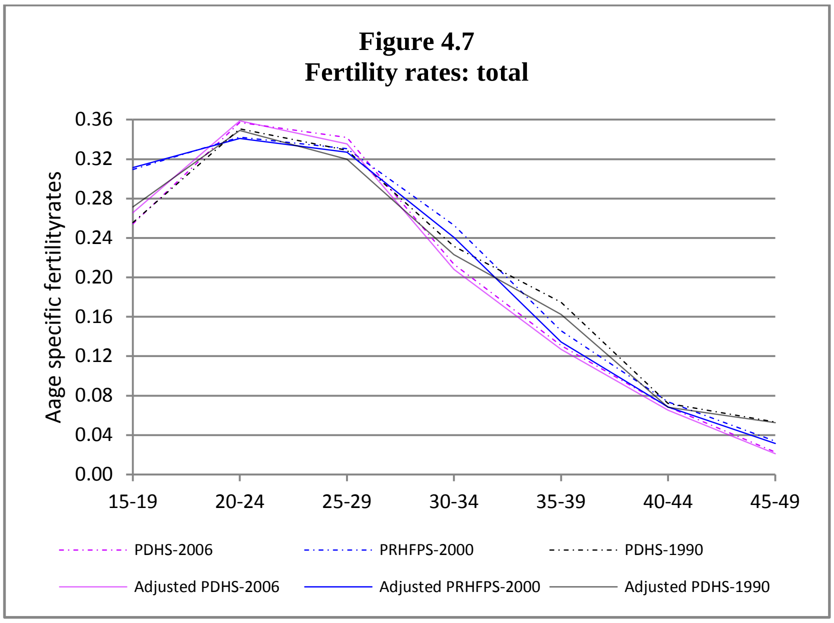


Figure 4.6: Unadjusted and adjusted for age misreporting the age specific fertility schedules of ever married women in different geographic entities of Pakistan, 1990, 2000 and 2006

In addition to single year age specific fertility rates, the fertility rates for five year age groups have also been estimated and are shown in Figure 4.7 through Figure 4.8. As expected, the fertility schedules exhibits the traditional patterns that is the reciprocal of V-shape. Previously, the same pattern of fertility schedules have been reported and modelled (Nasir et al. 2009a) using the different data (other than PDHS) for period 1980s-2000s at national levels. The pattern of fertility schedules is consistent with the findings available in previous research. The estimated unadjusted and age specific marital fertility rates adjusted for age misreporting for total women have been shown in Table 4.8. The highest age specific fertility rates were found in the (20-24) year age group and the lowest fertility rates in the last age group (45-49). It could be said that in the reproductive span of Pakistani women the age group 20-24 (or 20-29) is the most fertile period (Table 4.8), while the age group 45-49 is the least fertile period for each geographic entities (Figure 4.7, Figure 4.8). Table 4.8 shows the percentage changes in the adjusted and unadjusted age specific fertility rates for total women from one survey time to other.



PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

Figure 4.7: Unadjusted and adjusted for age misreporting the grouped age specific fertility schedules for total ever married women in Pakistan, 1990, 2000 and 2006

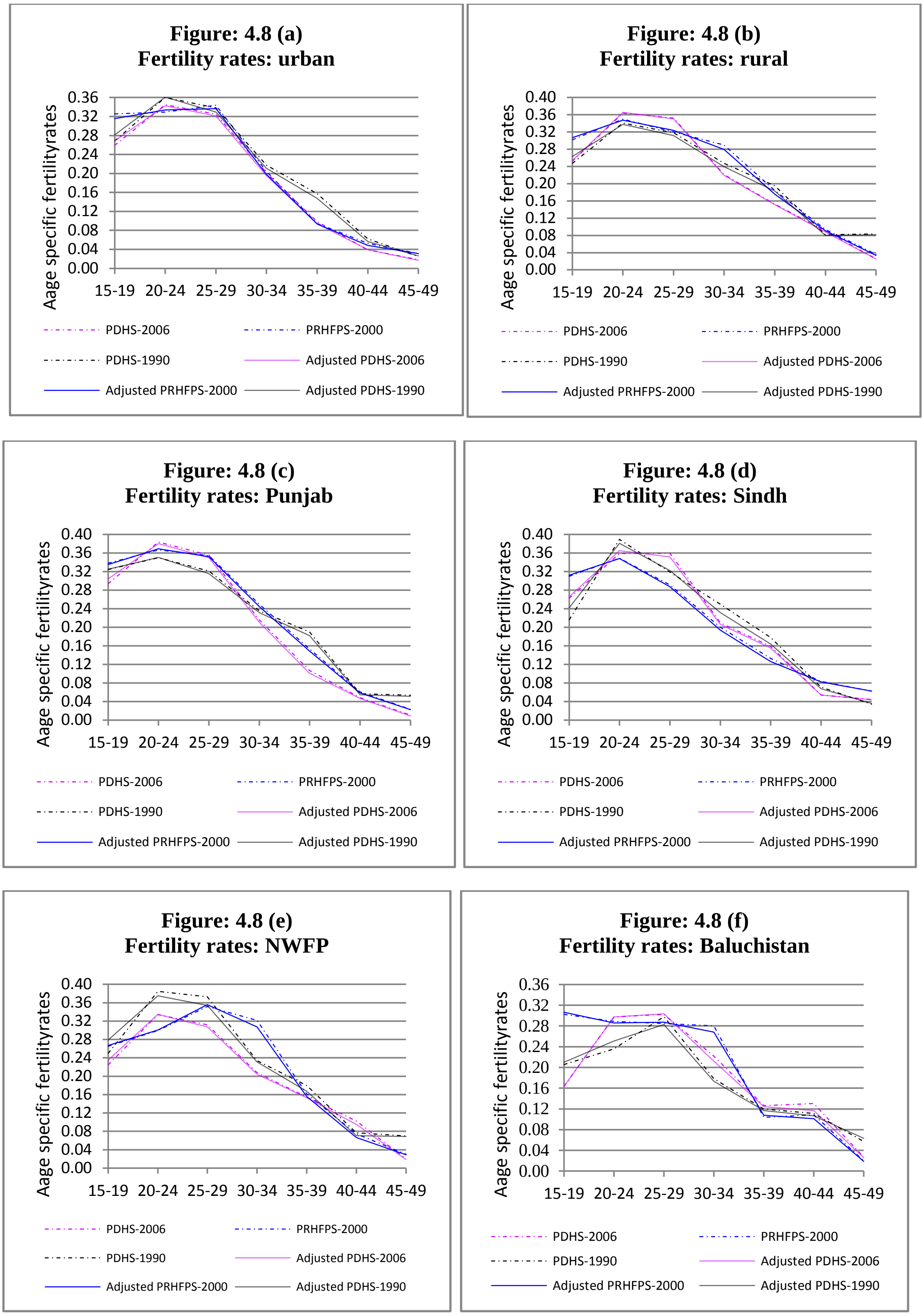


Figure 4.8: Unadjusted and adjusted for age misreporting the grouped age specific fertility schedules of ever married women in different geographic entities of Pakistan, 1990, 2000 and 2006

Table 4.8: Age specific fertility rates (per thousand) for total ever married women in Pakistan, 1990, 2000 and 2006

Age	Unadjusted			Adjusted for age misreporting		
	PDHS 1990	PRHFPS 2000	PDHS 2006	PDHS 1990	PRHFPS 2000	PDHS 2006
15-19	256	309	254	272	312	266
20-24	351	342	357	349	341	359
25-29	329	330	342	320	327	335
30-34	232	253	213	223	241	208
35-39	175	146	131	162	134	127
40-44	72	74	69	68	69	65
45-49	53	34	23	53	31	21

PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

Table 4.9: Changes (%) in age specific fertility rates (per thousand) for total ever married women in Pakistan, 1990, 2000 and 2006

Age	Unadjusted			Adjusted for age misreporting		
	1990-2000	2000-2006	1990-2006	1990-2000	2000-2006	1990-06
15-19	21.1	-17.8	-0.5	14.7	-14.7	-2.2
20-24	-2.4	4.3	1.9	-2.3	5.2	2.7
25-29	0.5	3.4	4.0	2.3	2.5	4.9
30-34	9.2	-15.7	-7.9	7.9	-13.4	-6.6
35-39	-16.5	-10.1	-25.0	-17.2	-5.5	-21.8
40-44	2.3	-6.8	-4.6	0.8	-4.8	-4.0
45-49	-36.4	-32.6	-57.2	-40.4	-32.6	-59.8

PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

In case of unadjusted fertility rates for age misreporting, fertility of five age groups (15-19; 30-34; 35-39; 40-44; 45-49) decreased since 1990 while in the two middle age groups (20-24; 25-29) it increased (Table 4.9). The pattern of increase or decrease in fertility across age groups remained similar in case of fertility rate adjusted for age misreporting; however, the amount of change in any age group differs substantially between the adjusted and unadjusted fertility rates. For example, the percentage decrease was lower (-7.9, negative sign just show the decrease) in the (30-34) year age group when compared to decrease in fertility adjusted for age misreporting (-6.6) (Table 4.9).

Table 4.10 presents the estimated unadjusted and adjusted (for age misreporting) total marital fertility rates for seven geographic entities over three time periods. In addition the fertility of urban and rural areas within each province is presented. The percentage change of adjusted total marital fertility rates with respected to unadjusted rates have also been shown in Table 4.10. It is interesting to note as a general conclusion that the total marital fertility rates adjusted for age misreporting are higher when compared to unadjusted rates. The positive signs of column 3 (Table 4.10) indicate the level of increase, while the magnitude of increase is shown in numeral terms. For example, the adjusted total marital fertility rate in Baluchistan in 1990 was 4.8 per cent time higher as compared to unadjusted rates. In case of year 2000 for Sind, the amount of increase for adjusted total marital fertility rate is 4.5 percentage points. Finally, in 2006 for ever married women in urban areas, the adjusted total marital fertility rate in 9.5 per cent time is higher for example as compared to unadjusted one. Overall, the total marital fertility marginally decline from 1990 to 2006. The decline was slowest. Regionally, urban areas and NWFP has more fertility decline when compare to other regions. Within provinces a great variation is found between urban and rural areas. By following adjusted fertility rates urban Balochistan in 2006 found very different compared to urban regions of other provinces. The explanation might be that: age misreporting could potentially be related to literacy levels. We have seen in chapter one (Table 1.4) that literacy ratio for urban Balochistan (literacy ratio=46.9) was greatly high than rural Balochistan (17.5). Another interesting result is the adjusted fertility rates in rural Punjab (TMFR=6.8) are lower than urban Punjab (TMFR=8.1) in 2006. This finding is also supported by looking at the no difference in urban (6.8) and rural Punjab (6.8) unadjusted fertility rates in 2006. Demographically, it looks a rare and unique situation, where urban marital fertility rates equal rural fertility rates particularly in 2006 in Punjab.

Table 4.10: Comparison of unadjusted total marital fertility rate with total marital fertility rates adjusted for age heaping, 1990, 2000 and 2006, Pakistan

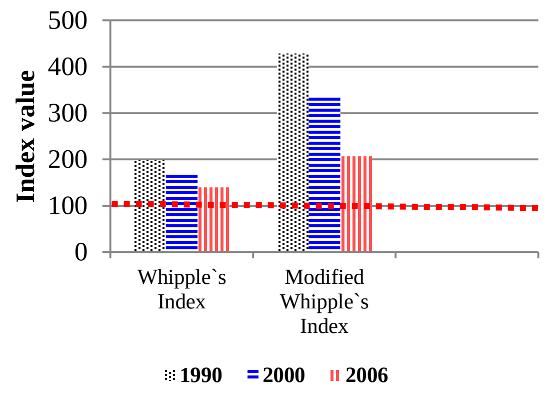
Time		Based on past one year births TMFR (95% CI) (Unadjusted)	TMFR (95% CI) (Adjusted)	change (%) with respect to unadjusted rates
Total				
1990		7.0 (5.5-8.5)	7.4 (6.1-8.7)	5.7
2000		7.0 (5.4-8.5)	7.1 (5.6-8.5)	1.4
2006		6.6 (5.1-8.2)	6.8 (5.3-8.3)	3.0
Place of residence				
Urban				
1990		6.9 (5.3-8.5)	7.4 (5.9-8.9)	7.2
2000		6.5 (4.9-8.2)	7.0 (5.5-8.5)	7.7
2006		6.3 (4.8-7.9)	6.9 (5.4-8.4)	9.5
Rural				
1990		7.3 (5.8-8.7)	7.6 (6.3-8.8)	4.1
2000		7.4 (5.8-8.9)	7.5 (6.9-9.0)	1.4
2006		6.9 (5.3-8.4)	7.0 (5.5-8.6)	1.4
Region/provinces				
Punjab 1990		7.0 (5.4-8.6)	7.2 (5.6-8.7)	7.1
	Urban	6.4 (4.6-8.1)	6.3 (4.6-8.0)	
	Rural	7.5 (5.9-9.1)	7.6 (6.1-9.2)	
2000		7.3 (5.6-9.1)	7.5 (5.9-9.2)	2.7
	Urban	5.9 (4.6-7.2)	6.4 (5.1-7.6)	
	Rural	7.6 (6.3-9.0)	7.7 (6.3-9.1)	
2006		6.7 (5.0-8.5)	7.0 (5.3-8.7)	4.5
	Urban	6.8 (4.8-8.9)	8.1 (5.9-10.2)	
	Rural	6.8 (5.0-8.6)	6.8 (5.0-8.6)	
Sindh 1990		7.1 (5.5-8.8)	7.5 (6.0-9.0)	5.6
	Urban	8.1 (5.7-10.5)	9.0 (6.6-11.5)	
	Rural	6.6 (4.8-8.3)	6.4 (5.0-7.8)	
2000		6.6 (5.1-8.1)	6.9 (5.5-8.3)	4.5
	Urban	6.7 (5.4-7.9)	7.1 (6.0-8.3)	
	Rural	8.5 (7.1-9.9)	8.8 (7.4-10.1)	
2006		6.9 (5.3-8.5)	6.9 (5.3-8.5)	0.0
	Urban	6.5 (4.8-8.2)	6.6 (4.9-8.3)	
	Rural	7.3 (5.6-9.0)	7.4 (5.7-9.1)	
NWFP 1990		7.7 (6.0-9.5)	7.9 (6.5-9.4)	2.6
	Urban	6.6 (4.7-8.4)	6.4 (4.8-8.0)	
	Rural	8.5 (6.5-10.5)	8.7 (7.1-10.3)	
2000		7.1 (5.4-8.8)	6.9 (5.3-8.6)	-2.8
	Urban	7.5 (6.0-9.1)	7.3 (5.9-8.8)	
	Rural	7.7 (6.2-9.3)	7.8 (6.2-9.3)	
2006		6.4 (5.0-7.9)	6.8 (5.4-8.2)	6.2
	Urban	6.3 (4.0-8.6)	8.1 (5.2-11.0)	
	Rural	6.8 (5.2-8.3)	7.0 (5.5-8.6)	
Baluchistan				
1990		6.2 (4.9-7.6)	6.5 (5.4-7.7)	4.8
	Urban	6.9 (5.1-8.7)	6.9 (5.5-8.4)	
	Rural	4.6 (2.9-6.2)	5.2 (3.8-6.6)	
2000		6.3 (4.6-7.9)	6.5 (5.0-8.0)	3.2
	Urban	7.3 (5.7-8.8)	7.5 (6.0-8.9)	
	Rural	8.4 (7.0-9.8)	8.2 (6.8-9.6)	
2006		6.1 (4.7-7.5)	6.6 (5.4-7.9)	8.2
	Urban	4.8 (3.1-6.5)	4.8 (3.3-6.4)	
	Rural	6.6 (5.1-8.2)	7.1 (5.8-8.4)	

TMFR: total marital fertility rate
CI: confidence interval

4.6 Summary of age misreporting influencing fertility

This chapter has used graphs as well as standard and modified (proposed) versions of the indices of the age heaping to analyse the accuracy of age reporting among Pakistani ever married women on three survey dates. This analysis was of three main types. The first pertained only to reproductive age composition (single year and 5-year groups) of women and degree to which Pakistani women preferred or avoided in their survey responses the ages ending in certain digits. With respect to age heaping in general, graphically the issue is observed to be very pronounced (peaks and toughs). Secondly, the analysis is presented for seven major entities (region and provinces). Residents from rural areas and from Baluchistan followed by Sindh are somewhat different in age reporting when compared to other entities. Thirdly the analysis is pertained to the comparisons of popular methods of age heaping (Whipple, Myer`s index) with the proposed versions. Though based on different methods, the pattern of age heaping as a summary measure and in digit specific manners is almost similar (Figure 4.9). The most observed pattern of digit preference in seven entities was: 0, 5, 8 and 2. Digits 1 and 9 were identified to be the most avoided digits across seven entities with digit 6 as least avoided.

Figure 4.9
Summary of age misreporting



The age ratio analysis provided the highest age heaping on ages 20-29 across all entities. Within a broader age range 20-29 years, the most heaping across entities was noted on 25-29 (total, urban, Punjab and Baluchistan) year age group when compared to 20-24.The age groups 40-44 was identified to be the most avoided in terms of age ratio analysis. Further, out of seven entities Baluchistan ranks highest with exceptionally high values of age accuracy index over three dates.

The second part of the chapter has demonstrated the influence of age misreporting on fertility through the proposed method of digit shifts. The probabilities of digit preference or avoidance were calculated using no covariate multinomial logistic regression model. The fertility estimates adjusted for age misreporting were higher than was the case with the unadjusted rates. Total marital fertility (unadjusted) declined in Pakistan by 5.7% from 1990 survey to 2006-07 PDHS, whereas the total marital fertility adjusted for age misreporting declined by 8.1% when comparing the two surveys. There were regional differentials in the decline. For example, the case the Sindh was notable, fertility was not significantly declined when comparing the two survey figures.

5 FERTILITY INHIBITING DETERMINANTS IN PAKISTAN

5.1 Introduction

The major aim of this chapter is to present the results of the analysis of current fertility in terms of proximate determinants in Pakistan since 1990s. Fertility change could be traced through the examination of many demographic measures, for example crude birth rate (CBR), age-specific fertility rate (ASFR), total fertility rate (TFR), children ever born (CEB), parity progression ratios (PPR). For the present work, the change in fertility is observed through CBR, ASFR and TFR. Section 5.2 describes the fertility levels and trends in the country as a whole. Section 5.2.1 concerned with regional fertility levels and trends. The statistical description of proximate determinants model is given in section 5.3. Section 5.4 examines the four principal indices of Bongaarts fertility inhibiting determinants since 1990s and section 5.5 describes their role in the slow paced fertility transition of Pakistan.

5.2 Fertility transition: overall levels and trends

Crude birth rates (CBRs) per thousand population and age-specific fertility rates obtained from the four surveys are presented in Table 5.1 and Table 5.2. Comparing the CBRs of four surveys, it is observed that there is decline of four percent between two surveys of 1974-75 Pakistan Fertility Survey (PFS) and 1984-85 Pakistan Contraceptive Prevalence Survey (PCPS), 1.6 percent between 1984-85 and 1990-91, and 4.3 percent between 1990-91 and 2006-07. The largest decline in CBRs occurred between 1990 and 2006 when compared to other surveys. Figure 5.1 presents the age-specific fertility rates for all women across seven different surveys of Pakistan since 1975. These rates are based on the respondent fertility experience in n years prior to each survey. For example, PDHS-1990 provides the fertility rates based on respondents six year (1985-1990) experience prior to survey. Table 5.2 shows the percentage change in fertility with respect to the previous survey since 1975. No significant decline in fertility was observed from 1975 to 1996, however, substantial decrease (-24.07 %) in fertility is observed from 1990 to 2006. The age-specific decline in fertility is witnessed in the first two age groups of 15-24 particularly after 1996 (Table 5.2). The decline appeared to be modest in 25-39 age group after the 1990s. It is interesting to note that a trivial decline in fertility for the age group 45-49 is observed before 1990s.

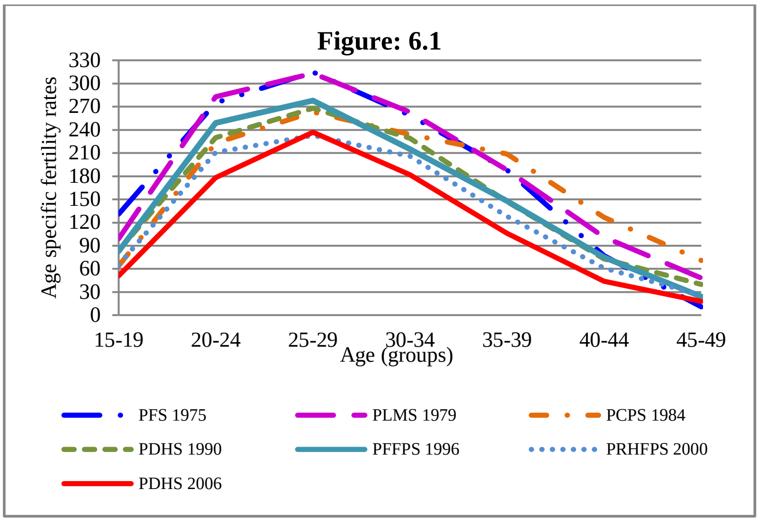
Overall, fertility in Pakistan declined from 6.3 children in 1975 to 4.1 children in 2006, however, the PFS in 1975, PDHS in 1990 and 2006, show evidence of faster decline between 1990 and 2006. In short, a decline of 1.3 children in total fertility rate between 1990 and 2006 is 31.7 percentage points higher when compared to the decline between 1975 and 1990. These lines of argument suggest that the regional levels of fertility should be observed after 1990s.

Table 5.1: Crude birth rates according to selected surveys in Pakistan, 1975-2006

Year	Survey	Crude birth rate Total	Urban	Rural
1974-75	Pakistan Fertility Survey (PFS)	40.5		
1984-85	Pakistan Contraceptive Prevalence Survey (PCPS)	36.6	NA	37.1
1990-91	Pakistan Demographic and Health Survey (PDHS)	35.0	33.7	35.6
2006-07	Pakistan Demographic and Health Survey (PDHS)	30.7	27.6	32.3

Note: Based on data for three year prior to the interview for 2006-07 PDHS, six year prior to the interview for 1990-91 PDHS, and one year prior to the interview for PFS and PCPS.
NA: not available.

Figure 5.1: Age specific fertility rates from selected surveys, Pakistan, 1975-2006



Age-specific fertility rates are per 1000 women; total fertility rate is per woman
PFS: Pakistan Fertility Survey
PLMS: Pakistan Labour Force and Migration Survey
PDHS: Pakistan Demographic and Health Survey
PFFPS: Pakistan Fertility and Family Planning Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

Table 5.2: Change (%) in age-specific fertility rates from selected surveys in Pakistan, 1975-2006

Age group	1979-1975 (PLMS-PFS)	1984-1985 (PCPS-PLMS)	1990-84 (PDHS-PCPS)	1996-1990 (PFFPS-PCPS)	2000-1996 (PRHFPS-PFFPS)	2006-00 (PDHS-PRHFPS)
15-19	-24.43	-35.35	31.25	-1.19	-21.69	-21.54
20-24	2.91	-21.20	3.14	8.26	-15.26	-15.64
25-29	-0.63	-15.97	1.90	3.73	-16.19	1.72
30-34	1.54	-11.03	-2.14	-6.11	-4.19	-11.65
35-39	0.00	11.17	-29.67	0.68	-13.51	-17.19
40-44	31.17	25.74	-42.52	2.74	-18.67	-27.87
45-49	336.36	47.92	-43.66	-40.00	8.33	-30.77
TFR	3.17	-7.69	-10.00	0.00	-11.11	-14.58

Note: Years in parentheses indicates the period of births preceding the survey
Age-specific fertility rates are per 1000 women; total fertility rate is per woman
PFS: Pakistan Fertility Survey
PLMS: Pakistan Labour Force and Migration Survey
PDHS: Pakistan Demographic and Health Survey
PFFPS: Pakistan Fertility and Family Planning Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

5.2.1 Regional fertility transition: levels and trends

Table 5.3 shows the fertility trends by region in Pakistan since 1990s. A decline has occurred in all regions. As expected, fertility has substantially declined in urban areas than in rural areas. Among provinces, the case of Baluchistan is interesting to note: since 1990, the largest decline in both absolute (1.7 children) and relative (29.3%) terms have occurred, which is contrary to its socio-economic development. Socio-economically, Baluchistan is the least developed province of Pakistan, particularly when compared to Punjab (most developed province). Throughout the period, the lowest decline in fertility was reported in Sind and rural areas of Pakistan. Keeping the regional fertility differentials in view, the Bongaarts fertility inhibiting determinants have been explored in section 5.4 because of its direct influence on fertility.

Table 5.3: Total fertility rate by geographic region in Pakistan, 1990, 2000 and 2006

Region	1990-1991	2000-2001	2006-2007	Absolute difference 2006-1990	Relative decline 2006-1990
Place of residence					
Urban	4.9	3.7	3.3	-1.6	-32.7
Rural	5.6	5.4	4.5	-1.1	-19.6
Province					
Punjab	5.4	4.7	3.9	-1.5	-27.8
Sindh	5.1	4.7	4.3	-0.8	-15.7
NWFP	5.5	5.1	4.3	-1.2	-21.8
Baluchistan	5.8	5.4	4.1	-1.7	-29.3

5.3 The proximate determinants model

The proximate determinant model of fertility proposed by John Bongaarts is based on the scheme first introduced by Davis and Blake (Davis and Blake 1956, Bongaarts 1978, Bongaarts and Potter 1983). The model is enormously in vogue in demographic research over the past three decades. During this time different modifications in the main standard model have been introduced. Apart from discussing these modifications; the standard model measures the impact of four main determinants (called proximate determinants) on fertility through a set of quantitative indexes.

Typically a woman's fertility is the result of her three step mileage.

First step is: she should be sexually active (normally in the age of 15) and involve in intercourse (presumably held under union ship in many societies). Bongaarts identified this step as one of his first determinant of fertility and had given a name to this exposure: 'the proportion of women married'. Quantitatively speaking, the proportion of women married (a measure of exposure to intercourse) is referred as 'the index of marriage(C_m)' and symbolically it is presented as the following expression:

$$C_m = \frac{\sum_{x=a}^{b} m(x)g(x)}{\sum_{x=a}^{b} g(x)}$$

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

(1)

C_m is the weighted average of the age-specific proportions of married women; where in equation (1), $m(x)$ is the proportion of currently married women aged x years, $g(x)$ is the age specific marital fertility rate (g(x) can be computed by dividing the age specific fertility rates (ASFR) by the proportion of women that is currently married at each age x). Pakistan is a society in which it can be exclusively assumed that sexual activity would take place within marriage for validity of the formula (C_m) presented in equation (1). In the expression for (C_m) shown in equation (1), the TMFR stands for the total marital fertility rate. However, the index C_m can take values between '0' and '1' inclusive. A particular value of marriage index (C_m) say 0.8 for example; indicates that fertility is reduced as a result of 20% women being not sexually active throughout the entire reproductive period and therefore gives the proportion by which TFR is smaller than TMFR. Hence the extreme values of marriage index can easily be interpreted and understood: a value of 1 indicates that there is no effect in lowering fertility because all women of reproductive age are married, and a value of '0' indicates that fertility is completely protected with the complete absence of marriage. For any society the extreme values of index (0,1) are quite impractical, however, the values between '0' and '1' are readily available and varies from one society to another.

Second step is: intercourse (first step) leads to conception (second step), this stage or state of conception could be controlled by using contraception. Bongaarts identified this step as second or next proximate determinant of fertility and had given a name to this exposure: 'contraceptive use' including abstinence and sterilization. Quantitatively speaking, 'contraceptive use' (a measure of exposure to contraception) is referred as 'the index of contraception(C_c)' and symbolically it is presented with the following expression:

$$C_c = 1 - 1.08 \text{ u e}$$

(2)

Where 'u' (prevalence of current contraceptive use among married women) is the proportion of married women currently using contraception, and 'e' is the average method-use effectiveness (the proportionate reduction in the monthly probability of conception due to contraception). The value of 'e' is estimated using the weighted average of the method-specific use-effectiveness, (say for any method 'm') 'e_m', by the proportion of the women using a given method, u_m, by using the following expression:

$$e = \frac{\sum e_m u_m}{u_m}$$

(3)

Further, average use method effectiveness could be estimated using the following expression shown in equation (4). The expression is suggested by Bongaarts and Potter and has been used by researchers for application purposes (Nasir et al. 2009b, Islam et al. 2005, Bongaarts and Potter 1983).

$$e_m = 1 - \left({}^{f_m}/_{f_n}\right)$$

(4)

Where f_m in equation (4) indicates the m^{th} contraceptive method failure rate and f_n is the natural infertility. The constant 1.08 (sterility correction factor) in equation (2) is an adjustment for the fact that non-sterile women do not use contraception if they believe that they are sterile (Bongaarts and Potter 1983). Since estimates of contraceptive effectiveness are rarely available, the values measuring the method specific use-effectiveness have been taken from the Bongaarts and Potter (1983, p. 84): 1.0 for female sterilization, 0.9 for pill, 0.95 for IUD, 0.99 for injectable, 0.99 for implants, 0.9 for condoms (modern methods); 0.7 for withdrawal, 0.8 for abstinence and 0.3 for other traditional methods. These values of use-effectiveness have been used for computing the index of contraception in this study.

Step three is: intercourse (first step) leads to conception (second step), and conception is followed by gestation and parturition. The state of gestation and parturition could face the abortion. Bongaarts identified this step as third proximate determinant of fertility and had given a name to this exposure: 'induced abortion'. Quantitatively speaking 'induced abortion' (a measure of exposure to parturition) is referred as 'the index of abortion(C_a)' and symbolically it is presented with the following expression:

$$C_a = \frac{TFR}{TFR + 0.4\ (1 + u) \times TAR}$$

(5)

Where TAR is the total abortion rate and equal to the average number of induced abortions per woman at the end of reproductive period, the term $0.4\ (1 + u)$ is an estimate of the births averted by a single abortion. A modification of this index is suggested by Stover (Stover 1998), and according to him u should be multiplied by e to describe the proportion of women protected by contraception and equation (5) by incorporating Stover's modification would be

$$C_{\grave{a}} = \frac{TFR}{TFR + 0.4\ (1 + u \times e) \times TAR}$$

(6)

Where e indicates the average use effectiveness of contraception and details are given above equation (3) to (6).

Finally, after having birth, a woman is in the state of post-partum (the period when woman adjust physically to the process of childbearing or conception). Bongaarts identified this stage as the fourth proximate determinant of fertility and had given a name to this exposure: 'post-partum infecundability' or 'duration of post-partum amenorrhea'. The index of post-partum infecundability (C_i) is presented with the following expression:

$$C_i = \frac{20}{18.5 + i} \tag{7}$$

Where i (measured in months) is the average duration of postpartum infecundability caused by breastfeeding or postpartum abstinence. The value of i can be estimated using the following equation:

$$i = 1.753 \text{ Exp } (0.1396 \times B - 0.001872 \times B^2) \tag{8}$$

Where B is the mean or median duration of breastfeeding in months (Bongaarts and Potter 1983).

Based on these four indexes, Bongaarts suggested the following multiplicative model of proximate determinants of fertility:

$$\text{TFR} = C_m \times C_c \times C_a \times C_i \times \text{TF} \tag{9}$$

Where TF in equation (9) is the woman's biological capacity to produce called average potential fertility or total fecundity. The theoretical maximum fertility of a woman is 35 births, not counting multiple births. This theoretical maximum is based on the maximum reproductive life span of age 15 to 50 and the absence of all biological and behavioural constraints. If the constraints waiting time to conception, risk of intrauterine mortality and onset of permanent sterility are taken into account, the average potential fertility is about 15.3 children per woman (range between 13 and 17) with minor variations in human sub-populations (Bongaarts and Potter 1983). The proximate determinant model shown in equation (9) assumes that each of the determinants has an independent inhibiting effect on fertility. Equation no (9) can be re-written as:

$$\text{TFR} = \frac{\text{TFR}}{\text{TMFR}} \times \frac{\text{TMFR}}{\text{TN}} \times \frac{\text{TN}}{\text{TF}} \times \text{TF} \tag{10}$$

With the standard version of proximate determinant model of fertility depicts in equation (9), it is argued that the model is good at discerning inter population variations and has been widely used by researchers. Nevertheless some weaknesses of the model have been identified (Reinis 1992, Stover 1998).

5.4 Basic characteristics of the study sample

This chapter uses the information of three study samples from 2006 and 1990 Pakistan Demographic and Health Survey (PDHS) and 2000 Pakistan Reproductive Health and Family Planning Survey (PRHFPS). The time between 1988 and 2002 is identified as the best duration (fastest as compared to other period—greatest decline in total fertility rate) in the fertility transition of Pakistan. Therefore to best cover this time period with reliable information this study uses information from above mentioned three surveys which are national in scope.

Table 5.4 shows the frequency and percentage distribution of respondents by their basic background characteristics (age is years, place and province of residence, respondent and her husband education level and respondent age at first marriage). More than three-fifths of the sampled women were aged between 20 and 39 years. Geographically, most of the population of Pakistan in rural resident—more than half of the sample is from rural areas of Pakistan particularly in 2006 and 2000 survey. Punjab is the most densely province of Pakistan. More than two-fifths of the women were from Punjab followed by Sindh and NWFP. Baluchistan is the least populated province of Pakistan—least proportions of women were selected from Baluchistan. Vast majority of women was having no level of education. By looking at the individual categories of level of education across three surveys, less than 10 per cent of women were have higher education. In case of respondent's husband education, more than fifty per cent were have some level of education (either primary or secondary or higher). Maximum number of women get marry in (16-20) year age category; however average age at first marriage seems higher in 2006 (18.29 years) compared to 2000 or 1990 sample.

Table 5.4: Percentage distribution of selected demographic and socio-economic characteristics of study sample, Pakistan

Characteristics	2006 PDHS		2000 PRHFPS		1990 PDHS	
	N	(%)	N	(%)	N	(%)
Age (years)						
15-19	578	5.8	404	6.1	407	6.2
20-24	1560	15.6	1081	16.4	1064	16.1
25-29	2010	20.1	1410	21.4	1469	22.2
30-34	1716	17.1	1233	18.7	1200	18.2
35-39	1649	16.5	1036	15.7	1031	15.6
40-44	1282	12.8	883	13.4	820	12.4
45-49	1228	12.3	532	8.1	620	9.4
Total	10023	100.0	6579	100.0	6611	100.0
Place of residence						
Urban	3830	38.2	2826	43.0	3384	51.2
Rural	6193	61.8	3753	57.0	3227	48.8
Total	10023	100.0	6579	100.0	6611	100.0
Province of residence						
Punjab	4263	42.5	3015	45.8	2207	33.4
Sindh	2716	27.1	1791	27.2	1798	27.2
NWFP	1862	18.6	1167	17.7	1665	25.2
Baluchistan	1182	11.8	606	9.2	941	14.2
Total	10023	100.0	6579	100.0	6611	100.0
Education of respondent						
No	6665	66.5	4604	70.0	5055	76.5
Primary	1344	13.4	804	12.2	600	9.1
Secondary	1348	13.4	801	12.2	842	12.7
Higher	666	6.6	370	5.6	114	1.7
Total	10023	100.0	6579	100.0	6611	100.0
Husband education						
No	3675	36.7	2561	38.9	2999	45.4
Primary	1589	15.9	1013	15.4	1039	15.7
Secondary	3144	31.4	1929	29.3	2083	31.5
Higher	1615	16.1	1076	16.4	493	7.5
Total	10023	100.0	6579	100.0	6611	100.0
Age at first marriage (years)						
<=15	2588	25.8	1730	26.3	2116	32.0
16-20	5010	50.0	3305	50.2	3036	45.9
20+	2425	24.2	1544	23.5	1459	22.1
Total	10023	100.0	6579	100.0	6611	100.0
Mean=18.29			Mean=18.24		Mean=17.83	
Median=18.00			Median=18.00		Median=17.00	
Mode=16			Mode=16		Mode=15	
Standard deviation (SD) = 3.97			SD=3.97		SD=4.11	

PDHS: Pakistan Demographic and Health Survey
PRHFPS: Pakistan Reproductive Health and Family Planning Survey

5.5 Bongaarts fertility inhibiting determinants

Bongaarts (Bongaarts 1978) suggested eight factors (which he called intermediate factors) namely: female proportion married, contraceptive use and effectiveness, prevalence of induced abortion, duration of postpartum infecundability, fecundability, spontaneous abortion, prevalence of sterility and duration of fertile period. Among these, the first four factors are the most important because of their higher and direct inhibiting effect on fertility. The fertility-inhibiting effects of the four most important intermediate variables are measured by four indices. We have estimated the four proximate determinants indices. Each index has a value between '0' and '1'. The complement value of index represents the proportionate reduction in fertility attributable to the fertility inhibiting determinant (the lower the index value, the greater is the fertility reducing impact).

5.5.1 Index of proportion married (C_m)

The marriage index is designed to represent the proportion by which TFR is smaller than the TMFR as a result of marital pattern (the effect of non-marriage in terms of a reduction in fertility per women). Table 5.5 shows the calculated TMFR for seven geographic stratums. For example, the estimated TFR and TMFR showed that the observed total fertility level for overall respondents for 2006 is 4.5 and 7.2 respectively (Table 5.5 and Table 5.6). For total women, C_m equals 0.698, 0.66 and 0.624 in 1990-91, 2000-01 and 2006-07 respectively (Table 5.6). The marriage pattern accounts that 30.2% (1990-91), 34% (2000-01), and 37.2% (2006-07) of women in their reproductive period are not sexually active (for not being married) to reduce the actual fertility levels. In addition, it shows a proportion of married reduced by 0.074 points during 1990 to 2006.

This is consistent in Pakistani case where low contraceptive use within marriage and the delay in the age at marriage have a substantial impact to delay the exposure of intercourse which ultimately contribute to reducing the fertility levels. The marriage pattern among urban women (Cm for 2006: 0.564) and those living in Punjab (Cm for 2006: 0.575) has the highest fertility reducing effect, accounting for 43.6% (urban) and 42.5% (Punjab) reduction in actual fertility levels (Table 5.6). Notably, it is observed that marriage index shows declining trends for overall sample and across geographic regions since 1990s. There are two exceptions in two regions (Sindh and NWFP) to this conclusion. First, in case of Sindh, the marriage index (0.68) observed to be constant since 1990s; second, in case of NWFP, no decline is observed from 1990 (0.693) to 2000 (0.710), but after 2000 a substantial decline is observed (Table 5.6).

Table 5.5: Estimates of selected reproductive measures used in proximate determinants of fertility model, 1990, 2000 and 2006, Pakistan

Time	TMFR	U	e	TA	MPPI (months)
Total					
1975*	8.9	0.050	0.83	--	12.65
1984**	7.7	0.091	0.84	0.00	12.41
1990	7.5	0.118	0.895	0.00	12.29
2000	7.3	0.275	0.925	0.07	12.06
2006	7.2	0.297	0.895	0.14	11.75
Place of residence					
Urban					
1990	7.3	0.257	0.886	0.00	10.60
2000	6.6	0.397	0.888	0.06	11.01
2006	6.6	0.409	0.890	0.11	11.76
Rural					
1990	7.8	0.058	0.908	0.00	14.22
2000	7.8	0.216	0.879	0.05	13.09
2006	7.6	0.239	0.900	0.12	11.75
Region/province					
Punjab					
1990	7.6	0.219	0.893	0.00	12.52
2000	7.6	0.299	0.872	0.08	11.77
2006	7.2	0.331	0.891	0.14	11.27
Sindh					
1990	7.8	0.124	0.881	0.00	12.28
2000	7.0	0.270	0.905	0.02	11.76
2006	7.4	0.265	0.915	0.16	11.04
NWFP/Khyber					
1990	8.2	0.086	0.935	0.00	12.86
2000	7.4	0.235	0.897	0.04	14.17
2006	7.0	0.248	0.885	0.15	13.20
Baluchistan					
1990	7.5	0.021	0.911	0.00	12.61
2000	6.7	0.159	0.898	0.01	10.93
2006	6.8	0.145	0.925	0.07	12.71

*(Bongaarts and Potter 1983)
**(Aziz 1994)
TMFR: Total marital fertility rate (estimated)
U: Proportion currently using contraception
e: Contraceptive use-effectiveness
TA: Total abortion rate
MPPI: Mean postpartum infecundability (months)

Table 5.6: Proximate determinants of fertility model, 1990, 2000 and 2006, Pakistan

Time	Index	Marriage (C_m)	Contraception (C_c)	Abortion (C_a)	Postpartum infecundability (C_i)	TFR	TF
Total							
1975*		0.785	0.955	1.000	0.642	7.4	15.4
1984**		0.779	0.917	1.000	0.647	7.1	16.7
1990		0.698	0.886	1.000	0.650	5.2	13.0
2000		0.660	0.738	0.994	0.654	4.8	15.3
2006		0.624	0.713	0.983	0.661	4.5	15.5
Place of residence							
Urban							
1990		0.651	0.754	1.000	0.687	4.7	14.1
2000		0.599	0.619	0.991	0.678	4.0	15.9
2006		0.564	0.607	0.982	0.661	3.7	16.7
Rural							
1990		0.749	0.943	1.000	0.611	5.8	13.5
2000		0.708	0.795	0.995	0.633	5.6	15.7
2006		0.665	0.768	0.988	0.661	5.0	15.1
Region/province							
Punjab							
1990		0.682	0.876	1.000	0.645	5.2	13.4
2000		0.625	0.718	0.991	0.661	4.8	16.3
2006		0.575	0.681	0.981	0.672	4.2	16.1
Sindh							
1990		0.689	0.882	1.000	0.672	5.4	13.2
2000		0.680	0.736	0.998	0.661	4.8	14.4
2006		0.682	0.738	0.983	0.677	5.1	15.1
NWFP/Khyber							
1990		0.693	0.913	1.000	0.638	5.7	14.0
2000		0.710	0.772	0.996	0.612	5.3	15.7
2006		0.635	0.763	0.983	0.631	4.5	14.9
Baluchistan							
1990		0.737	0.913	1.000	0.643	5.5	12.8
2000		0.700	0.846	1.000	0.680	5.0	12.4
2006		0.648	0.855	0.993	0.641	4.4	12.5

*(Bongaarts and Potter 1983)
**(Aziz 1994)
TFR: Total fertility rate (model estimate)
TF: Total fecundity rate

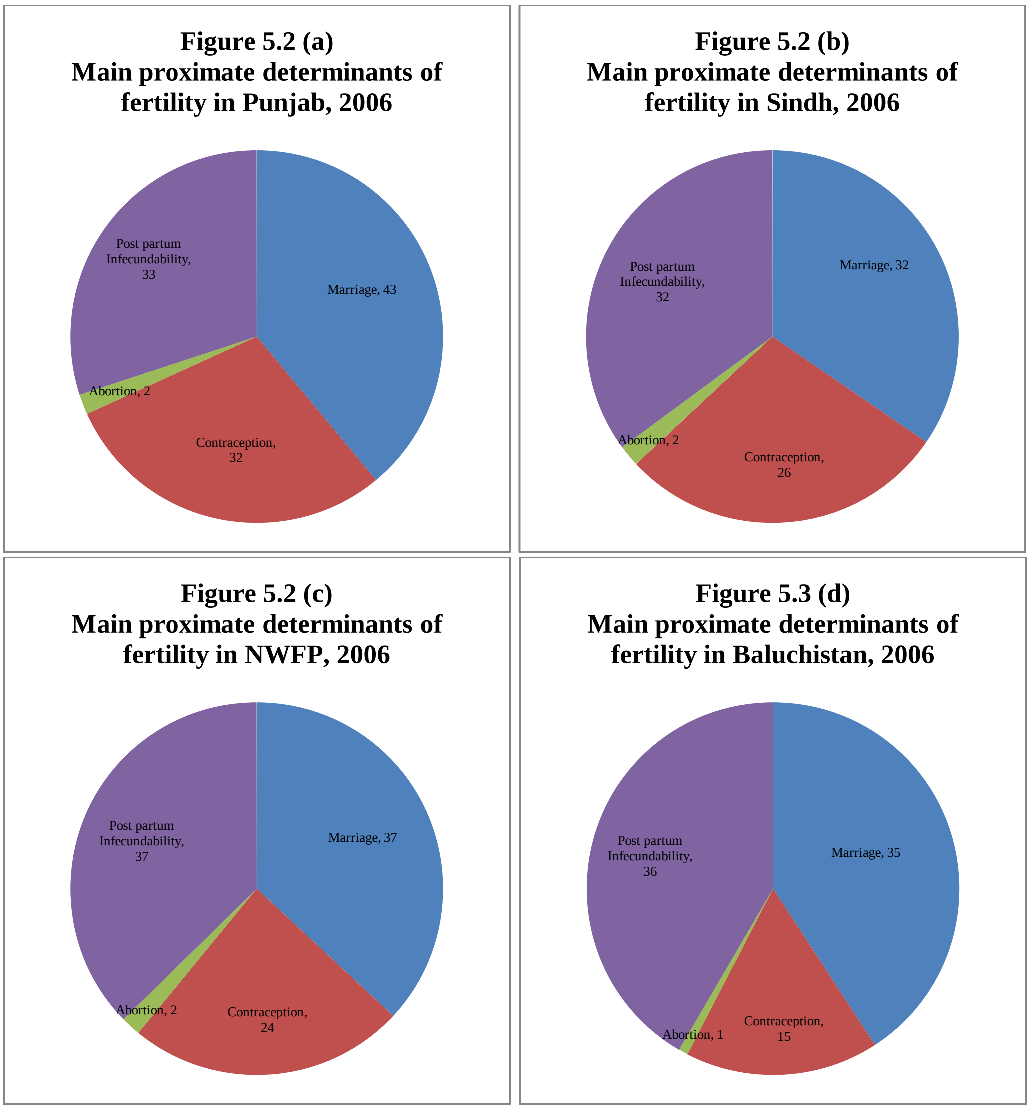


Figure 5.2: Contribution (%) of four proximate determinants of fertility in provinces of Pakistan, 2006 Pakistan Demographic and Health Survey

In addition, the variation in four proximate determinants of fertility in four provinces of Pakistan is shown in Figure 5.2 (a) to (d) for a period of 2006. Punjab compared to other provinces is at the front—43% of the women in Punjab are not sexually active because of not being married followed by women in NWFP (37%) and Baluchistan (35%).

Table 5.7: Percentage change (impact) of the proximate determinants on fertility change in Pakistan, 1990, 2000 and 2006

Time	Marriage (C_m)	Contraception (C_c)	Abortion (C_a)	Postpartum infecundability (C_i)	TF	I	TFR
Total							
1990 to 2000	-5.44	-16.70	-0.60	0.62	17.02	-2.71	-7.82
2000 to 2006	-5.45	-3.39	-1.11	1.07	1.37	0.06	-7.45
1990-2006	-10.60	-19.53	-1.70	1.69	18.62	-3.18	-14.69
Place of residence							
Urban							
1990 to 2000	-7.99	-17.90	-0.90	-1.31	13.37	-1.51	-16.24
2000 to 2006	-5.84	-1.94	-0.91	-2.51	4.48	-0.09	-6.80
1990-2006	-13.36	-19.50	-1.80	-3.78	18.45	-1.95	-21.94
Rural							
1990 to 2000	-5.47	-15.69	-0.50	3.60	16.29	-2.69	-4.48
2000 to 2006	-6.07	-3.40	-0.70	4.42	-3.86	0.06	-9.55
1990-2006	-11.21	-18.56	-1.20	8.18	11.79	-2.60	-13.60
Region/province							
Punjab							
1990 to 2000	-8.36	-18.04	-0.90	2.48	21.67	-4.04	-7.18
2000 to 2006	-8.00	-5.15	-1.01	1.66	-0.90	0.42	-12.97
1990-2006	-15.69	-22.26	-1.90	4.19	20.58	-4.14	-19.22
Sindh							
1990 to 2000	-1.31	-16.55	-.20	-1.64	9.46	-1.27	-11.50
2000 to 2006	0.29	0.27	-1.50	2.42	4.77	0.04	6.29
1990-2006	-1.02	-16.33	-1.70	0.74	14.68	-2.32	-5.94
NWFP/Khyber							
1990 to 2000	2.45	-15.44	-0.40	-4.08	11.87	-1.81	-7.41
2000 to 2006	-10.56	-1.17	-1.31	3.10	-5.34	0.42	-14.86
1990-2006	-8.37	-16.43	-1.70	-1.10	5.89	0.54	-21.16
Baluchistan							
1990 to 2000	-5.02	-7.34	0.00	5.75	-2.86	-0.12	-9.58
2000 to 2006	-7.43	1.06	-0.70	-5.74	-11.80	0.72	-11.80
1990-2006	-12.08	-6.35	-0.70	-0.31	-20.25	-2.16	-20.25

TF: Total fecundity rate
TFR: Total fertility rate (model estimate)
I: Interaction factor (calculated by subtracting the sum of marriage, contraceptive use, abortion, postpartum infecundability and total fecundity from TFR; for details see(Bongaarts and Potter 1983), p.108)

Turning now to the impact of the marriage index with respect to the previous survey date, Table 5.7 provides the decomposition of the contribution made by each proximate determinant to a given change in fertility. The decomposition procedure (Bongaarts and Potter 1983) suggested by Bongaarts and Potter has been followed to understand the contribution of each proximate determinant of fertility (p. 107). For total women, the results indicate that the index of marriage contributed 5.44% decline in reducing TFR due to a decrease in the proportion of women for not being sexually active because of no marriage during the period 1990 to 2000. Regionally, the contribution of marriage pattern in TFR decline is the highest (13.36%) in urban areas than in rural areas (11.21%). Across provinces, for the period 2000 to 2006 two results are interesting to note: the marriage pattern in Sindh (0.29%) has contributed little for any point of decrease in TFR, while, the marriage pattern in NWFP (10.56%) has shown the highest (when compared to other provinces for the same period) and substantial contribution for the decline in the TFR (from 5.3 to 4.5: see Table 6.5). Another notable result for the overall period from 1990 to 2006 across provinces is that Punjab observed to be a leading province in terms of delayed marriage (15.69%) followed by Baluchistan (12.08%) for the decline in the TFR.

5.5.2 Index of contraception (Cc)

The index of contraception is designed to measure the effect of contraception to reduce the risk of conception (effect of contraception on marital fertility assuming induced abortion is absent). In terms of marital fertility rate, the index of contraception gives the proportion by which TMFR is smaller than total natural fertility (fertility in the absence of any deliberate birth control practice). However, the contraception index value depends on the current contraceptive prevalence rate and the average use effectiveness of the contraception. Table 5.5 presents both contraceptive prevalence (U) and its use-effectiveness (e) for the seven geographic stratums. In 1990, 12 per cent of the women aged 15-49 years were currently using a method of contraception. This level increased to 30 per cent in 2006 showing a low increase of 1.13 per cent per annum for the period from 1990 to 2006. Regionally, there is more contraceptive use in urban population (41%) than their rural counterparts. Punjab is the leading province in terms of contraceptive prevalence.

The index of contraception varies inversely with the contraceptive prevalence and use-effectiveness. If the contraceptive prevalence is completely absent then the index value would be 1. The calculated values of contraceptive index have been shown in Table 5.6. The calculated value of Cc for total population in 2006 (0.713) indicates that 29% of maximum potential fertility of married fecund women has been suppressed by contraceptive use. Table 5.6 provides estimates of the index of contraception across regions (urban-rural) and provinces since 1990s. The contraceptive index across all seven geographic stratums shows a slow increase during the period 1990 to 2006. As expected, increase in urban areas is greatest than in rural areas. For instance, rural resident women in 2006 are 16 percentage points behind in contraceptive use than women living in urban areas. For the same case in 1990, this urban-rural difference is noted to be greatest (19%). Across provinces, the effect of contraceptive use in Punjab is the greatest, accounting for a 32% reduction of natural fertility relative to marital fertility in 2006 (Figure 5.2). Table 5.7 illustrates the contribution made by each proximate determinant to a given change in fertility with respect to previous survey. For all women, the results indicate that contraception contributed 16.70% decline in reducing TFR, attributed an increase in contraceptive practice during 1990 to 2000. The contribution of contraceptive use is greater during 1990 to 2000 than 2000 to 2006. The results hold similar observations across all seven geographic regions. The rural-urban differences are trivial during the same period. Across provinces, Punjab has the greatest fertility reduction effect than other provinces, accounting for a 22.26% reducing effect of contraception between 1990 and 2000.

5.5.3 Index of abortion (Ca)

This index is designed to describe the fertility inhibiting effects of induced abortion. Total abortion rate (TA) and contraceptive prevalence rate are needed to compute the index of induced abortion. In Pakistan, abortion is illegal except for medical reasons or when the life of mother is at risk. It is believed that induced abortion is practiced in the society of Pakistan; however, it is extremely difficult to get accurate information about the level of induced abortion. In the 2000-01 PRHFPS all ever-married women were asked whether they ever experienced a pregnancy, which ended in a miscarriage or an abortion? Those who responded positively were then asked about the total number of spontaneous and induced abortions. The information on induced abortion is utilized in this study to estimate the TA for the survey. In 2006-07 PDHS, several questions (for example miscarriage, abortion and stillbirth) about pregnancies have been asked that did not end in live births. The information on induced abortion from survey has been used to calculate the TA. There is no information available on induced abortion in the 1990-91 PDHS. It is further believed that induced abortions might be under reported for a variety of reasons, disapproval by the religion for example.

The overall measure of the incidence of induced abortion is the TA, equal to the average number of induced abortions per woman at the end of the reproductive period if induced abortion rates remain at prevailing levels throughout the reproductive period (excluding abortions to women who are not married). Table 5.5 provides the calculated values of the TA for two surveys (2000-01 PRPHFPS; 2006-07 PDHS). For 1990-91 PDHS the TA values are assumed to be zero. Among all geographic stratums the calculated values for the index of induced abortion reaches a maximum of 0.998 in 2000 for Sindh and a minimum of 0.981 in 2006 for Punjab (Table 5.6). This range of abortion index provides almost negligible contribution to the reduction of fertility in Pakistan.

Box 2: Quality of abortion data in Pakistan

To date, only limited research concerning induced abortion has been conducted in Pakistan. Demographic surveys in Pakistan suffers in collecting the quality information on abortion because women are unlikely to report their abortion experiences when questioned directly in face-to-face interviews, particularly where the abortion is prohibited by law or because the safe abortion services are inaccessible or because the cost of induced abortion is not affordable. In addition, the quality of estimates using abortion statistics depends on the completeness of abortions reported and recorded. Selective omissions from the reproductive birth histories of women are potentially the serious data quality issues. For example, in 2006-07 Pakistan Demographic and Health Survey only 2 per cent of the sampled women had said they had an abortion. Therefore, by following the quality and quantity issue of abortion data at national scope in Pakistan, the contribution of abortion index taken with care.

5.5.4 Index of postpartum infecundability (Ci)

The index is designed to describe the effect of extended periods of postpartum infecundability caused by breastfeeding or postpartum abstinence and is the ratio of total natural fertility to total fecundity. The index value varies inversely with the average duration of postpartum infecundability denoted by 'i' in the index formula (see equation 7: section 5.3). Average duration of breastfeeding in months is needed to compute the value of 'i'. Because the practice of breastfeeding has an inhibitory effect on ovulation and thus increases the birth interval and reduces the natural marital fertility. The use of mean duration is preferred although some have used the median duration of breastfeeding for a variety of reasons. For example, DHS data produce distributions of duration of breastfeeding that are highly skewed. Consequently, the median duration have been observed to be shorter than the mean duration with a variation of 1.5 to 2 months and the other reason of preferring mean duration is based on the mathematical structuring (indexes are expressed as proportion) of the proximate determinant model indexes (Stover 1998).

Consequently, I have used the mean duration of breastfeeding using the current status data. Mean duration of postpartum infecundability (MPPI) using the duration of breastfeeding have been calculated for the seven geographic entities and are shown in Table 5.5. Among all geographic stratums the calculated values for the MPPI reaches a maximum of 14.22 months in 1990 for rural resident women and a minimum of 10.60 in 1990 for urban resident women (Table 5.5). The gap in MPPI values since 1970s has not been significant. The MPPI values for period earlier than 1990s are 12.65 (for period 1975) and 12.41 (for period 1984) months which fall in the range between 10.60 and 14.22 months. The value of MPPI has not much changed in Pakistan since 1970s.

Table 5.6 presents the estimated values of index of postpartum infecundability across all regions. For total women, postpartum infecundability reduce the total fecundity rate by 34% (C_i=0.661) in 2006. For the period 1990 to 2006, a marginal increase in the index value (1.10 percentage point) is observed. Across all seven geographic stratums the greatest effect of postpartum infecundability is observed in case of rural resident women in 1990. The index value (0.611) shows that the total fecundity (physiological capacity to bear children) is supressed by 39%. It is interesting to note that the postpartum infecundability index presents the same level in 2006 for total, urban and rural resident women (index value=0.661).

For total women, the results indicate that the index of postpartum infecundability contributed only 1.69% decline in reducing TFR (14.69%) due to shortening of the duration of breastfeeding during the period 1990 to 2000 (Table 5.7).

Overall, the index of postpartum infecundability demonstrated an increasing trend for women in total, rural and Punjab since 1990s. In urban strata since 1990s, a clear declining trend in breastfeeding is observed. The breastfeeding decline in urban areas is 4 per cent in magnitude for the period 1990 to 2006.

5.6 Role of fertility inhibiting determinants in Pakistan, 1990-2006

To assess more precisely the relative importance of fertility inhibiting determinants of fertility, the following logarithmic transformation was used:

$$\log(C_m \times C_c \times C_a \times C_i) = \log C_m + \log C_c + \log C_a + \log C_i \qquad (1)$$

Addition to the expression shown in equation (1) the contribution of each of the four determinants could be explained in percentage points by using the following proportions.

$$Marriage = \left[\frac{\log C_m}{\log C_m + \log C_c + \log C_a + \log C_i} \right] \qquad (2)$$

$$Contraception = \left[\frac{\log C_c}{\log C_m + \log C_c + \log C_a + \log C_i} \right] \qquad (3)$$

$$Abortion = \left[\frac{\log C_a}{\log C_m + \log C_c + \log C_a + \log C_i} \right] \qquad (4)$$

$$Infecundability = \left[\frac{\log C_i}{\log C_m + \log C_c + \log C_a + \log C_i} \right] \qquad (5)$$

In addition to the equation (2) through (5); absolute contribution of each of the four determinants of fertility could be explained by using the following expression.

$$Marriage = \left[\frac{\log C_m}{\log C_m + \log C_c + \log C_a + \log C_i} \right] \times (TF - TFR) \qquad (6)$$

$$Contraception = \left[\frac{\log C_c}{\log C_m + \log C_c + \log C_a + \log C_i} \right] \times (TF - TFR) \qquad (7)$$

$$Abortion = \left[\frac{\log C_a}{\log C_m + \log C_c + \log C_a + \log C_i} \right] \times (TF - TFR) \qquad (8)$$

$$Infecundability = \left[\frac{\log C_i}{\log C_m + \log C_c + \log C_a + \log C_i} \right] \times (TF - TFR) \qquad (9)$$

At the national level for total women, postpartum infecundability (C_i) and marriage (C_m) contribute the most to explain the fertility level observed in Pakistan in 1990 (Figure 5.3). In addition postpartum infecundability was the most important (rank first) fertility inhibiting determinant and contributes 47.3% to the reduction in the fertility levels. Pakistani marriage pattern is the next factor contributing to the slow paced fertility decline, accounting for 39.5%. Over the subsequent 16 years the index of proportion married became more substantial when compared to postpartum infecundability particularly after year 2000. Despite the impact of postpartum infecundability and marriage in the fertility decline between 1990 and 2006, the importance of contraception in increasing the length of birth intervals emerged as important fertility-inhibiting determinant from 2000.

The contribution of the three main fertility inhibiting determinants (postpartum infecundability, marriage and contraception) across all seven geographic stratums in Pakistan has been shown in Figure 5.3 through Figure 5.4. The geographical pattern suggests that postpartum infecundability and marriage played the main role as fertility inhibiting factors however, practice of contraception over time turned out to be other key fertility inhibiting determinant in urban areas and Punjab during the second half of 1990s.

For example in case of urban women in 1990, the practice of contraception contributed to reduce the total fecundity (total fecundity rate of 13.0 children per Pakistani women) by 2.4 children per woman. The contribution of contraception increased significantly in the next 10 years, and in 2000 it contributed to decrease fertility from its theoretical maximum (TF=15.3) by more than 4 children per woman (4.2) (Figure 5.4a). Then within the next 6 years (from 2000 to 2006), the contribution of contraception expressed in terms of percentage points reduces 33.2% of fertility levels in 2006 (contributes to decrease TF by 4.4 children per woman). Finally regarding urban areas it could be said that the fertility inhibiting effect of contraception in terms of children per woman (or percentage point) was doubled when compared to contribution observed in 1990.

The final approach to examine the role of three proximate determinant of fertility in terms of absolute changes in the difference between total fecundity and total fertility rate (TF-TFR) per woman is used. Table 5.8 presents the absolute changes in (TF-TFR) in connection with the contribution made by the marriage pattern, contraceptive practice and breastfeeding behaviours since 1990s. The values shown in Table 5.8 (column 2 through 4) have been calculated by using equations (6)-(9). For example between 1990 and 2006 for total population, the contribution of contraception and marriage index is seen to be greatest. In terms of absolute change of fertility inhibiting determinants, contraception and marriage played a significant role between 1990 and 2006.

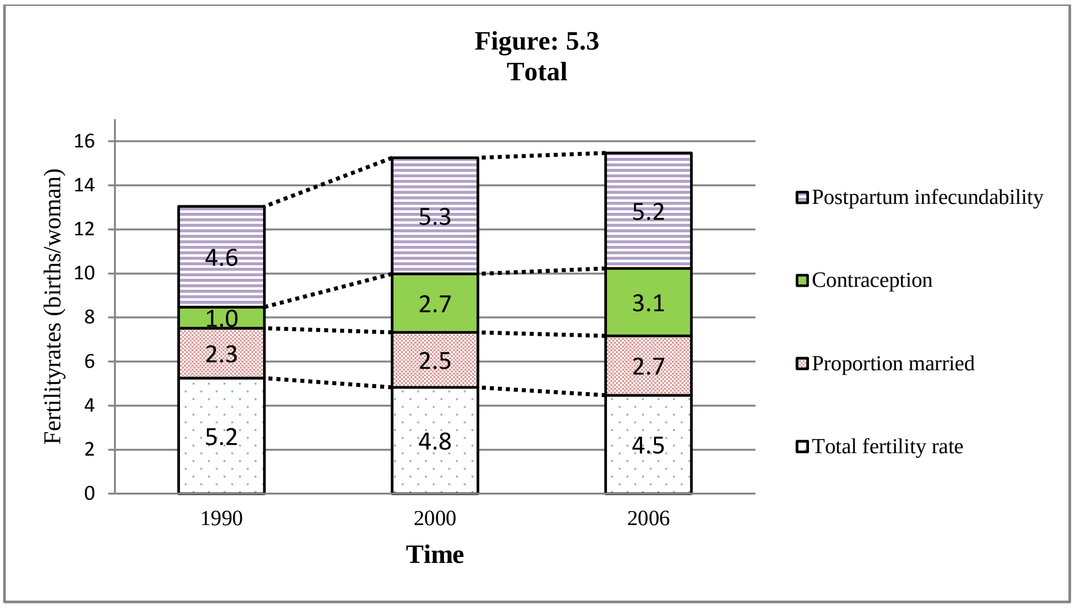


Figure 5.3: Changing contribution of the fertility-inhibiting determinants to the Pakistani fertility decline, 1990, 2000 and 2006

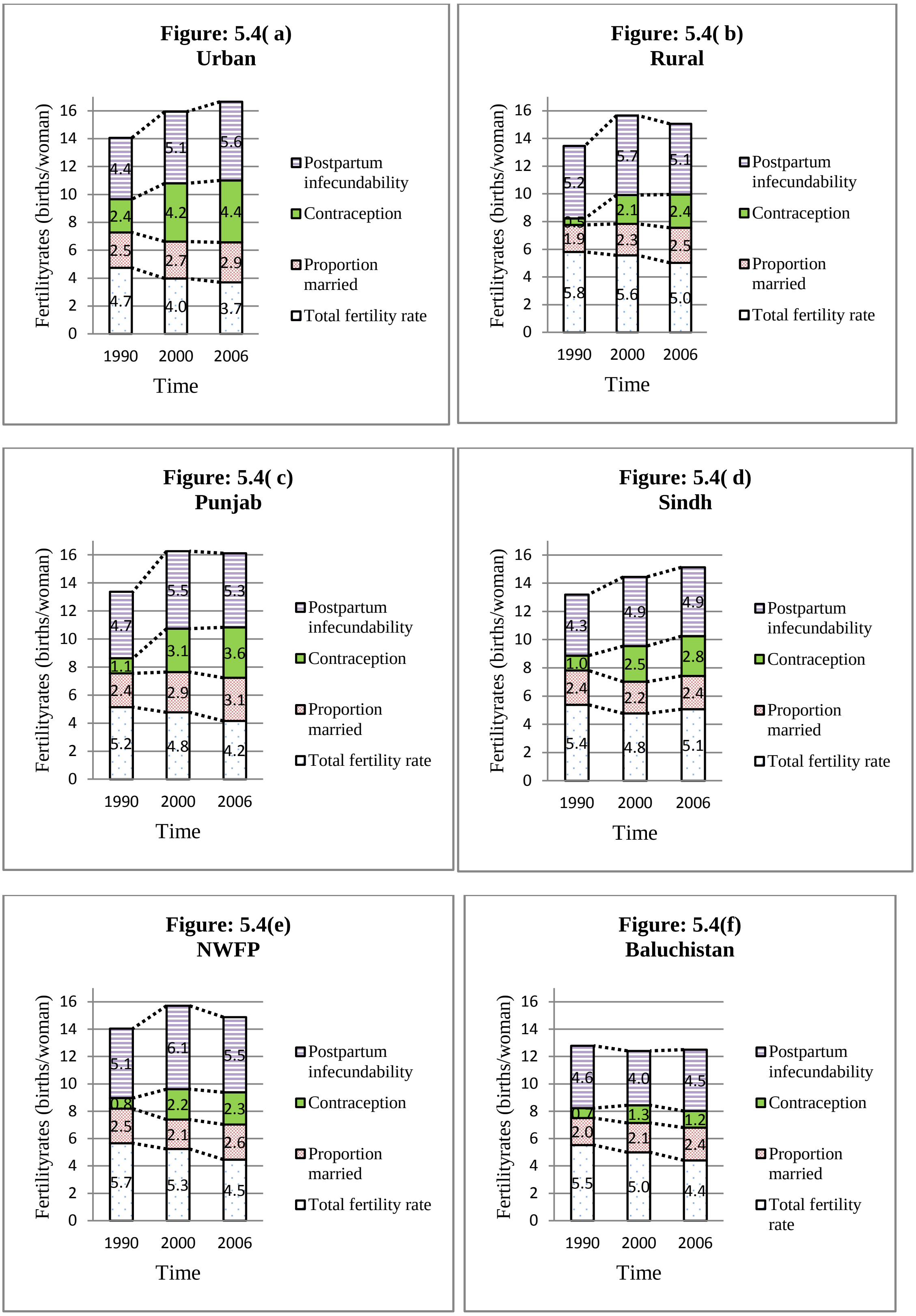


Figure 5.4: Changing contribution of the fertility-inhibiting determinants to the Pakistani fertility decline in different geographic entities, 1990, 2000 and 2006

Table 5.8: Absolute effect on fertility in connection with fertility inhibiting determinants in Pakistan, 1990, 2000 and 2006

Time Contribution	Marriage	Contraception	Postpartum infecundability	TF-TFR
Total				
1990	3.1	1.0	3.7	7.8
2000	3.8	2.8	3.8	10.4
2006	4.2	3.0	3.7	11.0
Change 1990-2006	1.1	2.0	0.0	3.2
Place of residence				
Urban				
1990	3.7	2.4	3.2	9.3
2000	4.4	4.1	3.3	12.0
2006	4.9	4.3	3.6	13.0
Change 1990-2006	1.2	1.9	0.4	3.7
Rural				
1990	2.6	0.5	4.5	7.7
2000	3.4	2.2	4.5	10.1
2006	3.7	2.4	3.8	10.0
Change 1990-2006	1.1	1.9	-0.7	2.3
Region/province				
Punjab				
1990	3.3	1.1	3.8	8.2
2000	4.4	3.1	3.9	11.5
2006	4.9	3.4	3.5	12.0
Change 1990-2006	1.6	2.3	-0.3	3.8
Sindh				
1990	3.2	1.1	3.5	7.8
2000	3.4	2.7	3.6	9.7
2006	3.5	2.8	3.6	10.1
Change 1990-2006	0.3	1.7	0.1	2.3
NWFP/Khyber				
1990	3.4	0.8	4.1	8.4
2000	3.3	2.5	4.7	10.5
2006	3.9	2.3	4.0	10.4
Change 1990-2006	0.5	1.5	-0.1	2.0
Baluchistan				
1990	2.6	0.8	3.8	7.3
2000	2.9	1.4	3.1	7.4
2006	3.4	1.2	3.5	8.1
Change 1990-2006	0.8	0.4	-0.3	0.8

TF: Total fecundity (model estimate)
TFR: Total fertility rate (model estimate)

The absolute change in Baluchistan is interesting to note: marriage effect is greatest followed by contraception to reduce the fertility in Pakistan between 1990 and 2006.

5.7 Summary of fertility inhibiting determinants

This chapter has used the non-age specific model of fertility inhibiting determinants to analyze Pakistani slow paced fertility change between 1990 and 2006. In the Pakistani context it is important to understand explicitly the role of proximate determinants. The fertility inhibiting indices show that within first 10 years during 1990 through 2006, contraception has the greatest fertility reducing effect and marriage is seen to be the other most important fertility reducing factor; after year 2000 the reverse is true (marriage pattern has the highest fertility reducing effect). From the analysis presented in this chapter, it could be inferred that contraception has the significant effect across all geographic stratums; only exception is Baluchistan. Marriage patterns are on the front to reduce the fertility levels in urban areas and those living in Punjab. In addition two results are very interesting in this chapter. First, in general the effect of contraception despite low prevalence rates across all entities could not be ignored whereas the effect of contraception emerged as the second most important fertility inhibiting determinant in urban population between 2000 and 2006 accounting for 34.5% and 33.2% reduction of natural fertility relative to marital fertility respectively. The second interesting result is that: during the period 2006 in Punjab, first main determinant to reduce fertility is marriage but the second main determinant to reduce fertility is hard to quantify. Both postpartum infecundability and contraceptive use are equally available to declare as the second most important fertility reducing factor. Postpartum infecundability index accounts for a 29.4% decrease in total fecundity rate and marriage index accounts for a 28.4% decrease to reduce the actual fertility levels. The only 1 percentage point difference between the two fertility inhibiting determinants (postpartum infecundability and marriage) might not truly quantify the second most important determinant of fertility reduction.

In summary, at one side the explicit analysis of fertility inhibiting determinants in this chapter reveals that marriage and contraception are the two most important determinants, whereas; on the other side fertility inhibiting effect of postpartum infecundability could not be ignored despite its little change in index value over time due to social norms set among Pakistani women. Consequently, there is a further need to investigate these main determinants through different approaches. Previous population research in Pakistan has mainly focused on the age at first marriage and this is really the case of interest for researchers when it is proved as a main fertility inhibiting determinant. This study also focuses on the issue in a different manner. For example in Pakistani context it could safely be assumed that childbearing occurred with the marriage. This assumption could be true for a variety of cultural and religious norms set in Pakistani society. It is also true that first visible outcome of the fertility process in the birth of the first child. The timing of this event is measured by the mother's age commonly known as mother age at first birth. The next chapter (Chapter 6) aims to focus on two issues: age at first marriage, and the timing of first parenthood including the timing of first conception in Pakistan. Therefore Chapter 6 of dissertation aims to investigate the important determinants of age at first marriage and age at first conception in Pakistan.

6 AGE AT FIRST MARRIAGE AND BIRTH IN PAKISTAN

6.1 Introduction

This chapter presents the results as well as statistical techniques for the analysis of age at first marriage and childbearing in Pakistan since 1990s. Age at first birth could be traced through the descriptive analysis of average age of married women at her first birth. Section 6.3 describes the age at first marriage (AFM) and age at first birth (AFB) in the country as a whole along with geographical subdivides. Mean number of children ever born (CEB) by the AFB is also presented in this section. Various other characteristics that influence the timing of marriage in Pakistan are also presented in section 6.3. The conceptual framework for multivariate modeling age at first marriage is presented in section 6.4. Section 6.5 examines the importance of time-independent factors that are related to age at first marriage among currently married women in Pakistan. Waiting time to first conception is the main even of interest after modeling AFM. Section 6.6 explains statistical techniques for waiting time analysis. Section 6.7 present the application of multivariate statistical models of waiting time to first conception in Pakistan, and then chapter ends up with concluding remarks in section 6.8.

6.2 Background of 2000-01 PRHFPS: a data limitation

Pakistan being the signatory of 1994 International Conference on Population and Development (ICPD) has agreed to adopt the reproductive health program in its national population policy. Pakistan Reproductive Health and Family Planning Survey (2000-01 PRHFPS) was the first survey which addressed the issue of reproductive health within family planning programs. In addition to reproductive health, the raising of women's status was also agreed in as part of the ICPD proceedings. Following PRHFPS, another survey namely 'Status of Women, Reproductive Health and Family Planning Survey' (SWRHFPS) was held between March and October 2003. This was another major survey which combines reproductive health and women's empowerment with family planning program of Pakistan. During 1990 to 2006, the four surveys (1990-91 PDHS, 2000-01 PRHFPS, 2003 SWRHFPS, and 2006-07 PDHS) share a similar methodology in terms of survey design and its implementation and the surveys were coordinated by the National Institute of Population Studies (NIPS), Islamabad, Pakistan. The main interest in this chapter is to assess the mother's age at first birth and subsequently the correlates of age at first conception (AFC) for different cross sectional surveys; ultimately there is a need to have data covering the complete birth history of ever-married women. The birth history information collected in both 2000-01 PRHFPS and 2003 SWRHFPS was limited to last three live births which make the 2000-01 PRHFPS inappropriate for the analysis of the present chapter. Also, the analyses of AFB and AFC analysis has remained a neglected dimension of population research in Pakistan. Birth history data from the 1990-91 PDHS and 2006-07 have been used for the analysis.

Box 3: Age misreporting and age at first marriage
There is a strong dire for the accurate information on two variables for the analysis presented in this chapter: age at first marriage and age at first conception. In traditional societies like Pakistan where contraceptive use is low, age at first marriage is the conventional marker for the beginning of exposure to the risk of pregnancy. By following DHS guidelines there are three remedies to overcome and assess the extent of errors in the reporting of date of first marriage and first birth (Institue for Resource Development 1990): for example checking the reporting of dates using indicators of age heaping, internal checks of consistency, and comparison of DHS data with other surveys. Chapter 4 has already addressed the issue of age misreporting. The distortions in age misreporting found in chapter four suggest that sampled women may provide a best guess of their date of first marriage and this is hypothesised for the analysis of age at first marriage presented in this chapter. However, the limitations of the results of this analysis should be considered on paying attention to the effect of age misreporting .

6.3 Woman's age at first marriage and birth: descriptive analysis

Marriage and birth are the main family events within the individual life course. The timing of both events (marriage and first birth) is measured by the woman's age at first marriage and age at first birth. It is well known fact that first birth is the first step in the childbearing process and has a strong effect on the level of fertility, yet it is also associated with age at marriage. In societies where pre-marital sex is uncommon, marriage is presumed to be the only exposure to the risk of fertility. Pakistan could generally be assumed one such society where initiations of fertility occur within marriage. The analysis in this section is based on currently-married women born in the period 1941-1965 (1990-91 PDHS) and 1957-1981 (2006-07 PDHS). Table 6.1 shows mean ages at first marriage and first birth among currently married Pakistani women aged 25-49 since 1990s. In Table 6.1, together with mean age at first marriage and first birth, Pearson correlation coefficients between AFM and AFB for the total and six major geographic stratums are also presented. As expected, the correlation between AFM and AFB is positive and highly significant ($p^{***} < 0.001$ $p^{**} < 0.01$) across all geographic regions.
In 2006, Sindhi women married on average about one and half years to two years earlier than women from other geographic regions. The first birth interval (duration after marriage to first birth) of Sindhi and Baluchi women in 2006 is 30 months against 24 months among women from Punjab and NWFP. In 1990, the first birth interval of Pakthoon (NWFP) women is 19 months which increased to about 25 months during the next 16 years (Table 6.1). The duration from marriage to first birth among Pakthoon women is minimum (19 months) in 1990 when compared to other geographic regions. These figures suggest that immediate childbearing after marriage in NWFP is more likely to be planned than the women from other regions. In 2006, the duration from marriage to first birth reaches a maximum of about 31 months (Baluchistan) to a minimum of 24 months (Punjab). The Punjab – NWFP difference of one month in mean AFM is increased to three months in the mean AFB.

In addition, mean age at first marriage and birth are compared for five different five year birth cohorts of women: aged 45-49, 40-44, 35-39, 30-34, and 25-29 at the time of survey. The mid-points of these cohorts are shown on the horizontal axis of Figure 6.1through Figure 6.2: those who born in 1943 (aged 45-49 years at the time of 1990 survey), 1948, 1953, 1958, 1963, 1969, 1974 (aged 15-19 years at the time of 1990 survey; aged 30-34 years at the time of 2006 survey) and 1979. Figure 6.1 through Figure 6.2 also shows plots of mean age at first marriage and at first birth for these birth cohorts of women in seven geographic stratums. A first glance on these plots indicates an identifiable (not very strong) selection bias; however, as evident from Table 6.1 correlation between AFM and AFB is high and positive. Together with correlation coefficients the estimates of AFM and AFM for 1990 and 2006 data are shown in appendix (Appendix E: Table E1 & E2). Between 1990 and 2006 for total sample, the difference in mean AFM increased about 11 months (0.89 year) of the first young age group (25-29). For the same period and same cohort the difference in mean AFB increased to 13 months (Figure 6.1 a). As expected, mean AFM for urban women increased by about 15 months and their mean AFB increased by about 16 months from 1990 to 2006 for 25-29 year age cohort. Baluchistan has shown a substantial increase in both mean AFM and AFB (Figure 6.2 f). For example women aged 30-34 years have married 18 months late in 2006 compared to those married in 1990. The likely reasons behind the variations in AFM and AFB from 1990 to 2006 could be explored through the associations of various factors affecting AFM and AFB. The issue is addressed through the multivariate statistical models shown in section 6.5 of this chapter.

Table 6.1: Mean age at first marriage (AFM) and age at first birth (AFB) for currently-married women aged 25-49: Pakistan, 1990 and 2006

Region & time	Sample size	Age at first marriage (Standard deviation)	sample size	Age at first birth (Standard deviation)	Correlation
Total					
1990	4946	18.24 (4.36)	4707	20.37 (4.30)	0.82**
2006	7477	18.68 (4.21)	7030	20.89 (4.21)	0.82**
Place of residence					
Urban					
1990	2579	18.40 (4.34)	2462	20.23 (4.24)	0.86**
2006	2958	19.07 (4.21)	2781	21.07 (4.10)	0.84**
Rural					
1990	2367	18.06 (4.37)	2245	20.51 (4.37)	0.79**
2006	4519	18.42 (4.20)	4249	20.77 (4.28)	0.81**
Region/province					
Punjab					
1990	1663	18.86 (4.25)	1571	20.82 (4.21)	0.87**
2006	3285	19.23 (4.29)	3078	21.22 (4.18)	0.86**
Sindh					
1990	1361	17.20 (4.17)	1309	19.98 (4.20)	0.70**
2006	1928	17.83 (3.78)	1824	20.36 (4.03)	0.73**
NWFP/Khyber					
1990	1247	18.79 (4.53)	1182	20.41 (4.49)	0.91**
2006	1349	18.26 (4.19)	1281	20.30 (4.07)	0.86**
Baluchistan					
1990	675	17.77 (4.24)	645	19.97 (4.27)	0.74**
2006	915	19.11 (4.48)	847	21.72 (4.55)	0.79**

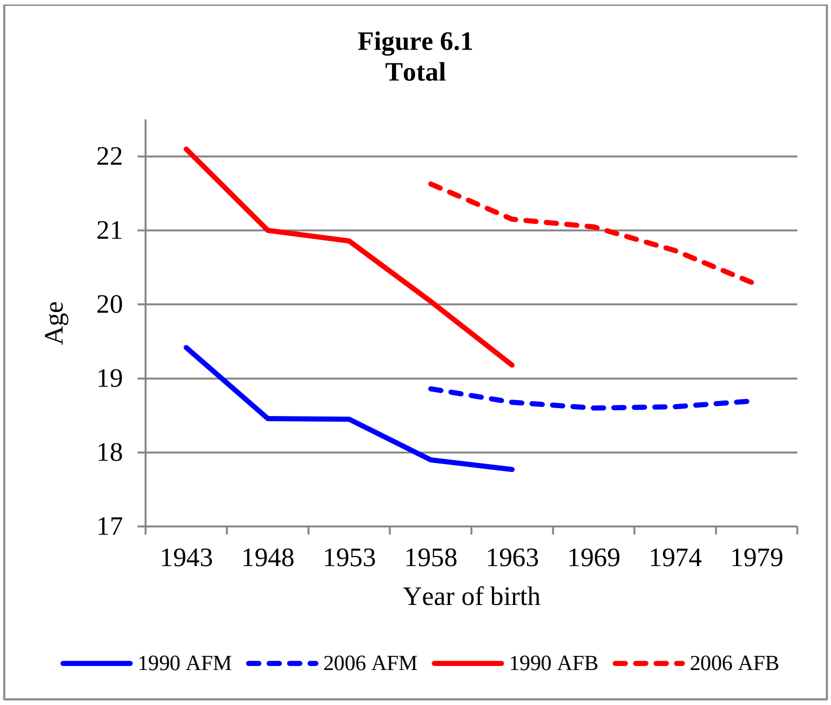


Figure 6.1: mean age at first marriage (AFM) and at first birth (AFB) for various birth cohorts of Pakistani currently-married women, 1990 and 2006

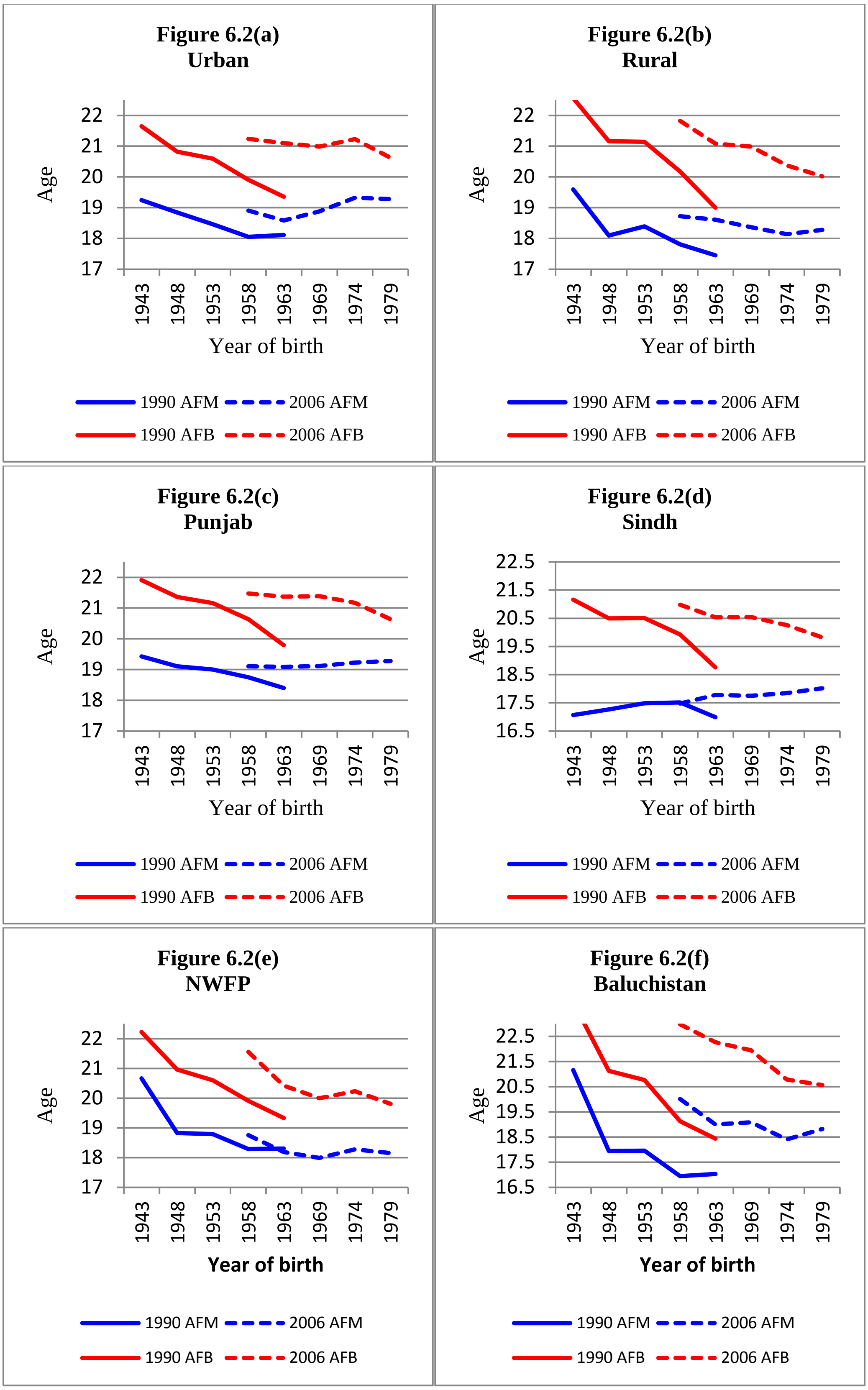


Figure 6.2: Mean age at first marriage (AFM) and at first birth (AFB) for various birth cohorts of currently married women in different geographic regions of Pakistan, 1990 and 2006

6.3.1 Age at first birth and mean number of children ever born

Table 6.2 presents the mean number of children ever born to women (aged at interview 25-49) by various ages at first birth (exact ages 15 through 24). This is done separately for two surveys (1990 PDHS and 2006 PDHS). As a whole the relation between AFB and cumulative fertility is visible from Table 6.2: as AFB increases mean number of children ever born decreases across all geographic regions. A detailed cohort wise comparison of mean number of children ever born with age at first birth for 2006 PDHS is shown in Table 6.3. For the 1990 PDHS, the table with similar information is provided in appendix (Appendix E: Table E3). The cohort wise pattern of AFB with mean number of children ever born also shows an inverse relationship: as age at first birth increased the mean number of children ever born showed a decrease. For example, the oldest group of women (45-49: born 1957-61) who had almost completed their fertility at the time of 2006 survey the relation of AFB to subsequent fertility is apparent: those who had first birth at exact age 17 years had mean number of 7.89 children ever born, while who had first birth at exact age 24 years had 6.49 children. In summary, the higher AFB reduces the number of children ever born in the other categories of age (Table 6.3). It is expected that the relation between AFB and mean number of children ever born would be inverse for other cohorts 25-29, 30-34, 35-39 because they have not completed their fertility and has additional years of reproductive life left. However, rural resident women have higher mean number of children ever born with respect to AFB than urban women. Overall, a decline in mean number of children ever born with AFB between 1990 and 2006 is observed across all geographic entities.

Table 6.2: Average number of children ever born (with sample size) by age at first birth for currently-married women aged 25-49: Pakistan, 1990 and 2006

Time	Age at first birth (year)									
	≤ 15	16	17	18	19	20	21	22	23	24
	Total									
1990	6.94 (531)	5.94 (314)	5.78 (418)	5.82 (491)	5.53 (452)	5.16 (429)	4.90 (374)	4.73 (5.00)	4.40 (294)	4.18 (277)
2006	6.48 (524)	6.35 (450)	6.08 (535)	5.81 (657)	5.51 (716)	5.23 (723)	4.72 (661)	4.43 (574)	4.34 (504)	3.86 (381)
	Urban									
1990	6.98 (281)	5.99 (177)	5.83 (226)	5.81 (260)	5.49 (243)	5.09 (241)	4.73 (185)	4.87 (191)	4.12 (153)	4.24 (133)
2006	6.52 (184)	6.05 (161)	5.86 (194)	5.70 (250)	5.10 (271)	4.82 (262)	4.29 (287)	4.09 (256)	3.90 (212)	3.72 (177)
	Rural									
1990	6.88 (250)	5.88 (137)	5.71 (192)	5.84 (231)	5.57 (209)	5.26 (188)	5.07 (189)	4.58 (184)	4.70 (141)	4.13 (144)
2006	6.46 (340)	6.51 (289)	6.20 (341)	5.88 (407)	5.76 (445)	5.46 (461)	5.05 (374)	4.70 (318)	4.66 (292)	3.99 (204)
	Punjab									
1990	6.90 (124)	5.96 (84)	5.66 (128)	5.95 (163)	5.49 (152)	5.23 (162)	4.99 (143)	4.78 (143)	4.58 (106)	4.40 (88)
2006	6.65 (197)	6.16 (174)	6.03 (195)	5.76 (266)	5.38 (325)	5.12 (309)	4.63 (286)	4.25 (281)	4.21 (234)	3.74 (172)
	Sindh									
1990	7.10 (177)	6.16 (98)	5.83 (124)	5.82 (142)	5.37 (123)	5.30 (117)	4.75 (99)	4.85 (89)	4.49 (79)	3.99 (79)
2006	6.44 (148)	6.87 (143)	5.99 (183)	5.74 (190)	5.58 (195)	5.01 (170)	4.71 (171)	4.62 (136)	4.29 (127)	3.91 (86)
	NWFP									
1990	7.06 (154)	6.01 (71)	5.79 (5.79)	5.91 (114)	5.96 (113)	4.80 (82)	5.08 (91)	4.75 (99)	4.13 (69)	4.19 (73)
2006	6.50 (133)	6.38 (88)	6.16 (108)	6.15 (130)	5.81 (134)	5.47 (139)	4.98 (127)	4.75 (83)	4.51 (85)	4.06 (67)
	Baluchistan									
1990	6.37 (76)	5.48 (61)	5.88 (56)	5.40 (72)	5.17 (64)	5.21 (68)	4.59 (41)	4.27 (44)	4.20 (40)	4.05 (37)
2006	5.85 (48)	5.33 (45)	6.43 (49)	5.56 (71)	5.34 (62)	5.59 (105)	4.66 (77)	4.42 (74)	4.71 (58)	3.95 (56)

Table 6.3: Average number of children ever born by age at first birth for various birth cohorts of Pakistani currently-women (2006-07 Pakistan Demographic and Health Survey)

Birth cohort (Age at interview)	Age at first birth									
	≤15	16	17	18	19	20	21	22	23	24
	Total									
1957-61 (45-49)	7.41	8.24	7.89	7.74	7.42	7.49	6.81	6.78	6.21	6.49
1962-66 (40-44)	7.48	7.66	7.28	7.14	6.92	6.13	6.21	6.06	6.32	5.22
1967-71 (38-39)	6.98	6.69	6.51	6.66	6.06	5.90	5.46	5.07	4.85	4.80
1972-76 (30-34)	6.30	6.25	5.64	5.51	5.10	4.55	4.32	3.75	3.73	2.96
1977-81 (25-29)	5.06	4.44	4.40	3.91	3.44	3.15	2.76	2.31	2.10	1.67
	Urban									
1957-61 (45-49)	7.31	8.00	8.11	7.73	6.59	6.92	6.11	6.03	5.60	6.14
1962-66 (40-44)	7.03	7.52	6.90	6.45	6.15	6.00	5.95	5.41	5.30	4.75
1967-71 (38-39)	6.85	6.20	5.97	6.30	5.63	5.22	4.84	4.61	4.66	4.25
1972-76 (30-34)	6.03	5.83	5.20	5.40	4.67	4.18	3.99	3.45	3.51	2.94
1977-81 (25-29)	5.37	4.38	4.15	3.70	3.33	2.90	2.71	2.36	2.09	1.75
	Rural									
1957-61 (45-49)	7.49	8.38	7.77	7.76	7.97	7.74	7.25	7.43	6.56	6.88
1962-66 (40-44)	7.83	7.72	7.65	7.63	7.41	6.23	6.37	6.60	6.96	5.65
1967-71 (38-39)	7.07	7.04	6.75	6.88	6.36	6.29	5.94	5.42	5.00	5.21
1972-76 (30-34)	6.40	6.46	5.88	5.57	5.34	4.82	4.59	4.03	3.88	2.98
1977-81 (25-29)	4.93	4.47	4.53	4.01	3.51	3.27	2.81	2.26	2.12	1.60
	Punjab									
1957-61 (45-49)	7.63	7.68	7.28	7.76	7.21	6.89	6.18	6.23	6.43	6.54
1962-66 (40-44)	7.83	7.03	6.97	6.38	6.62	5.70	5.79	5.46	5.40	4.71
1967-71 (38-39)	7.08	5.76	6.59	6.59	5.42	5.60	5.38	4.69	4.89	4.86
1972-76 (30-34)	6.11	6.48	5.29	5.49	4.95	4.75	4.37	3.88	3.75	2.72
1977-81 (25-29)	5.10	4.84	4.22	3.88	3.57	3.26	2.69	2.31	2.07	1.65
	Sindh									
1957-61 (45-49)	7.43	8.83	7.91	8.52	8.26	8.54	7.28	8.19	6.06	6.19
1962-66 (40-44)	7.22	7.88	7.37	7.18	7.43	5.50	6.15	6.85	6.74	5.42
1967-71 (38-39)	7.29	7.92	6.32	6.78	6.26	6.00	5.41	5.07	4.50	4.53
1972-76 (30-34)	5.97	6.57	5.70	5.23	5.14	4.37	4.13	3.68	3.55	3.65
1977-81 (25-29)	5.10	4.52	4.46	3.97	3.47	3.21	2.92	2.34	2.13	1.62
	NWFP									
1957-61 (45-49)	7.50	N.A*	N.A*	7.21	7.50	7.91	6.76	7.38	6.29	7.07
1962-66 (40-44)	7.82	8.65	7.69	8.43	7.32	6.83	7.12	6.20	7.64	5.50
1967-71 (38-39)	6.83	6.91	6.41	6.58	7.23	6.03	5.52	5.84	4.80	4.71
1972-76 (30-34)	6.71	5.76	5.85	6.04	5.21	4.66	4.76	3.76	3.76	2.82
1977-81 (25-29)	4.91	3.83	4.57	3.66	3.41	2.94	2.95	2.54	2.08	1.67
	Baluchistan									
1957-61 (45-49)	N.A*	N.A*	N.A*	N.A*	6.45	7.43	N.A*	5.90	5.70	6.00
1962-66 (40-44)	N.A*	N.A*	N.A*	N.A*	6.69	7.44	6.55	7.10	7.38	6.22
1967-71 (38-39)	6.10	N.A*	7.10	6.88	N.A*	6.44	5.79	5.55	5.43	5.11
1972-76 (30-34)	6.40	4.73	6.07	5.60	5.64	4.00	3.94	3.22	4.00	2.78
1977-81 (25-29)	5.14	4.12	4.36	4.11	2.81	2.92	2.42	2.00	2.23	1.79

N.A: stands for not applicable for estimation (less than 10 cases)

6.3.2 Age at first marriage and mean age first birth

Table 6.4 presents mean AFB of women (aged at interview 25-49) by various AFM (exact ages 15 through 24). It is quite obvious that as AFM increases, AFB would also increases. The difference between AFM and mean AFB steadily increases as the AFM increases. For example, the difference is greatest in Baluchistan. At older ages no systematic variation is observed in mean duration between AFM and AFB, instead some increase is observed at younger ages. A detailed cohort wise comparison of average AFB with AFM for 2006 PDHS is shown in Table 6.5. For 1990 PDHS, the table with similar information as produced in Table 7.3A is provided in Appendix (Appendix E: Table E4). For Baluchistan in 2006, the oldest cohort of women (born: 1957-61) who had almost completed their fertility has the greatest difference (AFM and mean AFB) as AFM increases than other geographic entities.

Table 6.4: Mean age at first birth for currently-married women aged 25-49 by age at first marriage in Pakistan, 1990 and 2006

Time	Age at first marriage (year)									
	≤15	16	17	18	19	20	21	22	23	24
	Total									
1990	16.93 (1467)	18.35 (455)	19.09 (413)	19.88 (457)	20.90 (339)	22.11 (405)	22.50 (238)	23.70 (254)	24.51 (181)	25.57 (157)
2006	17.31 (1773)	18.64 (756)	19.31 (693)	20.39 (769)	21.16 (615)	22.01 (593)	22.88 (389)	23.91 (334)	24.85 (272)	25.76 (267)
	Urban									
1990	16.58 (720)	18.03 (236)	18.86 (223)	19.70 (249)	20.77 (203)	21.91 (202)	22.45 (138)	23.51 (125)	24.39 (93)	25.54 (96)
2006	17.14 (596)	18.49 (265)	19.21 (270)	20.24 (300)	21.16 (261)	21.84 (250)	22.66 (185)	23.67 (159)	24.64 (128)	25.73 (124)
	Rural									
1990	17.27 (747)	18.69 (219)	19.35 (190)	20.08 (208)	21.10 (136)	22.31 (203)	22.57 (100)	23.88 (129)	24.64 (88)	25.62 (61)
2006	17.40 (1177)	18.72 (491)	19.37 (423)	20.49 (469)	21.15 (354)	22.13 (343)	23.08 (204)	24.13 (175)	25.04 (144)	25.78 (143)
	Punjab									
1990	16.75 (369)	18.65 (158)	19.07 (146)	20.05 (179)	21.02 (133)	21.90 (144)	22.47 (92)	23.77 (96)	24.62 (60)	25.68 (62)
2006	16.99 (631)	18.70 (306)	19.23 (301)	20.31 (342)	21.07 (274)	21.94 (259)	22.79 (208)	23.83 (174)	24.74 (129)	25.79 (144)
	Sindh									
1990	17.62 (559)	18.53 (106)	19.19 (104)	19.91 (113)	20.95 (91)	22.51 (94)	22.42 (52)	23.98 (56)	24.40 (42)	25.67 (30)
2006	17.73 (564)	18.67 (249)	19.35 (206)	20.68 (186)	21.23 (142)	22.12 (143)	22.85 (68)	23.92 (72)	24.73 (52)	25.81 (54)
	NWFP									
1990	15.85 (320)	18.02 (119)	18.82 (95)	19.61 (101)	20.78 (82)	21.92 (111)	22.62 (66)	23.37 (76)	24.65 (49)	25.39 (51)
2006	16.63 (370)	18.42 (132)	19.42 (121)	19.84 (140)	21.02 (124)	21.88 (108)	22.90 (70)	24.03 (37)	25.10 (51)	25.54 (39)
	Baluchistan									
1990	17.06 (219)	17.96 (72)	19.34 (68)	19.73 (64)	20.64 (33)	22.34 (56)	22.46 (28)	23.81 (26)	24.20 (30)	25.57 (14)
2006	18.38 (208)	18.72 (69)	19.32 (65)	20.91 (101)	21.55 (75)	22.18 (83)	23.37 (43)	24.10 (51)	25.05 (40)	25.77 (30)

Table 6.5: Mean age at first birth for various birth cohorts of Pakistani ever-married women by age at first marriage (2006-07 Pakistan Demographic and Health Survey)

Birth cohort (Age at interview)	Age at first marriage									
	≤15	16	17	18	19	20	21	22	23	24
	Total									
1957-61 (45-49)	18.16	19.20	19.62	20.80	21.66	22.07	22.96	24.40	25.40	25.62
1962-66 (40-44)	17.35	19.19	19.30	20.40	21.24	22.17	23.02	24.45	25.24	26.58
1967-71 (38-39)	17.47	18.68	19.21	20.71	20.98	22.25	23.06	23.85	24.73	26.02
1972-76 (30-34)	17.09	18.39	19.44	20.15	21.27	21.85	22.78	23.64	24.84	25.60
1977-81 (25-29)	16.88	18.11	19.09	20.10	20.86	21.82	22.72	23.65	24.48	25.45
	Urban									
1957-61 (45-49)	17.10	19.00	19.92	20.29	21.88	21.97	22.81	24.41	25.29	25.84
1962-66 (40-44)	17.55	18.88	19.34	20.67	20.82	22.58	23.10	24.26	24.47	26.39
1967-71 (38-39)	17.06	18.83	18.88	20.67	20.98	21.92	22.88	23.42	24.32	25.52
1972-76 (30-34)	17.19	18.15	19.31	19.78	21.23	21.46	22.28	23.37	24.71	25.85
1977-81 (25-29)	16.81	17.91	18.87	19.84	21.03	21.70	22.51	23.37	24.61	25.37
	Rural									
1957-61 (45-49)	18.72	19.31	19.44	21.17	21.51	22.14	23.11	24.39	25.46	25.39
1962-66 (40-44)	17.20	19.38	19.25	20.24	21.60	21.97	22.94	24.67	25.90	26.80
1967-71 (38-39)	17.70	18.61	19.42	20.74	20.99	22.52	23.19	24.13	25.14	26.54
1972-76 (30-34)	17.05	18.50	19.52	20.33	21.31	22.19	23.27	23.97	24.96	25.44
1977-81 (25-29)	16.91	18.22	19.20	20.27	20.74	21.91	22.93	23.87	24.37	25.51
	Punjab									
1957-61 (45-49)	17.59	18.90	19.33	20.82	21.32	21.98	23.00	24.07	24.82	25.28
1962-66 (40-44)	16.71	19.09	19.24	19.97	21.25	22.12	23.13	24.66	24.71	27.00
1967-71 (38-39)	17.26	18.97	19.26	20.73	20.79	22.00	23.10	23.74	24.70	26.03
1972-76 (30-34)	16.79	18.30	19.26	20.14	21.38	21.92	22.43	23.51	24.91	25.47
1977-81 (25-29)	16.67	18.25	19.06	20.01	20.83	21.77	22.44	23.55	24.59	25.50
	Sindh									
1957-61 (45-49)	18.81	19.59	19.94	20.57	22.38	22.14	23.09	24.60	N.A*	N.A*
1962-66 (40-44)	17.65	19.34	19.58	20.90	21.68	22.33	22.83	23.33	N.A*	N.A*
1967-71 (38-39)	17.94	18.51	18.93	21.07	20.90	22.77	23.56	24.38	24.94	N.A*
1972-76 (30-34)	17.54	18.52	19.40	20.73	21.15	21.82	22.63	23.89	N.A*	25.73
1977-81 (25-29)	17.17	18.09	19.18	20.24	20.84	21.80	22.60	23.44	24.50	25.45
	NWFP									
1957-61 (45-49)	17.55	19.40	20.13	20.79	21.42	22.00	22.42	N.A*	26.09	N.A*
1962-66 (40-44)	17.04	19.00	18.53	19.52	21.05	21.93	22.75	N.A*	26.27	N.A*
1967-71 (38-39)	16.26	18.33	19.38	20.07	20.72	21.86	22.77	23.00	24.80	26.25
1972-76 (30-34)	16.55	17.85	19.96	19.35	21.27	21.86	23.69	23.43	24.36	25.70
1977-81 (25-29)	16.32	18.06	19.00	19.95	20.88	21.79	22.71	24.00	24.00	25.36
	Baluchistan									
1957-61 (45-49)	19.27	18.91	19.00	21.21	21.96	22.38	24.00	24.50	N.A*	N.A*
1962-66 (40-44)	19.17	N.A*	N.A*	21.80	N.A*	22.29	N.A*	N.A*	N.A*	N.A*
1967-71 (38-39)	19.22	18.93	19.32	20.70	22.18	22.82	22.80	23.60	N.A*	N.A*
1972-76 (30-34)	17.82	18.89	N.A*	20.79	N.A*	21.60	N.A*	23.80	N.A*	N.A*
1977-81 (25-29)	17.51	17.79	19.05	20.36	21.00	22.04	23.63	23.92	24.64	N.A*

N.A: stands for not applicable for estimation (less than 10 cases)

6.4 Conceptual framework for multivariate modelling

After descriptive analysis, a key question for analysis in this chapter is whether there seems any influence of social, economic, geographic and demographic variables on age at first marriage and the duration of first pregnancy interval. In other words, we aim to identify something about the relative contribution of socio-economic, geographic, and demographic variables to age at first marriage and first pregnancy interval length in Pakistan. In the list of these variables, we include respondent's birth cohort, place and province of residence, respondent level of education and respondents husband level of education, as previous research showed the effect of those variables on age of first marriage (Islam and Mahmud 1996, Minh 1997, Islam and Ahmed 1998, Palamuleni 2011). The same list of variables is retained for modeling duration of first conception. We also included whether a woman was working or not before marriage with a view of positive correlation between woman`s labor force participation and her age at first marriage. We also included another variable called ethnicity—it was identified on the basis of respondent`s mother language. The information of this variable was available in 2006 PDHS only; hence, multivariate models of age at first marriage using 2006 data will present this variable.

For duration time between first marriage and first conception, separate models are presented in this chapter. We included the age at first marriage variable together with a list of variables mentioned above to assess the relative contribution of these variables on waiting time to first conception. Two variables, ever worked before marriage and ethnicity were not included in modeling waiting time to first conception models instead respondent`s childhood place of residence is included. The information on respondent`s childhood place of residence was collected in 1990 survey, but no information was available in 2006 data. The first conceptions models using 1990 data will show this variable.

6.5 Modelling age at first marriage

The unit of analysis in this modeling are currently married women aged 15 to 49. The outcome variable is the AFM data from the 2006 PDHS and 1990 PDHS. In order to assess the simultaneous strength of selected covariates on AFM, multiple linear regression models are used because AFM is treated as a continuous variable. In addition, to determine the most highly significant variables associated with AFM, forward stepwise regression modeling is performed. After obtaining the basic model using only the regression constant, the most highly significant variable out of ten variables is included in the basic model. This model is called first stage model. After obtaining the first stage model, next most highly significant variable out of remaining nine variables is then included in the first stage model. It is a stage two model. This process is continued until the final model is obtained. It is interesting to note that seven out of ten time-independent variables are observed to be significantly associated with AFM in the final estimated models. These variables are: birth cohort, place of residence, province of residence, education status of respondent, ever worked before marriage, ethnicity and husband education. Birth cohort refers to the year the woman was born. Place of residence refers where the woman lived at the time of survey; this is categorized into urban and rural areas. Place of province refers the province of residence of woman; this is classified into Punjab, Sindh, NWFP and Baluchistan. Education of respondent refers to the level of completed education which is categorized into no education, primary (1-5 year schooling), secondary (6-10 year schooling) and higher education (11+ years). Ever worked before marriage refers to the woman's work exposure before marriage; this is categorized into yes and no response. Ethnicity of the respondent refers to the woman's belonging to ethnic origin based on woman's mother language; this is categorized into Punjabi speaking, Urdu, Sindhi, Pashto, Balochi, Barauhi, Saraiki, Hindko, and other. Husband education refers to the level of husband's education which is categorized into no education, primary, secondary and higher educated. A set of dummy variables for each covariate is included in analytical models.

6.5.1 Bivariate analysis of age at first marriage

This section presents the investigation of relationship between time independent covariates and outcome variable (AFM). For 2006 PDHS, probability values (P-values) of significant associations with degrees of freedom (df) are given with in parenthesis against each variable in Table 6.6. For 1990 PDHS, the table with similar information as produced in Table 6.6 is provided in Appendix (Appendix F: Table F1).

Of the 7264 currently married women aged 25-49 across five birth cohorts; more than 90 per cent are married by the age of 25 (Table 6.6). Mean age at first marriage for each birth cohort does not differ much from 18; however, birth cohort shows insignificant relationship with AFM. Province and place of residence are both significantly associated with AFM (see p-values). Mean age at first marriage in Punjab (19.27 years) and Baluchistan (19.15 years) are higher than other provinces.

Table 6.6: Percentage distribution of currently married women aged 25-49 by various characteristics with age at first marriage (2006-07 Pakistan Demographic and Health Survey)

Characteristics	Cumulative percentage married by exact age			No. of women	MAFM
	$\leq$15	20	25		
Birth cohort					
1957-61	23.7	71.2	91.0	1056	18.93
1962-66	25.2	72.9	92.4	1140	18.67
1967-71	23.9	73.0	92.7	1513	18.62
1972-76	26.2	71.0	91.8	1619	18.67
1977-81	21.8	69.0	95.8	1936	18.73
(F-statistic using ANOVA test = 0.97; P-value = 0.42; degrees of freedom = 7263)					
Place of residence					
Urban	20.2	66.9	92.6	2868	19.11
Rural	26.5	74.0	93.3	4396	18.45
(T-statistic = -6.57; P-value = 0.000; degrees of freedom = 7262)					
Province of residence					
Punjab	19.1	65.4	91.6	3175	19.27
Sindh	29.7	79.4	95.7	1868	17.88
NWFP	28.5	75.5	94.0	1326	18.26
Baluchistan	22.8	68.4	91.2	895	19.15
(F-statistic using ANOVA test = 52.26; P-value =0.000; degrees of freedom =7263)					
Education of respondent					
No	28.9	77.8	94.5	4903	18.08
Primary	21.4	71.7	93.5	899	18.72
Secondary	12.0	58.3	91.5	928	20.01
Higher	4.7	32.2	81.1	534	22.31
(F-statistic using ANOVA test = 214.46; P-value = 0.000; degrees of freedom = 7263)					
Ethnicity: mother language					
Punjabi	15.7	61.8	90.7	2380	19.68
Urdu	14.2	58.2	88.6	577	19.94
Sindhi	31.6	83.6	96.9	866	17.55
Pashto	26.3	72.0	92.0	1508	18.69
Balochi	30.3	80.0	97.2	390	17.84
Barauhi	35.7	78.6	95.4	112	17.78
Saraiki	33.7	83.2	96.2	911	17.43
Hindko	26.5	71.6	94.4	215	18.47
Other	31.8	79.7	96.7	305	17.78
(F-statistic using ANOVA test = 47.89; P-value = 0.000; degrees of freedom = 7263)					
Husband education					
No	30.8	78.5	94.9	2740	17.95
Primary	26.7	75.4	94.7	1119	18.24
Secondary	19.5	67.2	91.9	2193	19.18
Higher	14.5	58.0	89.2	1212	20.02
(F-statistic using ANOVA test = 85.22; P-value = 0.000; degrees of freedom = 7263)					

MAFM: Mean age at first marriage

This is an interesting relationship because Punjab is the province which is economically more developed and this may contribute to the high mean age first marriage; whereas Baluchistan is economically the least developed province of the country. The reason for this finding may be better explained in the multivariate analysis (Section 6.5.2). Sindh has the lowest mean age at first marriage.

Previous research has shown a positive relationship between AFM and respondent education. As expected mean age at first marriage and women's level of education are positively related, with rising mean age at first marriage as women's educational level increases. There is a 4-year difference in the mean age at first marriage for women who have no education and women with higher level of education. Moreover, about 78 per cent of women with no education have married by the age of 20 while only 32 per cent of women with higher education have married by the same age.

Regarding the ethnic differences, three groups are obvious in terms of mean age at first marriage. First group consist of women belonging to Sindhi, Balochi, Barauhi, Saraiki and other ethnic origins; the mean age at first marriage for this group is lower (between 17 and 18 years) than other groups. Pashto and Hindko speaking women are categorized in second ethnic group and the mean age for this group lies between 18 and 19 years. Punjabi (19.68 years) and Urdu (19.94) speaking women have the greatest mean age first marriage. Moreover, about 80 per cent of Barauhi, Sindhi, and Saraiki women have married by exact age of 20 while about 60 per cent Punjabi and Urdu ethnic women have married by the same age.

Husband's education also has an association with women's timing of marriage (see p-values). Women's age at first marriage rises with husband's educational level. Mean age at first marriage of women whose husbands have no education is 2 years younger than that of women whose husbands have higher education.

6.5.2 Regression models for age at first marriage

Table 6.7 shows the characteristics of the sample used for modelling by mean age at first marriage. Younger age birth cohorts have high mean age at first marriage (MAFM) in 2006 compared to 1990. It is interesting to note that MAFM in rural areas in 1990 was higher compared to urban areas. In 2006, MAFM in urban areas found higher. Women from Punjab followed by Balochistan have significantly higher MAFM than other provinces. Women from Sindh are found to be very traditional in their marriage pattern (MAFM: 17.88 years in 2006)—no significant change is observed in AFM. Education, experience of labour force participation and Urdu speaking women has high MAFM.

To determine the relative importance of time independent covariates that are related to AFM, four linear regression models (two time periods with two age categories) are estimated. Table 6.8 displays the results of two final estimated models for currently married women aged 25-49 and 35-49 based on 1990 data. Table 6.9 displays the results of other two estimated models for 2006.

Table 6.7: Mean age at first marriage of currently married women by various characteristics, Pakistan, 1990 and 2006

Characteristics	2006 (n=7264) (25-49) years	1990 (n=4832) (25-49) years
Age cohort		
45-49	18.93 (1056)	19.43 (565)
40-44	18.67 (1140)	18.51 (751)
35-39	18.62 (1513)	18.47 (960)
30-34	18.67 (1619)	17.95 (1150)
25-29	18.73 (1936)	17.76 (1406)
Place of residence		
Urban	19.11 (2868)	18.06 (2303)
Rural	18.45 (4396)	18.44 (2529)
Province of residence		
Punjab	19.27 (3175)	18.92 (1612)
Sindh	17.88 (1868)	17.23 (1324)
NWFP	18.26 (1326)	18.76 (1231)
Baluchistan	19.15 (895)	17.79 (665)
Education		
No	18.08 (4903)	17.88 (3715)
Primary	18.72 (899)	18.06 (406)
Secondary	20.01 (928)	19.83 (616)
Higher	22.31 (534)	23.69 (95)
Ever worked before marriage		
No	18.64 (5289)	18.18 (4174)
Yes	18.95 (1975)	18.81 (658)
Ethnicity		**N.A**
Punjabi	19.68 (2380)	
Urdu	19.94 (577)	
Sindhi	17.55 (866)	
Pashto	18.69 (1508)	
Balochi	17.84 (390)	
Barauhi	17.78 (112)	
Saraiki	17.43 (911)	
Hindko	18.47 (215)	
Other	17.78 (305)	
Husband education		
No	17.95 (2740)	18.03 (2233)
Primary	18.24 (1119)	17.28 (760)
Secondary	19.18 (2193)	18.62 (1462)
Higher	20.02 (1212)	20.20 (377)

N.A: not applicable

Table 6.8: Multiple regression estimates of the factors associated with age at first marriage of currently married women, (1990-91 Pakistan Demographic and Health Survey)

Characteristics	1990 Currently married (25-49) Coefficients (SE) (n=4832)	t-statistic	1990 currently married (35-49) Coefficients (SE) (n=2276)	t-statistic
Birth cohort (age cohort)				
For 1990 data				
1941-45 (45-49) (RC)				
1946-50 (40-44)	-0.92** (0.23)	-3.98	-0.89** (0.26)	-3.43
1951-55 (35-39)	-1.03** (0.22)	-4.69	-1.00** (0.25)	-4.05
1956-60 (30-34)	-1.55** (0.21)	-7.28	-	
1961-65 (25-29)	-1.81** (0.21)	-8.71	-	
Place of residence	non-significant			
Rural (RC)				
Urban	-		-	
Province of residence				
Punjab (RC)				
Sindh	-1.53** (0.15)	-9.93	-1.82** (0.25)	-7.21
NWFP	0.05 (0.16)	0.34	0.07 (0.26)	0.26
Baluchistan	-0.70** (0.19)	-3.63	-0.30 (0.33)	-0.91
Education				
No (RC)				
Primary	0.37* (0.23)	1.63	-0.03 (0.40)	-0.06
Secondary	1.90** (0.21)	9.12	1.72** (0.38)	4.57
Higher	5.38** (0.48)	11.33	6.38** (0.79)	8.11
Ever worked before marriage				
No (RC)	non-significant			
Yes	-		-	
Husband education				
No (RC)				
Primary	-0.58** (0.18)	-3.31	-0.78** (0.29)	-2.68
Secondary	-0.08 (0.15)	0.53	-0.03 (0.26)	-0.11
Higher	0.39 (0.27)	1.41	-0.20 (0.47)	-0.42
Intercept	19.66** (0.20)	97.04	19.80** (0.26)	76.42

*0.05>p ≥ 0.01; **p<0.01
RC: reference category

Table 6.9: Multiple regression estimates of the factors associated with age at first marriage of currently married women, (2006-07 Pakistan Demographic and Health Survey)

Characteristics	2006 Currently married (25-49) Coefficients (SE) (n=7264)	t-statistic	2006 currently married (35-49) Coefficients (SE) (n=3709)	t-statistic
Birth cohort (age cohort)				
For 2006 data				
1957-61 (45-49) (RC)				
1962-66 (40-44)	-0.36* (0.17)	-2.12	-0.33 (0.18)	-1.8
1967-71 (35-39)	-0.42** (0.16)	-2.66	-0.37* (0.17)	-2.20
1972-76 (30-34)	-0.55** (0.16)	-3.49		
1977-81 (25-29)	-0.60** (0.15)	-3.89		
Place of residence				
Rural (RC)				
Urban	-0.37** (0.11)	-3.50	-0.51** (0.16)	-3.28
Province of residence				
Punjab (RC)				
Sindh	-0.42** (0.17)	-2.50	-0.40 (0.26)	-1.56
NWFP	-0.57* (0.22)	-2.53	-0.54 (0.34)	-1.60
Baluchistan	0.98** (0.22)	4.41	1.43** (0.33)	4.30
Education				
No (RC)				
Primary	0.41** (0.15)	2.71	0.41 (0.23)	1.82
Secondary	1.58** (0.16)	9.73	1.45** (0.26)	5.65
Higher	3.87** (0.22)	17.50	4.22** (0.33)	12.64
Ever worked before marriage				
No (RC)				
Yes	0.57** (0.11)	5.13	0.52** (0.17)	3.10
Ethnicity				
Punjabi (RC)				
Urdu	-0.40* (0.21)	-1.92	-0.31 (0.31)	-1.01
Sindhi	-1.50** (0.22)	-6.73	-1.91** (0.34)	-5.63
Pashto	-0.32 (0.23)	-1.41	-0.22 (0.34)	-0.65
Baluchi	-1.83** (0.28)	-6.57	-2.20** (0.42)	-5.17
Barauhi	-1.99** (0.42)	-4.70	-2.46** (0.63)	-3.90
Saraiki	-1.79** (0.17)	-10.80	-1.99** (0.24)	-8.15
Hindko	-0.72* (0.33)	-2.18	-1.47** (0.50)	-2.95
Other	-1.42** (0.27)	-5.26	-1.81** (0.43)	-4.24
Husband education			non-significant	
No (RC)				
Primary	0.22 (0.14)	1.54		
Secondary	0.56** (0.12)	4.64		
Higher	0.52** (0.16)	3.22		
Intercept	19.11** (0.16)	120.48	19.44** (0.18)	108.40

*0.05>p ≥ 0.01; **p<0.01
RC: reference category

For 1990 PDHS, women who were born between 1961 and 1965 marry on average about 2 year younger than women born between 1941 and 1945 (reference category); for 2006 PDHS, women who were aged between 25 and 29 year marry on average half of a year younger than women aged 45-49 year at the time of survey (Table 6.8, Table 6.9). This indicates that AFM for 25-29 age cohort goes up by one and half year between 1990 and 2006. Similarly for age 30-34 cohort, the AFM goes up by 1 year between 1990 and 2006. Using models for 35-49 year currently married women, women who were born between 1951 and 1955 marry on average a year younger than women born between 1941 and 1945 for 1990 PDHS; for 2006 PDHS, women who were aged between 35 and 39 year marry on average 0.37 of a year younger than women aged 45-49 at the time of survey (Table 6.9). This indicates that AFM for 35-39 age cohort goes up by half a year between 1990 and 2006. In summary, AFM for 25-49 cohort is higher than that for the 35-49 cohort.

Women aged 25-49 year in urban areas marry, on average, 0.37 of a year earlier than women in rural areas; women who were aged between 35 and 49 marry, on average, half a year earlier than in rural areas in 2006. Place of residence is only significant characteristics in PDHS 2006 when compared to 1990. If women in urban and rural areas had similar birth cohorts there would be little urban-rural difference in timing of marriage.

Women who lived in Sindh have a significantly younger mean age at first marriage than women in Punjab. Between 1990 and 2006, the AFM rose 0.6 of a year women aged 25-49 in Sind. For 35-49 year old women in Sindh, AFM rose almost two (1.1 year) times than women aged 25-49. Women living in Sindh and NWFP significantly have different behavior of AFM compared to Balochistan and Punjab. The result of Baluchistan is as interesting as was not expected. Women aged 25-49 between 1990 and 2006 in Baluchistan marry 1.13 year older than other provinces. It is expected that the difference in mean age at marriage between Balochistan and Punjab has been widening from other two provinces (Sindh and NWFP).

The respondent's level of education has a very large and strongly significant association with AFM across all four models. This finding strongly support modernization theory: women tend to postpone their marriage while they are studying and their attitude on marriage may have changed. Women surveyed in 1990 who have higher education marry, on average 6 years later than those who have primary education. Secondary education associated with delay in AFM of 1.5-2 years in 1990 and 1.5 years in 2006 (Table 6.8, Table 6.9). Respondent levels of education suggest a great variation in increasing the AFM in particular from 1990 to 2006. For example, the final model predicts that a woman aged 35-49 with a primary level of education in 1990 do not increase her age at first marriage; conversely a 25-49 year old woman with a similar level of education in 1990 play a positive role in increasing her age at first marriage. In addition, if the woman living in Baluchistan with any level of education contribute a year and a half to increase her age at first marriage in 2006.

Only in 2006 survey work exposure before marriage has statistically significant effect on average AFM. Those women who have pre-marital work experience marry, on average half a year late than those who have no work experience. The joint effect of women level of education and employment greatly increase the age at first marriage. Given the importance of education and employment for women in Pakistan, this will likely to have profound implications for increasing the women age at first marriage. The information on ethnicity was not available in 1990 PDHS but in the 2006 survey ethnicity a respondent had was significant. Cultural backgrounds as measured by ethnicity strongly influence marriage behavior in Pakistan. There are 10 ethnic groups; the AFM varies across ethnic groups. Respondents belonging to Urdu and Pashto ethnic communities have higher mean AFM than others. Sindhi (17.53 year) and Saraiki (17.35 year) women (35-39) are very similar in their AFM. This close resemblance in marriage behavior is a factor which could be observed in history. The main Saraiki speaking areas are Multan, Bahawalpur, Dear Ghazi Khan, Dear Ismail Khan and most parts of Sargodha division in Pakistan. Saraiki is also spoken widely in Sindh and one of the Saraiki areas Multan was the capital of Sindh.

After controlling for woman's education there is a little effect of husband's education on AFM; it changed over time and age cohorts. In 1990, women who married husbands who have a primary education are more likely marry on average about a year younger than women whose husbands have higher education.

6.6 Statistical techniques for duration analysis

Duration or commonly known as survival analysis is a collection of statistical techniques for data analysis for which the outcome variable of interest is time until an event occurs. In the present study, the outcome variable is the amount of time a Pakistani woman survives without having a child. Survival analysis techniques keep the analytical problem in the data called censoring.

Censoring occurs when incomplete information is available about the survival times of some individuals. More simply two mechanisms that can lead to incomplete observations of survival times are censoring and truncation. Figure 6.3 shows the main censoring mechanisms. Where T_0 the starting is time of the study and T_1 is the ending time of the study. The + sign at the end of solid line (-) in figure 6.3 indicates an occurrence of the event of interest (first birth). The solid line (-) represent the amount of time a woman (W) survives without having a child. The line ending with an open point (0) indicates the occurrence of other than the event of interest (first birth); e.g. migrated from the area (loss to follow up), death, or sterile etc. For woman (W2) who has not yet had a child, her age at first birth is yet unknown (except it is known that the age at first birth will be at least as large as her current age) and hence the time (age) for W2 is censored (right censored).

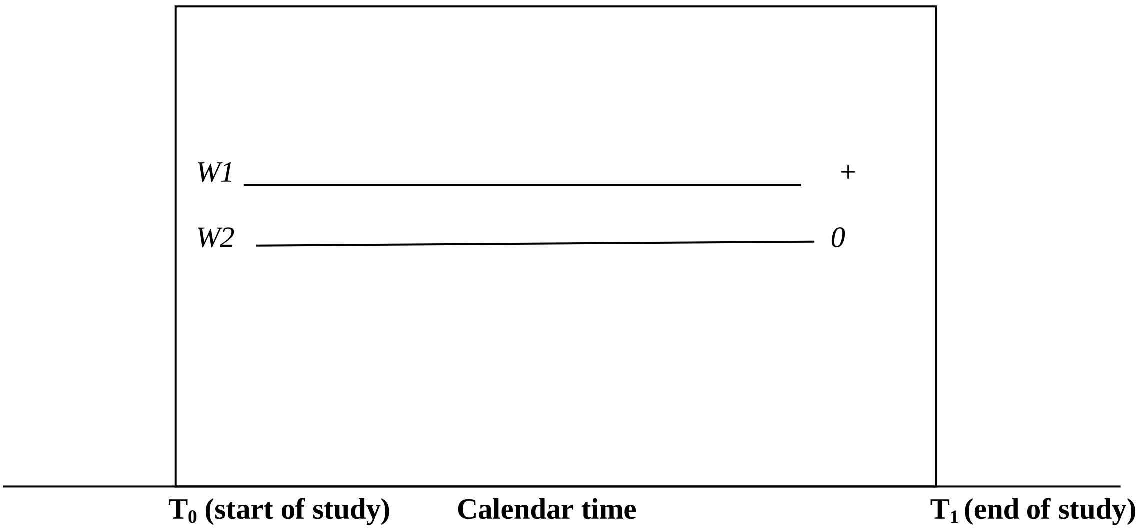


Figure 6.3: Censoring mechanism

Statistically speaking, let X is the time (age in completed years) until first birth occurred to woman(W_i). Then X is a non-negative random variable and let C_r is the fixed right censoring time. The variable X and C_r are assumed to be independent and $X's$ in addition assumed to independently and identically distributed with probability density function $f(x)$ and survival function $S(x)$. The exact age at first birth of a woman will be known if, and only if, $X \leq C_r$. If $X > C_r$ the woman has not experienced the first birth and her time is censored. The data can be conveniently represented by pair of random variables(t, δ); where δ is the censoring indicator whether a woman experienced the first birth $(\delta = 1)$ or is censored$(\delta = 0)$.

6.6.1 Estimating the survival function: Kaplan-Meier approach

Kaplan and Meier have developed a non-parametric estimator for estimating survival function S(x); and details can be found in books of survival analysis (Kaplan and Meier 1958, Cox and Oakes. 1984, Kalbfleisch and Prentice 2002, Kleinbaum and Klein 2005). The Kaplan-Meier (KM) estimator is also known as product limit (PL) estimator. Suppose that first birth to Pakistani women occur at D different ages: $t_a < t_{a+1} < t_{a+2} \dots < t_b$ (a and b are the lower and upper biological limits of the reproductive age of women) and that at women's age t_i there are b_i^1 first births. Let W_i be the number of women who are sexually active and available or at risk to produce the first child. The PL estimator using the life table technique would be as follows:

$$\widehat{S(t)} = \begin{cases} 1 & \text{if } \ t < t_i \\ \prod_{t_{i<t}} \left(1 - \frac{b_i}{w_i}\right) & \text{if } \ t_i < t \end{cases}$$

(1)

The variance of the PL estimator using Green-Wood's formula is given in Cox and Oakes (1984, P. 51):

$$\hat{V}[\widehat{S(t)}] = \hat{S}(t)^2 \sum_{t_i<t} \frac{b_i}{w_i(w_i - b_i)}$$

(2)

6.6.1.1 *Point and interval estimate of mean age at first birth*

The non-parametric summary measures (point and interval estimate) of mean survival time (mean age at first birth) can be obtained by substituting the PL estimator for the unknown survival function. Let μ be the mean time to the event of interest (first birth), then

$$\mu = \int_a^b S(t)dt$$

(3)

Let $\hat{\mu}$ be the estimated mean survival time:

$$\hat{\mu} = \int_a^b \hat{S}(t)dt$$

(4)

The variance of the point estimator $\hat{\mu}$ is:

$$\hat{V}[\hat{\mu}] = \sum \left[\int_a^b \hat{S}(t)dt\right]^2 \times \frac{b_i}{w_i(w_i - b_i)}$$

(5)

Finally, a $100\ (1-\alpha)\%$ confidence interval would be obtained as follows:

$$\hat{\mu} \mp Z_{1-\frac{\alpha}{2}} \sqrt{\hat{V}[\hat{\mu}]}$$

(6)

6.6.2 Cox proportional hazard model

Regression models for survival data come in many shapes. Accelerated failure time and family of proportional hazards models are the most common. Cox proportional hazard (CPH) model belongs to family of proportional hazard models and it is a type of multiplicative hazard model (Cox 1972). One of the objectives in this study is to determine the important determinants of pregnancy interval of Pakistani women or do the Pakistani ever married women have earlier their first child after marriage, the second child closer to the first and so on. In short, the study focuses to examine changes in the timing of births and the factors determining pregnancy intervals. Statistically speaking, the interest is, the subjects (women) have some additional characteristics that may affect their outcome (pregnancy interval duration), for example age, age at marriage, socioeconomic status including education level, children ever born and so on, a mathematical robust model CPH would safely be used to meet this objective. Let $h(t,z)$ be the hazard rate at time (birth duration time) for a woman with P covariates vector $Z = (Z_1, Z_2, Z_3, ... Z_p)$. The general expression of the CPH model is:

$$h(t,z) = h_0(t) \times \mathrm{Exp}\left(\sum_{j=1}^{p} \beta_j Z_j\right) \tag{7}$$

Where $h_0(t)$ in equation (7) is the baseline hazard function. One way to measure the effect of predictors is the use of hazard ratios (HR) which involves only regression coefficients β's (without estimating base line hazard function). The following is an expression for the HR of two women say A and B:

$$\widehat{HR} = \frac{\hat{h}(t, \text{Woman A})}{\hat{h}\ (t, \text{Woman B})} = \mathrm{Exp}\left[\sum_{j=1}^{p} \hat{\beta}_j \left(Z_{jA}^{*} - Z_{jB}\right)\right] \tag{8}$$

6.6.2.1 *Model building using a forward selection approach*

In building CPH models, we are mainly interested in finding factors which contribute to the distribution of pregnancy interval duration. The starting point of the modeling procedure is to perform local tests of primary hypothesis with all factors separately to determine the most highly significant variable affecting outcome variable—pregnancy interval duration (first conception interval duration, second conception interval duration, third conception interval duration, etc.) based on lowest likelihood statistics (-2loglikelihood). The highly significant factor or variable is included in the basic model. This model is called say first stage model. After obtaining the first stage model, the next most highly significant variable is then included in the first stage model. It is a stage two model. This process continued until the final model is obtained for pregnancy interval durations.

6.6.2.2 *Checking the proportional hazard assumption*

The validity of Cox's regression model relies heavily on the assumption of proportionality of the hazard rates of individuals with distinct values of covariates. There are three general approaches for assessing the proportional hazard assumption namely: graphical, goodness of fit (testing approach) and using time dependent covariates (extended Cox model). If we look at the hazard ratio (HR) shown in equation (8), which give a constant, which shows in addition that the hazard rates are proportional. The most common graphical techniques in vogue are log-log survival curves (log-log plots) and observed versus expected survival curves. The most common testing approach to check the proportional hazard assumption is Schoenfield test

(Schoenfeld 1982). By following the recommendation of Kleinbaum both hazard plots and Schonfield test have been used in the present study for evaluating the proportional assumption of the estimated CPH models (Kleinbaum and Klein 2005).

6.7 Modelling waiting time to first conception

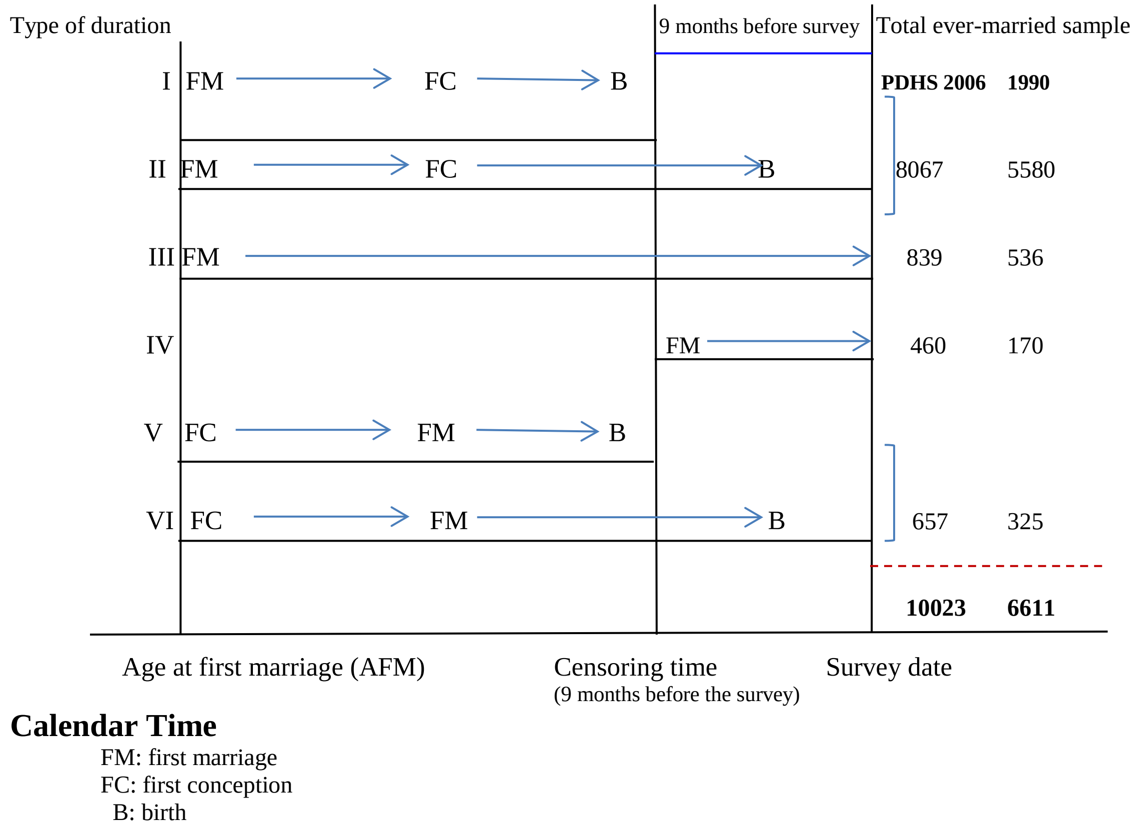
6.7.1 Data management and computation of waiting time to first conception

For modeling duration of first conception (DFC) the outcome variable is the time from first marriage to first conception. The outcome variable is calculated by subtracting nine months from the difference of duration between AFM and AFB for those women who have first birth after marriage; eventually first conception after marriage. Figure 6.4 presents the distribution of sample size in terms of consistent and inconsistent responses with censoring mechanism for two survey samples. Nine months before the survey date is assumed to be a fixed censoring time. The sample is broadly categorized into two groups: consistent (type of duration I, II, and III) and inconsistent cases (type of duration IV, V and VI). There are three types within each of consistent and inconsistent cases. The window starting from AFM to censoring time is of particular interest for calculating the valid waiting time of FC (Figure 6.4). Either first birth occurred within this window or the window between censoring time and survey date; the waiting time to FC could safely be determined, and hence this is shown as the first two types of consistent cases in Figure 6.4. If a woman first marriage occurred in the window of interest mentioned above and she has not have a live birth by the end of survey date then her waiting time by censoring date would be a consistent but censored case and this presents the type III of consistent cases (839 cases: PDHS 2006; 536 cases: PDHS 1990). Within inconsistent cases a woman who has no first birth and married after the censoring date is categorized as the type IV duration—inconsistent response because there is no information about timing of her future conception (460 cases for 2006 survey; 170 cases for 1990 data).

Box 4: Duration of first conception—nine months versus forty weeks & data quality

Birth and pregnancy information was collected by two procedures in 1990 and 2006 PDHS. First each respondent was asked about the number of sons and daughters she had (for example, see SECTION 3 of 2006 PDHS Questionnaire). Then she was asked to provide full live birth history in which name, date of birth, sex, survival status, age at last birth day, age at death was collected for each child. Then woman's age at first birth is calculated by subtracting her birth date from birth date of her first child. Thus the accuracy of information on age at first birth depends on the accuracy of the respondents reporting of her birth date and the birth date of her first child. By following medical standards, a normal pregnancy lasts 280 days from the women last menstrual period which is about 266 days from conception to birth. On week scale the pregnancy refers to 40 weeks or 9months plus 1 week period. The date of conception is not always known by women. There could be still births, perinatal issues or pregnancy loss issues influencing the calculation of conception time. The variables in DHS surveys using information on date are presented through Century Month Code (CMC) format. Calculating the conception using week scale considering the issues mentioned above for a live birth is the correct procedure to follow, but taking the liberty of CMC format in DHS surveys, I have used the information available on live births for the calculation of conception time (subtracting 9 months from the date of first birth).

Figure 6.4: Sample size distribution with censoring mechanism for age at first conception model of ever-married women (2006-07 Pakistan Demographic and Health Survey)



The last two types of inconsistent cases are interesting to note for negative duration time to FC which indicates that there are women who conceive before marriage in both surveys (657 cases: PDHS 2006; 325 cases: PDHS 1990). There could be another type of duration in which conception (FC) lead to live birth (B) and then marriage (FM). This type of duration does not exist in the data. However, from the total ever married sample, 1117 cases from PDHS 2006 and 495 cases from PDHS 1990 were categorized as inconsistent and these are excluded. Regression modeling is performed using consistent and currently married women sample; with an analysis sample consisting of 5798 cases for PDHS 1990 and 8283 cases for PDHS 2006.

Let X be the time until first conception (FC) after first marriage occurred to a currently married woman; (X is non-negative random variable from a homogeneous population.) Let C be the fixed right censoring time (which is 9 months before survey date). Any woman who married before censoring date and had a first child before or after the censoring date, waiting time to first conception is considered to be an event for this woman. Any woman who married before the censoring date and yet has no first birth after censoring date, DFC or waiting time to FC is unknown (except it is known that AFC will be at least as large as her current age or the waiting time to FC will be at least as large as waiting time since marriage), waiting time for this women is considered to be censored. X and C are assumed to be independent, Xs′ are assumed to be independent and identically distributed with probability density function f(x) and survival function S(x). The exact time duration to FC of a woman will be known if, and only if, X is less than or equal to C. In addition, the calculated time duration to first conception for values 0 and -1 were coded as 0.5 months. The time duration to first conception varies from 0.5 months to 411 months. A 48-month window for time duration to first conception is used in this study. The reason of using 48 months window is: about 87 per cent of first conceptions occur within forty eight months period after marriage. Therefore, times to first conception for the remaining cases (13 per cent) are coded as forty eight months and taken to be censored. This coding helps to avoid the problem of shifting the small sample sizes around time duration to first conception after 48 months.

6.7.2 Parametric survival models

Survival analysis techniques are available to model the time it takes for event (FC) to occur. In principle, prior to the Cox regression model, the application of parametric survival distribution is preferred for the analysis of time to event data. The key advantage of using a parametric model is that the functional form of the model is completely specified except for the values of unknown parameters. Some well-known common parametric survival models are available in the literature for example, the more widely used models are: exponential, Weibull, Gamma, Log normal, Log logistic (Klein and Moeschberger 2003).

To assess the suitability of applying a particular parametric survival model following approach is used: graphical examination of hazard functions. For example, if the distribution is exponential a plot of $[-\log \hat{S}(t)]$ against study time (t) should yield a straight line which is an empirical check for an exponential fit (Guo 2010, Tableman and Kim 2004, Lee and Wang 2003, Klein and Moeschberger 2003). If the survival data (empirical data) follow a Weibull distribution, then a plot of $\log[-\log \hat{S}(t)]$ against log (t) should yield a straight line. The application of graphical plots for four parametric survival models (exponential, Weibull, Log normal and Log logistic) presented in Appendix G1. The illustration is made PDHS 2006. Figures (G1 through G4) shown in Appendix G1 reveals a non-linear pattern suggesting that none of the four fitted models are suitable to model the duration of FC.

6.7.3 Examining the hazard function

To overcome the issues addressed in parametric survival models, hazard function has been estimated. Figure 6.5 presents the calculated hazard values for all women in PDHS 1990 and 2006. In addition, to compare the pattern of hazard function with the one shown in Figure 6.5, hazard values for following covariates have been estimated: respondents classified by various birth cohorts, their age at first marriage, place and province of residence, education level, and husband education status. The hazard plots for these subgroups are not separately shown since the pattern is almost similar with Figure 6.5.

Figure 6.5 reveals a similar behavior of hazard values for 1990 and 2006. It is interesting to observe the unusual behavior of hazard values of first conception for first 12-15 months after marriage—hazard shape at 0-15 months is not fitting any parametric form. There are explanations for this pattern. First, the hazard at 12-15 months does not either increase or decrease which confirms that parametric survival model is inappropriate instead a semi-parametric model could be considered. The shape of hazard for the first 12-15 months is inconclusive.

Furthermore, it is observed that hazard is decreasing for the 0-7 months. After about 7 months, the hazard of first conception started increasing until about 15 months. This phenomenon provides interesting explanations. Regarding parametric modeling for first conception, Weibull survival model might suit better for the 15 through 48 months window. From 15 through 48 months, the hazard for both data sets decreases in shape and hence the Weibull model with decreasing hazard would be appropriate. In addition, women observed in 2006 data are at more risk of FC between 28 and 48 months when compared to those in 1990.

There are two observations; first, women who deliberately delay their first conception after marriage. Second women who experience short delay attributed to biological factors especially when for those marrying very early in their reproductive life. The physiological capacity to produce at young age is small.

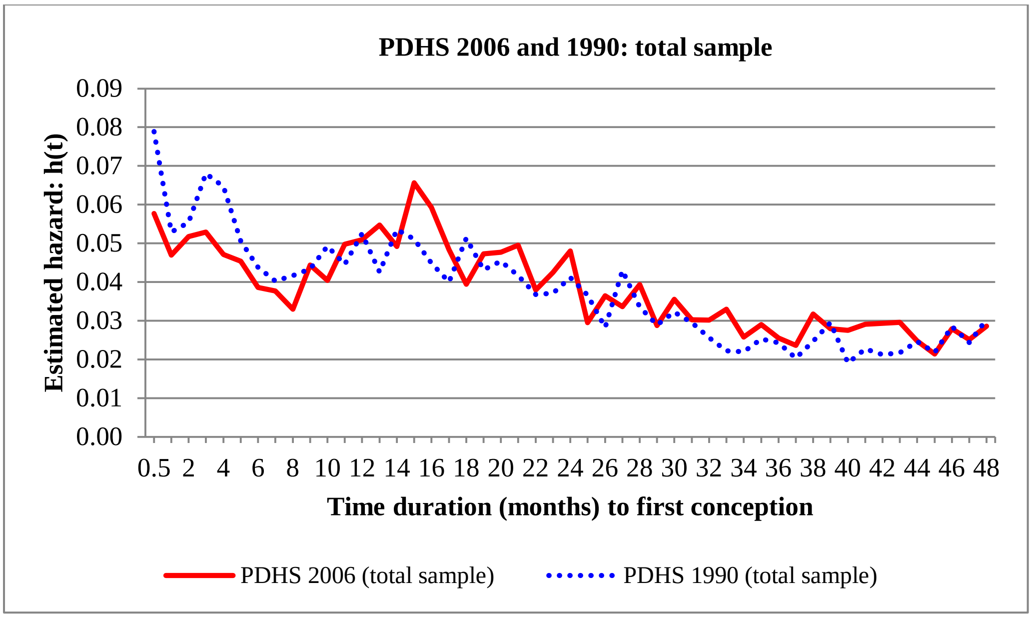


Figure 6.5: Hazard plot of age at first conception for currently married women in Pakistan, 1990 and 2006

Even conceiving at young age immediately after marriage might be affected with a higher rate of foetal wastage and results in declining the fecundability. This explanation is quite consistent for first 6-7 months; however women in 2006 data are at lower risk when compared to 1990 data (Figure 6.5). Early conceptions are culturally accepted in Pakistan. This explanation is supported with a pronounced evidence of first conception between 7 and 15 months after marriage. It would be important to note that this could not be the only explanation for the increasing hazard between 7 and 15 months; because the irregular peaks and troughs (particularly at month 15) presents an impression of misreporting the time of first birth which is a common problem in demographic data collection in Pakistan. Chapter 4 has already addressed the issue of misreporting in details. The next section discusses the Cox regression which is deemed as an alternative to parametric survival model.

6.7.4 Cox proportional hazard regression model

Cox regression model is used to model the time to FC among currently married Pakistani women. Cox model provides the robust estimates of regression coefficients and hazard ratios and it allows the shape of baseline hazard to be determined by data (Kleinbaum and Klein 2005). To determine the most highly significant variables affecting age at FC, forward stepwise regression modeling is performed. After obtaining the basic model using only the regression constant, the highly significant variable out of selected covariates is considered based on the -2loglikelihood statistic. The iteration process is continued until the final model is obtained. In the final model, 7 out of 10 time independent covariates are observed to be significant. These variables include: age at first marriage, birth cohort, place of residence, province of residence, education status of respondent, childhood place of residence, and husband education. Age at first marriage refers to the woman's age at her first marriage; this is categorized into four categories: less than or equal to 17 years, 18-19 years, 20-21 years, and 22 years and above. Place of residence (rural and urban) refers to the respondent place of residence at the time of survey. Province refers to the respondent location in the country. It is categorized in to four categories: Punjab, Sindh, NWFP and Baluchistan. Education refers to the respondent level of education. It is categorized in three categories: no, primary and secondary or higher. Husband education is classified into two categories: no or up to 10 year of schooling and 11 year or higher.

The multivariate modeling performed in earlier part of this Chapter has revealed that AFM for women in Baluchistan is older than other provinces of Pakistan in 2006 survey. Assuming the regional differentials in AFM it is hypothesized that Baluchistan would behave differently in terms of AFC. In addition to multivariate modeling, the hypothesis is supported by plotting smooth Kaplan-Meier survival curve for the three geographic regions in Pakistan using 2006 PDHS (Figure 6.6). Figure 6.6 shows the median time to FC in Baluchistan (19 months) which is higher than other regions (15 months). The prognosis for the first conception in Baluchistan is clearly different than other regions. For example, first 20 months survival proportion (chances of a woman survives without having a first conception) for a woman living in Punjab, Sindh or

NWFP is 36 per cent, compared with 44 per cent for a woman living in Balochistan. Under this hypothesis, three different types of models showing three different regions (all women, women in Punjab, Sindh and NWFP and Baluchistan cases only) are estimated for both data sets.

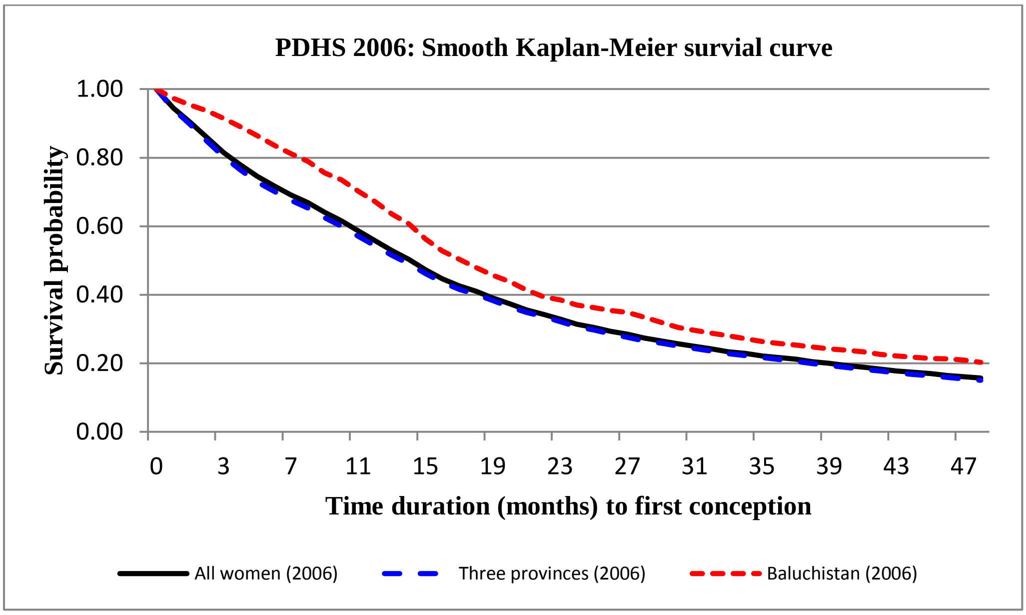


Figure 6.6: Survival plot of age at first conception for currently married women in three geographic regions of Pakistan, 2006

Overall six models are estimated; these models are labeled as Model 1A (for all women in 1990), Model 2A (women in Punjab, Sindh, and NWFP in 1990), Model 3A (women in Baluchistan in 1990), Model 1B (for all women in 2006), Model 2B (women in Punjab, Sindh, and NWFP in 2006) and Model 3B (women in Baluchistan in 2006). Table 6.10 (for PDHS 1990) and Table 6.12 (for PDHS 2006) presents the estimated regression coefficients with hazard ratios of six Cox models. Hazard ratio is simply the exponential of estimated coefficient value. For the reference category of each covariate, the hazard ratio is assumed to be fixed at 1.00 (hazard ratios for reference categories are not shown in tables). A hazard ratio greater (or less) than 1.00 indicate a higher (or lower) risk of getting conceived for first baby in that category as compared with that of the reference category. At first glance in both tables the hazard ratios are greater than 1.00 with only few exceptions (Sindh, urban place of residence, and primary educated women in Baluchistan in 2006).

The significance of estimated regression coefficients for birth cohort categories varies for three regional models (all women, women from three provinces, and women from Baluchistan only). For example, in the all women model, all coefficients for birth cohort categories in 1990 (Table 6.10) are significant except for birth cohort 1962-66 in 2006 (Table 6.12). The risk of first conception decreases 12 per cent between 1990 and 2006 for the total women aged 40-44 cohort. The possible explanation for this finding could be possibly the high use of contraception among older women—peak of contraceptive use (41.6% in 2006) in 40-44 year age group

(National Institute of Population Studies [Pakistan] and Macro International Inc 2008). Across three models in 1990, the highest risk of first conception is observed in (25-29) year age groups. The model for Baluchistan in 1990 shows that, other things being equal, the hazard of first conception for (25-29) year women is about twice for those aged 45-49 group (Table 6.10). Regression coefficients of birth cohorts presented for 2006 data, reveals that (15-24) old women are at highest risk of FC (Table 6.12). Across all six models, the hazard of first conception decreases as the age increases. In terms of statistical significance for estimated coefficients Model 3B (Baluchistan) is interesting: coefficients for all birth cohort categories are insignificant except for (15-24) age group.

Table 6.10: Cox regression estimates of the factors associated with age at first conception of currently married women, 1990, Pakistan

Characteristics	Model 1A Total sample (n=5798) Coefficients (SE)	HR	Model 2A Punjab, Sindh, NWFP (n=4984) Coefficients (SE)	HR	Model 3A Baluchistan cases only (n=814) Coefficients (SE)	HR
Birth cohort (age cohort)						
1941-45 (45-49) (RC)						
1946-50 (40-44)	0.13* (0.06)	1.14	0.11 (0.07)	1.12	0.30 (0.21)	1.35
1951-55 (35-39)	0.20** (0.06)	1.22	0.17* (0.07)	1.19	0.40* (0.19)	1.46
1956-60 (30-34)	0.27** (0.06)	1.31	0.24** (0.06)	1.27	0.53* (0.19)	1.65
1961-65 (25-29)	0.37** (0.06)	1.43	0.33** (0.06)	1.39	0.70** (0.18)	1.92
1966-75 (15-24)	0.16* (0.06)	1.16	0.12 (0.07)	1.13	0.46* (0.19)	1.51
Age at first marriage						
$\leq$17 (RC)						
18-19	0.31** (0.04)	1.35	0.31** (0.04)	1.36	0.25* (0.11)	1.28
20-21	0.30** (0.05)	1.35	0.29** (0.05)	1.34	0.31* (0.13)	1.35
22+	0.23** (0.04)	1.26	0.23** (0.05)	1.26	0.17 (0.13)	1.19
Place of residence						
Rural (RC)						
Urban	0.09* (0.04)	1.09	0.11* (0.04)	1.12	-0.08 (0.11)	0.92
Province of residence					N.A	
Punjab (RC)						
Sindh	-0.16** (0.04)	0.86	-0.17** (0.04)	0.84		
NWFP	0.14** (0.04)	1.14	0.14** (0.04)	1.14		
Baluchistan	-0.07 (0.05)	0.95	N.A			
Education						
No (RC)						
Primary	0.20** (0.05)	1.22	0.18** (0.05)	1.22	0.24 (0.18)	1.27
Secondary +	0.23** (0.05)	1.31	0.21** (0.05)	1.23	0.08 (0.18)	1.08
Childhood place of residence						
Rural areas (RC)						
Urban areas	0.15** (0.04)	1.16	0.20** (0.04)	1.22	-0.05 (0.11)	0.98
Husband education						
No or <=10 year schooling (RC)						
Higher	0.10 (0.06)	1.11	0.11 (0.06)	1.12	0.00 (0.18)	1.00
-2 log likelihood	75664.84		63940.48		7904.70	

*0.05>p$\geq$0.01; **p<0.01
RC: reference category
NA: not applicable
df: degrees of freedom
HR: hazard ratio

Table 6.11: Test of proportional hazard assumption (P-values) of the factors associated with age at first conception of currently married women in Cox model, 1990, Pakistan

Characteristics	Model 1A Total sample (n=5798) Probability (PH)	Model 2A Punjab, Sindh, NWFP (n=4984) Probability (PH)	Model 3A Baluchistan cases only (n=814) Probability (PH)
Birth cohort			
1941-45 (RC)			
1946-50	0.4604	0.3911	0.8963
1951-55	0.2569	0.2889	0.6263
1956-60	0.3333	0.2278	0.8838
1961-65	0.4238	0.2411	0.6388
1966-75	0.0917	0.1021	0.6768
Age at first marriage			
$\leq$ 17 (RC)			
18-19	0.8451	0.7620	0.3290
20-21	0.5149	0.3407	0.5210
22+	0.0032	0.0074	0.2334
Place of residence			
Rural (RC)			
Urban	0.9978	0.8688	0.6051
Province of residence			
Punjab (RC)			
Sindh	0.1936	0.2099	N.A
NWFP	0.7581	0.7625	
Baluchistan	0.5853		
Education			
No (RC)			
Primary	0.2306	0.3004	0.4179
Secondary +	0.0382	0.0610	0.4021
Childhood place of residence			
Rural areas (RC)			
Urban areas	0.1614	0.2803	0.3444
Husband education			
No or <=10 year schooling (RC)			
Higher	0.8394	0.8005	0.1611

Table 6.12: Cox regression estimates of the factors associated with age at first conception of currently married women, 2006, Pakistan

Characteristics	Model 1B Total sample (n=8283) Coefficients (SE)	HR	Model 2B Punjab, Sindh, NWFP (n=7313) Coefficients (SE)	HR	Model 3B Baluchistan cases only (n=970) Coefficients (SE)	HR
Birth cohort						
1957-61 (45-49) (RC)						
1962-66 (40-44)	0.02 (0.05)	1.02	0.03 (0.05)	1.02	-0.00 (0.14)	1.00
1967-71 (35-39)	0.11* (0.05)	1.11	0.12* (0.05)	1.13	0.08 (0.13)	1.09
1972-76 (30-34)	0.18** (0.05)	1.19	0.19** (0.05)	1.21	0.03 (0.14)	1.03
1977-81 (25-29)	0.23** (0.05)	1.26	0.24** (0.05)	1.27	0.14 (0.12)	1.15
1982-91 (15-24)	0.31** (0.05)	1.37	0.30** (0.05)	1.35	0.46** (0.14)	1.58
Age at first marriage						
$\leq$17 (RC)						
18-19	0.26** (0.03)	1.29	0.26** (0.04)	1.30	0.19 (0.10)	1.21
20-21	0.38** (0.04)	1.46	0.38** (0.04)	1.46	0.27* (0.11)	1.35
22+	0.31** (0.04)	1.36	0.28** (0.04)	1.32	0.48** (0.10)	1.63
Place of residence						
Rural (RC)						
Urban	0.16** (0.03)	1.17	0.19* (0.03)	1.21	-0.12 (0.09)	0.88
Province of residence					N.A	
Punjab (RC)						
Sindh	-0.24** (0.03)	0.78	-0.24** (0.03)	0.79		
NWFP	0.00 (0.03)	1.00	0.00 (0.03)	1.00		
Baluchistan	-0.31** (0.04)	0.74	N.A			
Education						
No (RC)						
Primary	0.06 (0.04)	1.06	0.07 (0.04)	1.07	-0.09 (0.17)	0.91
Secondary +	0.14 (0.04)	1.15	0.15** (0.04)	1.16	0.07 (0.12)	1.07
Husband education						
No or <=10 year schooling (RC)						
Higher	0.14** (0.04)	1.15	0.11 (0.04)	1.12	0.45** (0.10)	1.57
-2 log likelihood	111387.88		97435.58		9282.94	

*0.05>p$\geq$0.01; **p<0.01
RC: reference category
NA: not applicable
df: degrees of freedom
HR: hazard ratio

Table 6.13: Test of proportional hazard assumption (P-values) of the factors associated with age at first conception of currently married women in Cox model, 2006, Pakistan

Characteristics	Model 1B Total sample (n=8283) Probability (PH)	Model 2B Punjab, Sindh, NWFP (n=7313) Probability (PH)	Model 3B Baluchistan cases only (n=970) Probability (PH)
Birth cohort			
1957-61 (RC)			
1962-66	0.8627	0.8611	0.9575
1967-71	0.1728	0.1770	0.9611
1972-76	0.2196	0.1767	0.5236
1977-81	0.6999	0.5988	0.6015
1982-91	0.6488	0.4201	0.2653
Age at first marriage			
$\leq$17 (RC)			
18-19	0.7437	0.6118	0.4701
20-21	0.4767	0.1421	0.0068
22+	0.0013	0.0001	0.1707
Place of residence			
Rural (RC)			
Urban	0.4997	0.5239	0.3289
Province of residence			
Punjab (RC)			
Sindh	0.4783	0.5593	N.A
NWFP	0.3890	0.3971	
Baluchistan	0.0012		
Education			
No (RC)			
Primary	0.1473	0.1698	0.6414
Secondary +	0.0001	0.0029	0.0097
Husband education			
No or <=10 year schooling (RC)			
Higher	0.3696	0.6347	0.4885

Age at first marriage (AFM) is a significant covariate of FC in all six proportional hazard models. Women who had married at ages of 20 or 21 years are at 35 to 46 percent higher risk of FC than those who marry less than or equal to 17 years of age in Punjab, Sindh, NWFP in 2006 and all regions in 1990. Risk for FC in Baluchistan in 2006 is different.

There is no significant difference in FC risks between rural and urban areas in Balochistan; however, the risk of FC in urban areas of Balochistan is smaller than in rural areas. The risk of FC in Sindh is 22 per cent lower than Punjab in 2006. This is consistent with the results reported in earlier part of this Chapter (AFM models): women who lived in Sindh marry earlier than women in Punjab.

All six proportional hazard models revealed interesting findings regarding woman's education on DFC. A woman with secondary or above level education is 1.31 times more likely to conceive her first baby compared to woman with no education for all women model in 1990. AFM increased as level of education increases. The converse is true in model 3A: women who have secondary or above level of education are on lower risk of FC than those who have primary level of education. Another interesting result is: education up to secondary or above level of education is significant in three provinces (model 2B). Indeed, the same category is statistically insignificant in models 1B (all women) and 3B.

Husband's level of education is significant in 2006 data—where a woman is 1.57 more likely to conceive whose husband is highly educated. Woman's education has no effect in Baluchistan. In other region it has a rather weak effect in 2006 only at secondary level. Consequently husband's education in Balochistan accelerates childbearing.

6.7.5 Evaluating Cox proportional hazard models

The Cox model assumes that the hazard ratio comparing any two specifications of predictors is constant over time. Equivalently, this means that the hazard for one individual is proportional to the hazard for any other individual, where the proportionality constant is independent of time. Different approaches are available for the evaluation of proportional hazard assumption (Kleinbaum and Klein 2005). Goodness of fit test approach based on Schoenfeld residuals using a chi-square statistic is used in this study to evaluate the models shown in Table 6.11 and Table 6.13 (Schoenfeld 1982, Cleves et al. 2010). The judgment is based on the formal statistical test in which probability value (P-value) is used for evaluating the proportional hazard assumption. A non-significant P-value (greater than 0.05) suggest that the proportional hazard assumption is satisfied. Table 6.11 (for PDHS 1990) and 6.12 (for PDHS 2006) present P-values for the coefficients estimated in Cox models. For PDHS 1990, model 3A is completely satisfying the proportional hazard assumption. Model 1A and 2A satisfied the proportional hazard assumption on all covariates except those women whose AFM is 22 or above and those who have secondary or higher education. For AFC the main focus is placed on models for all women and women from Baluchistan only. Figure 6.7 presents the hazard plot for all women in 1990 with the hazard plot for women marrying at age 22 or above, where in this case; the proportional hazard assumption is not satisfied. The behavior of the hazard plot is quite similar with Figure 6.5—unusual shape of hazard for the first 15 months. Figure 6.8 presents the hazard plots of covariate categories not satisfying proportional hazard assumption for 2006 PDHS. The hazard shapes in both figures are quite similar in fashion. The main remark in this line of argument is that whether proportional hazard assumption is satisfied or not, the behavior of hazard for FC is same which left us with a decision to rely on the fitted Cox models.

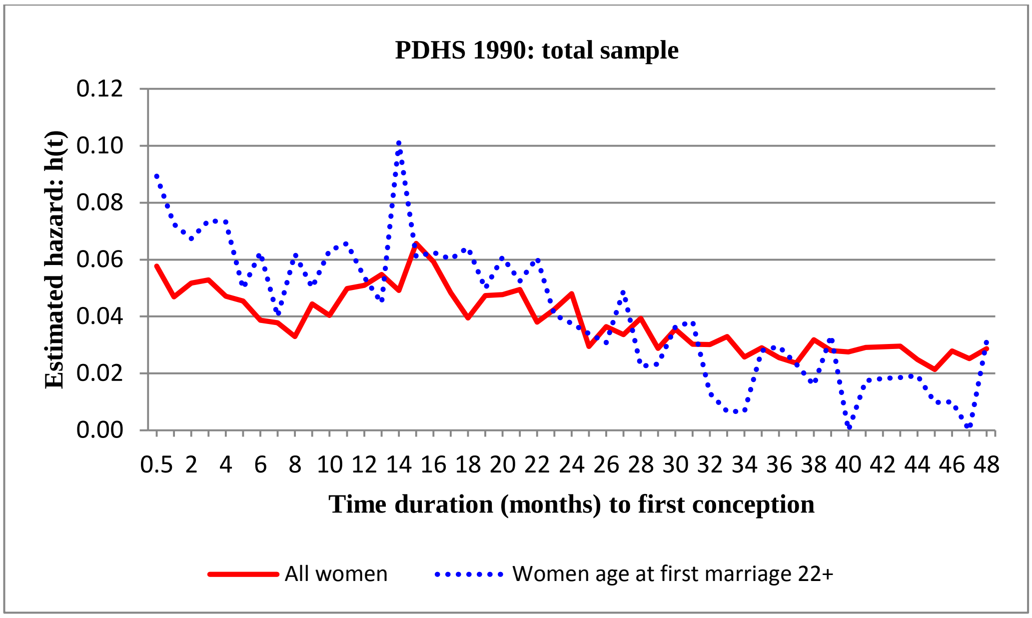


Figure 6.7: Hazard plots of age at first conception for currently married women with a category of covariate not satisfying proportional hazard assumption, Pakistan, 1990

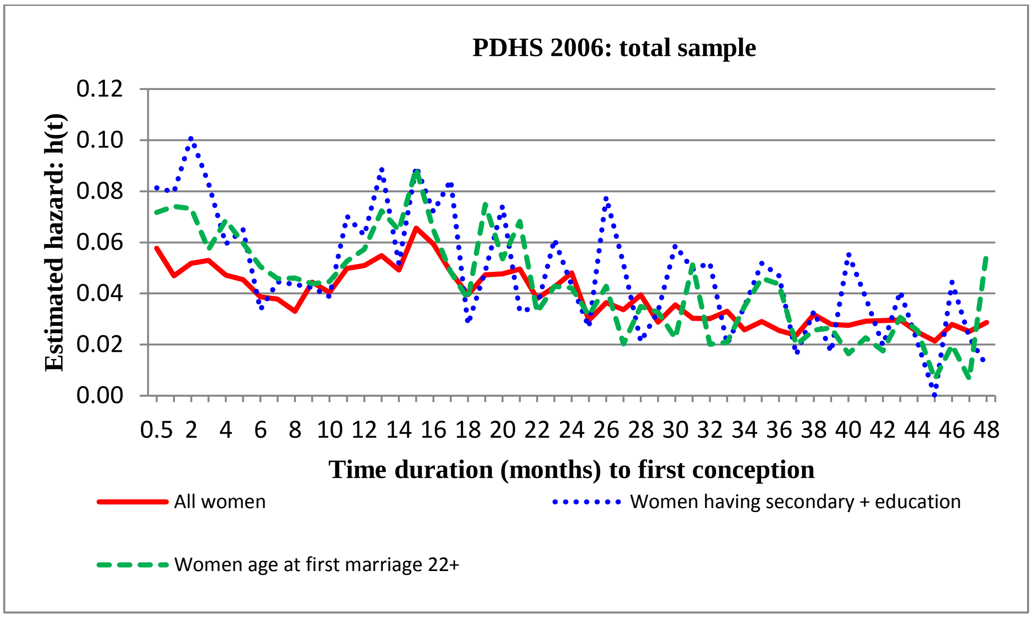


Figure 6.8: Hazard plots of age at first conception for currently married women with a category of covariates not satisfying proportional hazard assumption, Pakistan, 2006

6.8 Concluding remarks

Timing of marriage, first conception, and first birth forms an important group of variables in demographic analysis due to their influence on subsequent fertility especially in countries where contraceptive prevalence rates are low. This Chapter presents the analysis of these variables in the context of Pakistan. This is particularly important in Pakistan where there is scarcity of such investigation. Two Demographic and Health Surveys (1990 and 2006) provided unique opportunity to address this research gap.

The bivariate correlations between AFM and AFB are positive and highly (more than 70 per cent) significant across all geographic regions with some exceptions in Sindh and Baluchistan for 1990. The descriptive analysis of AFM and AFB suggests that urban areas and Baluchistan has shown a substantial increase in both variables (AFM, AFB). The higher AFB also reduces the number of children ever born. The rural resident women are at the front compared to other regions in the inverse type relation between AFB and mean number of children ever born. As expected, the relationship between AFM and AFB is positive, yet the difference revealed to be greatest in Baluchistan compared to other regions. The multivariate findings suggest that there are likely to be variations in the AFM exhibited by various provinces in Pakistan especially in Baluchistan where women aged 25-49 between 1990 and 2006 marry, on average, 1.13 year late than other provinces. For example, the final estimated models for AFM predicts that a woman aged 25-49 living in Baluchistan with higher level of education, and her husband having higher education would marry at about 24 years. Conversely, a 25-29 year aged non-Baluchistan woman with higher level of education and her husband with higher level of education would marry about 22 years (21.91 years). Thus the age at marriage diverges in provinces especially in Baluchistan. These findings have profound implications on woman's AFC in Baluchistan.

For the time to first conception analysis standard parametric models are attempted and results suggest that none of the fitted parametric models capture the behavior of waiting time to first conception among Pakistani women. The investigation of hazard plots explained the lack of fit for parametric models with unusual behavior of hazard for first 15 months. The prognosis for duration of FC in Baluchistan was found to be different using non-parametric estimator. However, the findings of Cox regression models for FC also suggest considerable variations in time to FC in provinces especially in Baluchistan. AFM is revealed to be a significant covariate of FC in multivariate Cox models. Age at marriage differences are observed such that women who are very young (married under age 16 years) more likely to delay sexual activity for some time after marriage or these women might experience a normal delay. Women who married aged 16 years or above are following the traditional and social pattern set in Pakistan in which first pregnancy takes place as soon as possible after the marriage thus these women will have high hazard of conception. These two features are evidenced by the following figures (Figure 6.9 and Figure 6.10) in the 1990 and 2006 data. Similar hazard plots for regions using 2006 survey are produced in Appendix G2.

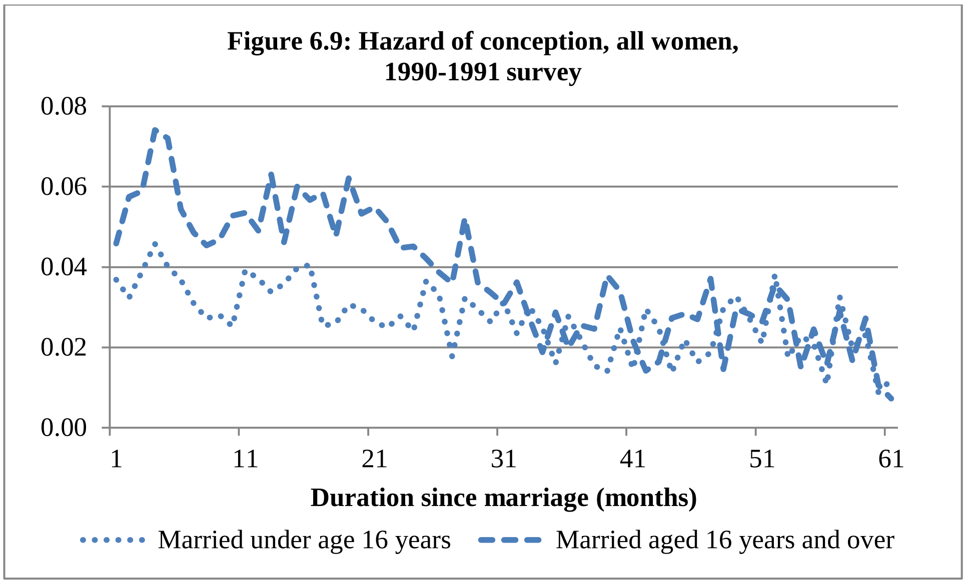


Figure 6.9: Hazard of conception, all women, 1990-91 survey

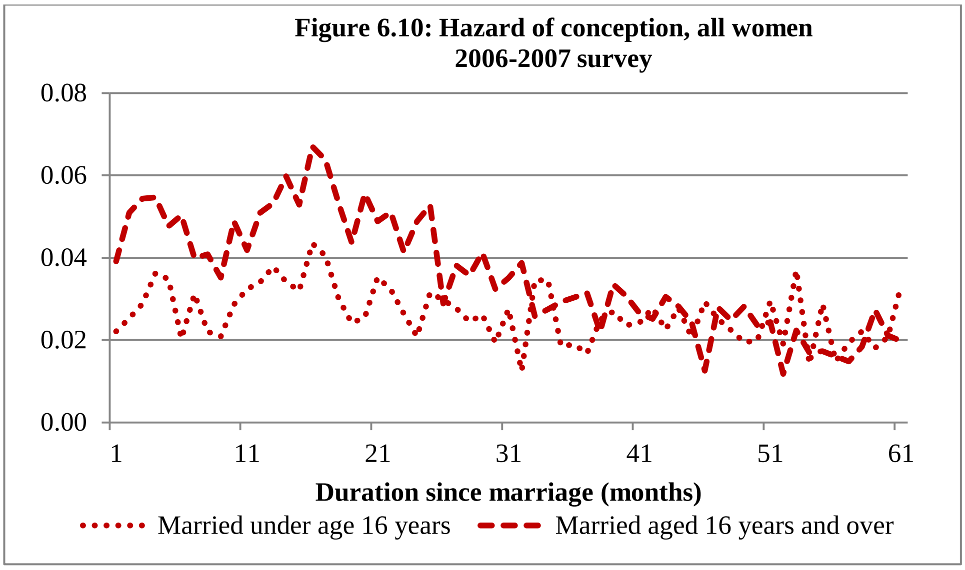


Figure 6.10: Hazard of conception, all women, 2006-07survey

7 BIRTH INTERVALS IN PAKISTAN

7.1 Introduction

One of the main aims of the analysis presented in this chapter is to determine the effect of fixed as well as time-varying covariates on birth interval length. This chapter presents the results of analysis of waiting time to second through sixth conception in Pakistan since 1990s. Section 7.2 explains statistical techniques for waiting time analysis. Section 7.3 highlights the factors from the literature influencing birth intervals and presents the conceptual framework developed for the present study. Section 7.4 explains the data management for pregnancy interval analysis. Hazard patterns for pregnancy intervals are examined in section 7.5. Section 7.6 discusses the application of multivariate statistical models for waiting time distributions of second through sixth conception in Pakistan since the 1990s. Additionally, this chapter aims to examine the calendar or person-month data to account for the effect of breastfeeding, amenorrhea and child survival by employing discrete time hazard models (section 7.7-7.8). The chapter concludes with summary statement in section 7.9.

7.2 Stratified Cox model

It is the modification of the Cox proportional hazard model. This model allows for control by stratification of covariate(s) that does not satisfy the proportional hazard assumption—covariate(s) being stratified is not included in the model. Following is a general expression for a simple stratified Cox model in which one binary covariate not satisfying the proportional hazard assumption.

$$h_g(t,z) = h_{0g}(t) \times \mathrm{Exp}\left(\sum_{j=1}^{p} \beta_j Z_j\right) \qquad (1)$$

For strata $g = 1,2,\cdots k^*$ in equation (1) and $h_{0g}(t)$ is the baseline hazard function for g stratum. Different baseline function for each stratum will yield different estimated survival curves of each stratum.

7.2.1 Extended Cox model

It is an alternative to the stratified Cox model which allows time varying covariates in the model. In the standard Cox model all covariates $Z_1, Z_2, Z_3, \ldots . Z_p$ are assumed to be time independent—Z`s do not incorporate time. The general expression for extended cox model is shown in equation (2).

$$h(t,z(t)) = h_0(t) \times \mathrm{Exp}\left(\sum_{j=1}^{p_1} \beta_j Z_j + \sum_{j=1}^{p_2} \delta_j Z_j g_j(t)\right) \qquad (2)$$

Where Z_j are the time independent covariates, $Z_j g_j(t)$ are the time varying covariates with $g_j(t)$ be a *heaviside step function*—exponential part of equation (53) contains both time independent and time varying covariates and $h_0(t)$ is the baseline hazards function.

In general $$g_i(t) = \begin{cases} 0 & if \quad t \geq t_0 \\ 1 & if \quad t < t_0 \end{cases}$$

7.3 Conceptual framework for pregnancy intervals

Demographic literature particularly for developing countries has shown the influence of several factors on the waiting time to conception. The factors affecting chances of conception may vary with the stage of the woman's reproductive life, e.g. as she moves from one parity to the next (Khalifa 1989). From previous research, the following prominent factors (birth cohort, mother age at first marriage, sex of the previous child, woman's and her husband education, region and province of residence, duration from marriage to first birth, age of the mother at previous pregnancy, immediate previous child is alive or not) are observed to have a relationship with waiting time to conception or birth intervals. The factors are formally grouped into three main determinants: demographic, socio-economic, biological and behavioral (time dependent). The visual presentation of relationship between determinants effecting pregnancy intervals is shown as conceptual framework in Figure 7.1.

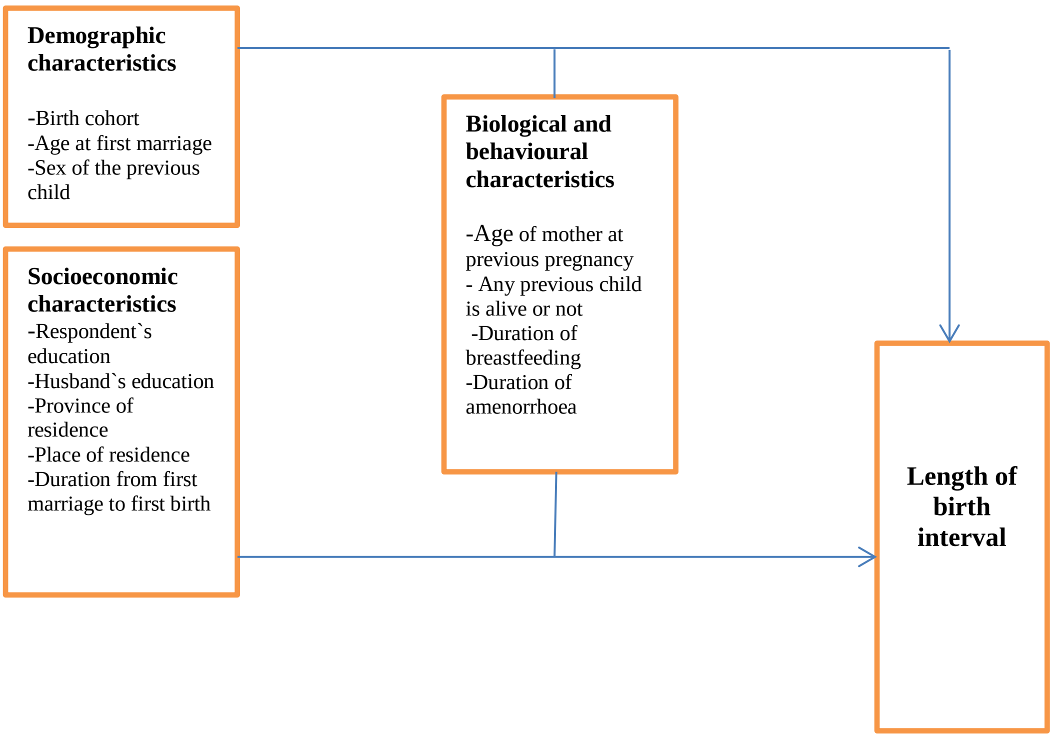


Figure 7.1: Conceptual framework for duration time from second through sixth conception model of currently-married women in Pakistan, 1990 and 2006

The framework is an adaptation of the work presented by Bongaarts (Bongaarts 1982). Using aggregate analysis with countries as units, Bongaarts demonstrated that demographic and socioeconomic characteristics influence the length of birth intervals through biological and behavioural characteristics. Contrary to the Bongaarts framework, previous research using individual-level birth intervals analysis has shown a direct effect of demographic or socioeconomic characteristics on the length of birth intervals (Trussell et al. 1985, Bumpass et al. 1986). Using Pakistan as case study, this analysis can help to provide a picture that whether demographic and socioeconomic characteristics have direct effect on length of birth interval after controlling for biological characteristics—in particular breastfeeding and amenorrhea.

7.3.1 Demographic factors

Birth cohorts: maternal age is observed to be an important determinant of child spacing in many studies (Mannan and Islam 1995, Ren 1995, Roudi 1995). Young women have a significantly greater risk of short birth interval than older women, presumably because of greater frequency of intercourse and perhaps greater fecundity. In addition to intercourse and fecundity, women in Pakistan at younger ages are less likely to use contraceptives than older women (Mahmood and Ringheim 1997). Based on the latest findings from 2006-07 Pakistan Demographic and Health Survey (PDHS), the ever and current use of contraception is relatively higher in age group 35 years and above. Following the remarks on age cohorts, following research hypothesis is proposed for the analysis of pregnancy intervals:

'Waiting time to pregnancy will increase as the age of the Pakistani women increases'

Age at first marriage: Age at marriage (AFM) has a highly significant effect on the length of birth intervals. Age at marriage has a strong effect on family size (Chi and Hsin 1996). Women who marry late have shorter birth intervals than those who marry at very young ages, which taken together mean that women marrying at older ages have fewer children than those who marry younger. Age at first marriage (AFM) has played a key role in the fertility transition of Pakistan particularly after 1990s; however, following hypothesis could be proposed:

'Waiting time to pregnancy will be shorter for females who marry late in Pakistan'

Sex of the previous child: many studies found that birth intervals are longer following a male than a female child (Wyshak 1969, Blanchard and Bogaert 1997, Awang 2003). In addition, parents particularly in South Asia provide better care for males than females. Son preference is evident in Pakistan and has an independent effect on contraceptive related decision making and birth intervals of women. The use of contraception is seemed to be lower among Pakistani women with daughters only (Hussain and Bittles 1999). In an earlier study, Nag found a preference for sons in Pakistan, India and Bangladesh (Nag 1991) and concluded a higher preference for sons in Pakistan as compared to India and Bangladesh. The proposed hypothesis is as follows: 'Waiting time to pregnancy will be shorter when the index child is female'

7.3.2 Socio-economic factors

Woman`s and husband`s education are mostly regarded as strong correlate of fertility. Literature exists for the negative relationship between education and fertility and between fertility and contraceptive use. Studies conducted in Pakistan also found the same relationship between fertility and education (Mahmood and Ali 1997, Mahmood and Ringheim 1997, Saleem and Pasha 2007). Educated women have a higher exposure to family planning which in turn increases the birth interval length:

'Waiting time to conception will be longer with increase in female education'

'Waiting to conception will be longer if a woman`s husband is highly educated'

Place and province of residence: these socio-demographic variables are frequently used in studies related to birth intervals. It could be expected that waiting time to pregnancy will be longer provided that woman live in urban areas. Literacy is widely acknowledged for its association with a number of positive outcomes to lower fertility levels. For example urban women (58 per cent) were much more likely to literate than rural women (24 per cent) in 2006-07 PDHS. It could be hypothesized that pregnancy intervals will also be longer if woman's place of residence is urban.

Duration from marriage to first birth: immediate childbearing after marriage is a social norm in Pakistani society—an indicator of family and marriage stability could be assessed through this event. It could be assumed that if the duration between marriage and first birth is shorter then pregnancy intervals after first birth would also be shorter.

7.3.3 Biological and time dependent factors

Mother's age at previous birth: birth interval dynamics differ with mother's age and have strong effect on birth spacing. Previous research in Pakistan reported a short interval duration for young mothers (Sathar 1988). This leads to the following research hypothesis:

'the higher the mother's age at previous pregnancy, the longer the waiting time to conception'

Immediate previous child is dead or not: among South Central Asian countries Pakistan ranks second in infant mortality rate (68 per 1000 live births)(Population Reference Bureau 2012). Culturally in Pakistan an immediate desire of a replacement child is normal following the death of a previous child, particularly a male baby. Under this scenario, it could be presumed that waiting time to conception would be shorter provided that the death of immediate previous child is under 17 months.

7.4 Data management for pregnancy intervals

For modeling waiting time duration from second through sixth conception, the outcome variables is the time gap between i^{th} birth to the conception of the $(i+1)^{th}$ birth, where $i = 1,2,\ldots 5$. The outcome variables are calculated by subtracting nine months from difference between i^{th} and $(i+1)^{th}$ birth. For example Figure 7.2 shows the presentation of sample size with censoring mechanism for second pregnancy interval of ever-married women in two survey samples. As pregnancy dates are computed from birth dates, for women who did not give birth before survey we will not know whether or not they are conceived during the 9 months immediately before the survey date. So we can divide women who had a first birth into 3 groups (1, 2, and 3). Note that B refers to births and C refers to censoring.

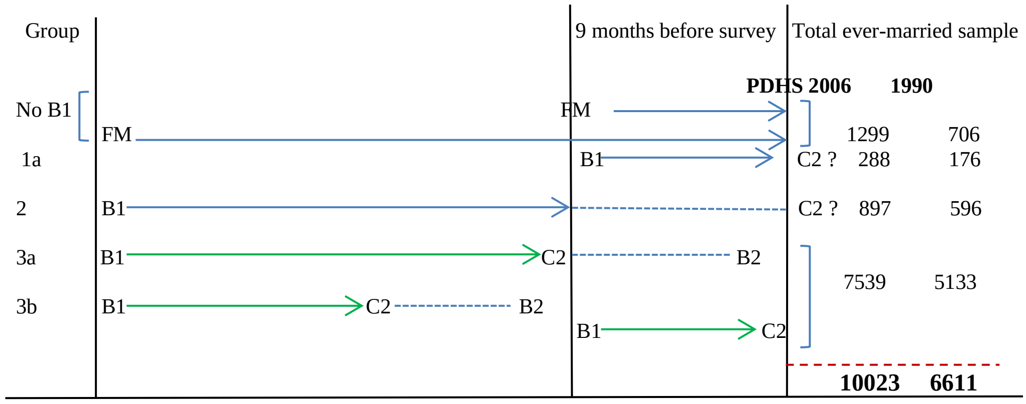
Group 1a: B1 within 9 months before the survey date with no C2

Group 2: B1 greater than 9 months before survey date but C2 did not occur by a the fixed censoring time (a point of 9 months) before survey date

Group 3a, b: First birth (B1) and second conception (C2) both greater than 9 months before survey date

Group 4: Theoretically within 9 months of survey date both B1 and C2 could occur, but this situation is very unlikely

Figure 7.2: Sample size distribution with censoring mechanism for duration time to second conception model of ever-married women in Pakistan, 1990 and 2006



Age at first marriage (AFM) Censoring time Survey date

(9 months before the survey)

Calendar Time

FM: first marriage

B: birth

C: Conception

PDHS: Pakistan Demographic and Health Survey

Table 7.1: Sample size distribution for pregnancy intervals of ever-married women in Pakistan, 1990 and 2006

Birth Order i	PDHS 2006 Birth i more Than 9 months Before survey	Birth $(i+1)$ in 9 months $(i+1)$	No Birth	PDHS 1990 Birth i more than 9 months before survey	Birth $(i+1)$ in 9 months $(i+1)$	No Birth
0	10023	288	1299	6611	176	706
1	8436	268	897	5729	167	596
2	7271	215	1042	4966	144	588
3	6014	179	1014	4234	128	691
4	4821	123	1019	3415	105	622
5	3679	-	-	2688		

For determining the second pregnancy interval second birth is the event of interest and this is shown with the green line starting from B1 to B2 in the window of interest—age at first birth to 9 months before the survey date (Figure 7.2). Other two duration lines for example starting from B1 and have not observed B2 by the fixed censoring time (897 women in PDHS 2006, and 596 women in PDHS 1990) and those starting from B1 leading to B2 in the window after the censoring time, these duration times are censored. The complete sample size distribution for pregnancy interval of ever-married women sample with no births is shown in Table 7.1. In 2006 survey there were 10,023 women of these 1,299 did not have a first birth before the survey date and 288 had their first birth in 9 months before the survey. None of these women would be included in the analysis of the second birth interval, leaving 10,023 - 1,299 = 8,436 women for whom we observe at least part of their second birth interval.

Of these 8,436 women, 897 did not have a second birth before the survey and 268 had a second birth within 9 months window of survey, leaving 8,436 - 897 - 268 = 7271 women for whom we observe at least part of their third birth interval.

We have some women whose intervals are computed as of length 0 or -1 in our data. This is because we estimate the data of conception from the reported date of the next birth. Clearly, the duration between birth i and conception of birth $i+1$ cannot be 0 or negative, so we recorded these to durations of 0.5 months. A 60-month window for duration second through sixth conception is used in this analysis. This coding helps to avoid the problem of shifting the small sample sizes around second through sixth pregnancy intervals after 60 months.

7.4.1 Descriptive analysis for pregnancy intervals

Table 7.2 presents two summary measures (mean and median time durations) for pregnancy intervals (months) in Pakistan. These are calculated separately for two surveys (1990 PDHS and 2006 PDHS) and for seven geographic strata.

Both mean and median shows that waiting time increases with birth order. Similarly, waiting times tend to be longer in 2006-07 than in the 1990 survey, especially at higher parities. For example in case of the waiting time to the second conception, no substantial change is observed from 1990 (median: 15 months) to 2006 (16 months).This is true across all geographic regions with perhaps an exception in Sindh (1990: 14 months, 2006: 16 months). In the case of waiting time to sixth conception for women in urban areas and the Punjab, a difference of four months is observed from 1990 to 2006.

Other interesting finding is that in 1990 for second (and third conceptions as well), waiting times are shorter in urban areas than their rural counterparts. For example in 1990, the mean duration until the second conception ($18.22 \approx 18$ months) of urban women is about two months shorter than that for rural women ($19.91 \approx 20$ months). Across provinces, second conception time (20.67 months) of women in Baluchistan is higher than Punjab, Sindh and NWFP in 1990. The directions of the findings of the analysis remained similar irrespective of mean or median.

Table 7.2: Descriptive measure for waiting time to conception (months) of currently married women in Pakistan, 1990 and 2006

Conception	PDHS 2006 Mean (SE)	Median (SE)	N	PDHS 1990 Mean (SE)	Median (SE)	N
Total						
Second	19.98 (0.18)	16.00 (0.15)	7833	19.04 (0.22)	15.00 (0.16)	5427
Third	22.45 (0.21)	17.00 (0.19)	6771	20.38 (0.25)	16.00 (0.18)	4710
Fourth	23.86 (0.25)	18.00 (0.26)	5583	22.37 (0.29)	17.00 (0.21)	4015
Fifth	25.94 (0.30)	19.00 (0.35)	4470	23.69 (0.34)	17.00 (0.26)	3243
Sixth	27.21 (0.37)	20.00 (0.47)	3400	24.99 (0.41)	18.00 (0.37)	2554
Urban						
Second	19.50 (0.29)	15.00 (0.26)	3036	18.22 (0.30)	15.00 (0.25)	2810
Third	23.33 (0.36)	18.00 (0.38)	2613	19.96 (0.34)	16.00 (0.25)	2456
Fourth	25.75 (0.44)	19.00 (0.59)	2133	22.35 (0.41)	17.00 (0.30)	2125
Fifth	28.60 (0.53)	21.00 (0.71)	1639	23.96 (0.48)	18.00 (0.36)	1692
Sixth	29.62 (0.65)	22.00 (1.07)	1182	24.82 (0.56)	18.00 (0.51)	1323
Rural						
Second	20.28 (0.23)	16.00 (0.17)	4797	19.91 (0.31)	16.00 (0.23)	2617
Third	21.90 (0.27)	17.00 (0.23)	4158	20.84 (0.36)	16.00 (0.27)	2254
Fourth	22.70 (0.30)	17.00 (0.28)	3450	22.40 (0.42)	17.00 (0.29)	1890
Fifth	24.39 (0.36)	18.00 (0.40)	2831	23.39 (0.48)	17.00 (0.38)	1551
Sixth	25.89 (0.44)	19.00 (0.49)	2218	25.17 (0.59)	18.00 (0.54)	1231
Punjab						
Second	19.53 (0.27)	16.00 (0.20)	3323	18.31 (0.35)	16.00 (0.25)	1762
Third	21.91 (0.32)	17.00 (0.24)	2899	19.89 (0.40)	16.00 (0.28)	1544
Fourth	24.16 (0.39)	18.00 (0.40)	2395	23.02 (0.50)	17.00 (0.38)	1312
Fifth	26.98 (0.47)	19.00 (0.57)	1913	24.34 (0.59)	19.00 (0.53)	1047
Sixth	28.76 (0.58)	22.00 (0.80)	1430	24.98 (0.71)	18.00 (0.71)	814
Sindh						
Second	20.22 (0.36)	16.00 (0.32)	2105	18.77 (0.43)	14.00 (0.31)	1504
Third	23.01 (0.43)	18.00 (0.44)	1808	20.64 (0.50)	15.00 (0.38)	1307
Fourth	24.01 (0.51)	18.00 (0.49)	1470	21.77 (0.57)	16.00 (0.48)	1119
Fifth	25.77 (0.60)	19.00 (0.81)	1152	23.58 (0.67)	17.00 (0.61)	903
Sixth	25.35 (0.72)	19.00 (0.78)	858	25.14 (0.79)	18.00 (0.77)	724
NWFP						
Second	19.47 (0.41)	16.00 (0.33)	1492	19.32 (0.43)	16.00 (0.31)	1368
Third	22.32 (0.47)	18.00 (0.46)	1305	21.05 (0.50)	16.00 (0.34)	1186
Fourth	22.86 (0.55)	18.00 (0.67)	1089	22.02 (0.54)	17.00 (0.37)	1006
Fifth	24.59 (0.63)	19.00 (0.69)	891	22.67 (0.61)	17.00 (0.43)	840
Sixth	26.82 (0.77)	19.00 (0.82)	706	24.36 (0.75)	18.00 (0.51)	676
Baluchistan						
Second	21.89 (0.57)	17.00 (0.71)	913	20.67 (0.63)	16.00 (0.50)	793
Third	23.44 (0.66)	18.00 (0.60)	759	19.71 (0.66)	16.00 (0.51)	673
Fourth	24.11 (0.73)	19.00 (0.76)	629	22.73 (0.83)	17.00 (0.51)	578
Fifth	24.78 (0.87)	18.00 (0.81)	514	24.28 (0.95)	17.00 (0.66)	453
Sixth	26.35 (1.02)	19.00 (1.13)	406	25.89 (1.18)	19.00 (1.07)	340

PDHS: Pakistan Demographic and Health Survey

7.5 Hazard examination for pregnancy intervals

Figure 7.3 (a) through (e) present the unadjusted hazard plots for the second through the sixth birth intervals using two survey samples. The pattern of hazard values is similar for all birth intervals. For the first 16 months the hazard increases pattern, with the modal waiting time to conception being about 16 months. This finding is consistent with the descriptive analysis shown in section 7.4—a waiting time of 16-20 months (median) is observed for second through sixth conception. Why does the hazard increase for about 16 months in all pregnancy intervals? One obvious explanation is breastfeeding, which is very common in Pakistan. Culturally non-breastfeeding is not accepted. The practice of breastfeeding has an inhibitory effect on ovulation and increases the birth interval length. In Chapter 6 the mean duration of duration of postpartum infecundability (MPPI) using the duration of breastfeeding has been calculated (MPPI: 12.06 months in 1990 and 11.75 months in 2006). It explains that on average breastfeeding causes Pakistani women to remain infecund for about 12 months after each birth. The period after 12 months up to 16 months is important for most women in Pakistan as the hazard of conception increases rapidly. There is clear possibility of no use of contraception during this period and hence the women have complete exposure and are sexually active for their next conception. It may be true that during the waiting time 12 to 16 months many of Pakistani women are still breastfeeding partially and presume that they will not conceive while they are breastfeeding when their reduction in the frequency of lactation has used their fecundity. Age heaping could be noticed in figure 7.3 (a) through (e), which is more widespread in 1990 survey than in 2006-07.

Figure 7.3 a
Hazarad plot of second pregnancy interval: total sample

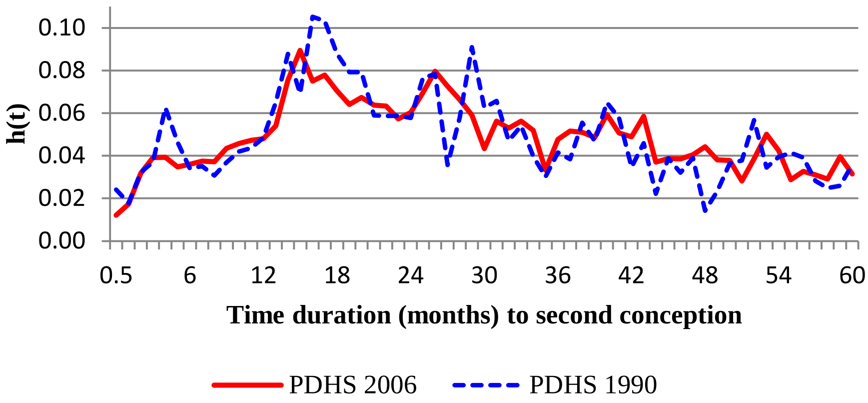


Figure 7.3 b
Hazarad plot of third pregnancy interval: total sample

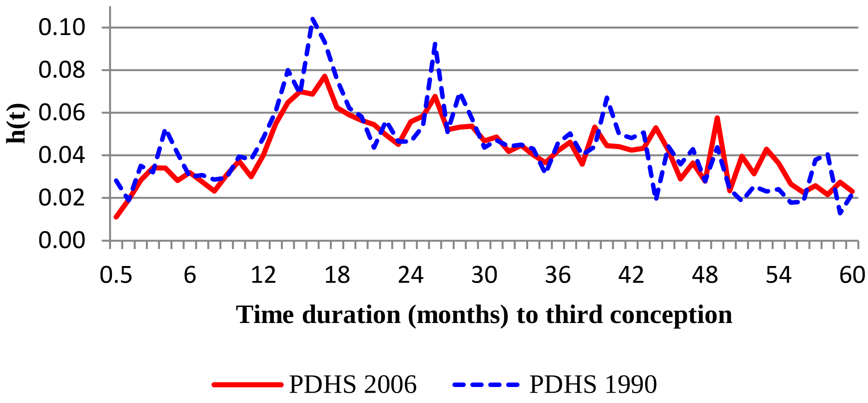
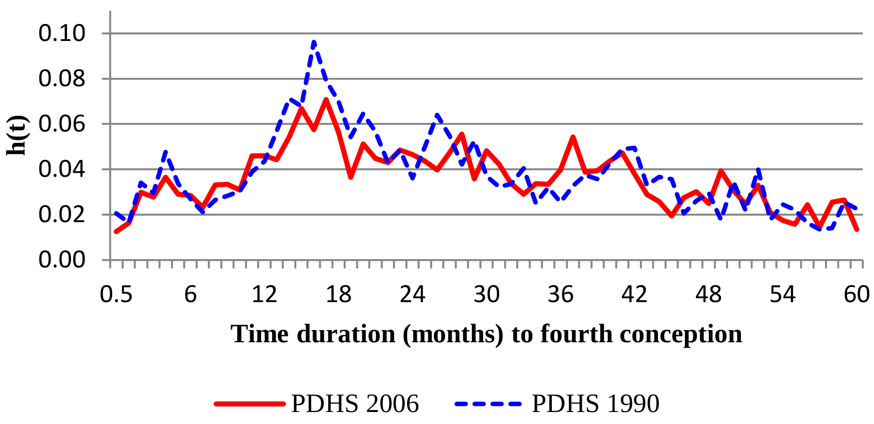


Figure 7.3 c
Hazarad plot of fourth pregnancy interval: total sample



PDHS: Pakistan Demographic and Health Survey

Figure 7.3: Hazard plots of second through sixth pregnancy intervals for currently married women in Pakistan, 1990 and 2006

Figure 7.3 continued

Figure 7.3 d
Hazarad plot of fifth pregnancy interval: total sample

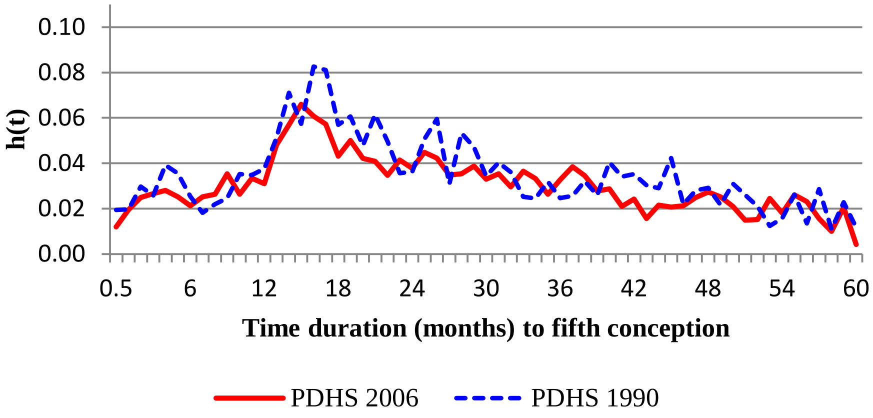
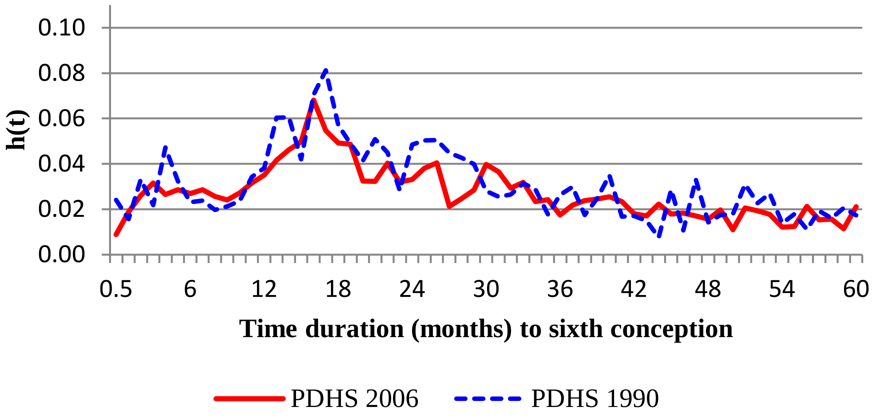


Figure 7.3 e
Hazarad plot of sixth pregnancy interval: total sample



PDHS: Pakistan Demographic and Health Survey

Statistically speaking for modeling purposes, for the first 16-20 months the hazard behavior could be captured using parametric probability distribution, for example, Weibull, lognormal or log-logistic distribution. After sixteen months, the hazard values are roughly decreasing. By dividing the hazard plots into two patterns, for 0-16 months increasing and after 16 months decreasing, it is argued that parametric probability models with increasing and decreasing hazard could be combined to capture the waiting time distribution of pregnancy intervals—or mixture distribution might well model the behavior of the hazard values.

7.6 Regression models for pregnancy intervals

The shapes of hazard plots for pregnancy intervals shown in section 7.5 conclude that parametric survival model would not be simple instead a semi-parametric or non-parametric probability model could be better in this case. For empirical checks on parametric modeling the application of graphical plots of two parametric survival models (Log normal and Log logistic) are presented in Appendix H. The illustration is made for PDHS 2006. Figures (H1 through H10) shown in Appendix H reveals a non-linear pattern suggesting that none of the fitted models are suitable to model the hazard of pregnancy intervals.

One of the semi-parametric models namely Cox regression model is deemed an appropriate choice to model the hazard patterns. Currently married women sample is used for Cox regression with its versions—stratified Cox and extended Cox (Cox model using time dependent covariates). The factors shown in the conceptual framework of this chapter for pregnancy intervals (section 7.3, Figure 7.1) are used for modeling purposes. Overall for second through sixth pregnancy intervals two types of Cox models are estimated: Cox model with fixed, constant covariates including standard Cox and stratified Cox model, and Cox model with time-dependent covariates (extended Cox model).

However, Table 7.3 shows the frequency and mean waiting time from second through sixth conception of respondents by their basic background characteristics (age is years, place and province of residence, respondent and her husband education level and respondent age at first marriage). We split the description, between those characteristics that appear to have no increase on the mean waiting time to conception, those that found to have increase. Those characteristics that appear to have little variation in the waiting time to conception are plentiful. They include, for example in 2006, birth cohorts, gender of the index child, between Sindh and NWFP, those women and their husbands who have no level of education. In addition, younger age birth cohorts have high mean average duration of conception in 2006 compared to 1990. If the index child is a male baby, waiting time is found to be higher compared to a female baby. Average duration to conception is urban areas was found higher compared to rural areas. Given our understanding of waiting time to conception shown in Table 7.3, there are few surprises: Women from Balochistan found to have longer durations to conception than other provinces particular in middle order conception—second (19.90 months), third (21.52 months) and fourth (22.03 months) conception in 2006. Education level of the respondent particularly in 2006 is found to have great variation in increasing the waiting time to conception. For example, women having higher level of education conceive third baby (26.71) about seven months late compared to those having no level of education (19.86 months).

Table 7.3: Average duration (months) of waiting time to conception of currently married women by basic background characteristics in Pakistan, 1990 and 2006

Characteristics	2006 PDHS					1990 PHS				
	Second n=7833	Third n=6771	Fourth n=5583	Fifth n=4470	Sixth n=3400	Second n=5427	Third n=4710	Fourth n=4015	Fifth n=3243	Sixth n=2555
Age cohort										
45-49	20.45(1016)	21.26(999)	21.44(962)	23.68(903)	25.34(805)	19.77(546)	19.84(530)	21.88(514)	23.38(480)	23.78(435)
40-44	19.62(1090)	21.56(1061)	22.87(1012)	26.04(923)	25.87(782)	20.05(726)	20.31(712)	22.16(682)	22.71(632)	24.25(569)
35-39	19.42(1438)	21.33(1382)	22.89(1288)	24.41(1117)	25.33(891)	18.77(931)	19.47(901)	21.09(852)	21.94(757)	22.13(656)
30-34	18.60(1508)	21.47(1403)	22.23(1199)	22.34(930)	21.11(650)	17.40(1099)	18.94(1029)	19.54(923)	21.93(756)	19.90(560)
25-29	18.27(1647)	19.07(1331)	19.93(889)	17.93(521)	15.96(252)	16.43(1256)	18.14(1071)	18.77(814)	17.71(528)	17.56(301)
15-24	14.82(1134)	14.93(595)	13.76(233)	13.02(76)*	10.57(20)*	15.21(869)	15.61(467)	15.70(230)	12.92(90)*	18.60(34)*
Age at first marriage										
≤ 17	19.23(3870)	20.00(3487)	20.84(3027)	22.48(2536)	23.30(2003)	17.97(2916)	18.89(2609)	20.16(2279)	20.91(1909)	21.95(1536)
18-19	18.00(1543)	20.35(1347)	21.49(1085)	23.78(861)	24.71(645)	17.31(944)	18.41(805)	19.86(679)	21.55(531)	21.32(408)
20-21	17.61(1060)	20.73(879)	22.65(695)	24.33(541)	25.05(390)	17.45(680)	18.85(586)	20.04(484)	23.09(368)	21.53(287)
22+	17.77(1360)	21.37(1058)	24.08(776)	24.81(532)	24.25(362)	17.11(887)	19.13(710)	21.15(573)	21.68(435)	22.01(324)
Gender of the index child										
Female	18.08(3742)	19.68(3277)	20.57(2687)	22.24(2137)	23.36(1666)	17.21(2577)	18.95(2262)	19.42(1969)	21.12(1565)	21.50(1271)
Male	18.91(4091)	21.02(3494)	22.64(2896)	24.12(2333)	24.37(1734)	18.06(2850)	18.73(2448)	21.03(2046)	21.59(1678)	22.12(1284)
Place of residence										
Urban	18.06(3036)	21.15(2613)	23.08(2133)	25.60(1639)	26.23(1182)	16.98(2810)	18.54(2456)	20.15(2125)	21.56(1692)	21.72(1323)
Rural	18.81(4797)	19.89(4158)	20.75(3450)	21.87(2831)	22.61(2218)	18.38(2617)	19.17(2254)	20.33(1890)	21.14(1551)	21.90(1232)
Province of residence										
Punjab	18.27(3323)	19.90(2899)	21.93(2395)	24.33(1913)	25.23(1430)	17.08(1762)	18.27(1544)	20.62(1312)	21.27(1047)	21.56(814)
Sindh	18.64(2105)	20.78(1808)	21.64(1470)	22.59(1152)	21.82(858)	17.54(1504)	19.23(1307)	19.76(1119)	21.54(903)	22.04(724)
NWFP	18.05(1492)	20.22(1305)	20.79(1089)	21.99(891)	23.75(706)	17.89(1368)	19.45(1186)	20.18(1006)	20.63(840)	21.45(676)
Baluchistan	19.90(913)	21.52(759)	22.03(629)	22.62(514)	23.63(406)	18.74(793)	18.31(673)	20.39(578)	21.55(453)	22.56(341)
Education										
No	18.63(5288)	19.86(4696)	20.41(4037)	22.20(3398)	22.96(2714)	17.97(4168)	18.52(3652)	19.75(3164)	20.58(2629)	21.38(2124)
Primary	18.06(1032)	19.21(866)	22.34(693)	24.01(533)	25.54(383)	16.08(492)	18.75(430)	18.90(354)	22.52(273)	22.32(221)
Secondary	18.00(1015)	21.49(804)	24.96(597)	27.78(418)	29.62(248)	16.82(678)	19.86(556)	23.28(444)	25.98(321)	25.20(203)
Higher	19.27(498)	26.71(405)	31.44(256)	32.62(121)	31.52(55)	17.69(89)	27.44(72)	32.79(53)	35.00(20)	35.14(7)
Husband education										
No	19.16(2901)	20.03(2588)	20.29(2226)	21.72(1910)	21.44(1555)	18.18(2473)	18.74(2176)	19.99(1903)	20.66(1580)	21.38(1283)
Primary	17.73(1233)	19.10(1087)	19.45(928)	22.46(758)	23.89(593)	17.20(863)	18.02(771)	19.65(662)	20.67(544)	21.07(439)
Secondary	17.92(2428)	20.09(2017)	22.86(1599)	24.62(1227)	26.80(883)	17.19(1685)	18.79(1423)	19.47(1172)	22.07(932)	22.19(710)
Higher	18.94(1271)	23.07(1079)	25.37(830)	26.21(575)	26.94(369)	17.31(406)	21.52(340)	26.53(278)	25.82(187)	26.61(123)

N.A: not applicable
PDHS: Pakistan Demographic and Health Survey
*: cases excluded in multivariate modelling

7.6.1 Pregnancy interval models with time independent covariates

Table 7.5 through Table 7.10 presents the estimated regression coefficients with hazard ratios for the second through sixth birth intervals using two survey samples. For the reference category of each covariate, the hazard ratio is assumed to be fixed at 1.00 (hazard ratios for reference categories are not shown in the tables).

7.6.1.1 Second conception model

Table 7.5 shows the testing of PH assumption based on Schoenfeld residuals for eight individual fixed covariates (birth cohorts, age at first marriage, sex of the index child, respondent and her husband level of education, place and province of residence, and age of mother at previous pregnancy). For 2006 data, we found the evidence that two categories of birth cohorts (1977-1981, and 1982-1991) violate the PH assumption (probability values are less than 5 per cent level of significance). In addition to the formal PH assumption test, graphical approach for testing PH assumption is followed, and Figure 7.4 presents estimated survival plots. Graphically, the same conclusion regarding the PH assumption is observed that birth cohorts violate the assumption of proportionality. This is a situation where one of the predictor does not satisfy the PH assumption. To deal with this situation, a model stratified by birth cohorts is fitted to the data. Table 7.5 presents the estimated regression coefficients with hazard ratios and probability values P(PH) testing PH assumption for waiting time to second conception model adjusted for the PH assumption. In case of 1990 data two covariates place and province of residence (Punjab and Baluchistan) do not satisfy the PH assumption (Table 7.5). This is a situation where two of the covariates violate the PH assumption. To perform the stratified Cox procedure, we defined a new stratifying variable showing eight combinations of place and province of residence—rural with four provinces and urban with four provinces. A model stratified by place and province is shown Table 7.5.

Finally, the estimated survival plots for third through sixth pregnancy interval models using standard and stratified Cox procedures (presented in Table 7.6 through 7.9) are shown in Appendix I.

Table 7.4: Test of proportional hazard (PH) assumption (P-values) of the factors associated with duration of second conception of currently married women in Pakistan, 1990 and 2006

Determinant	Characteristics	2006 Cox model (n=7833) Probability (PH)	1990 Cox model (n=5427) Probability (PH)
Demographic	**Birth cohort (age cohort)**		
For 1990 data	**not applicable**		
	1941-45 (45-49) (RC)	-	0.8728
	1946-50 (40-44)	-	0.2133
	1951-55 (35-39)	-	0.1644
	1956-60 (30-34)	-	0.0701
	1961-65 (25-29)	-	0.9907
	1966-75 (15-24)	-	
	For 2006 data		**not applicable**
	1957-61 (45-49) (RC)		-
	1962-66 (40-44)	0.7654	-
	1967-71 (35-39)	0.5213	-
	1972-76 (30-34)	0.6719	-
	1977-81 (25-29)	0.0085	-
	1982-91 (15-24)	0.0091	-
Age at first marriage			
	≤17 (RC)		
	18-19	0.3912	0.7091
	20-21	0.2741	0.4931
	22+	0.5861	0.0988
Gender of the index child			
	Female (RC)		
	Male	0.1094	0.0712
Socioeconomic	**Education**		
	No (RC)		
	Primary	0.6482	0.6403
	Secondary +	0.7373	0.3802
Husband education			
	No or <=10 year schooling (RC)		
	Higher	0.8710	0.3710
Place of residence			
	Rural (RC)		
	Urban	0.0999	0.0003
Province of residence			
	Punjab (RC)		
	Sindh	0.1566	0.0000
	NWFP	0.7070	0.2795
	Baluchistan	0.3484	0.0037
Biological	**Age (years) of mother at previous pregnancy**		
	≤20 (RC)		
	21+	0.1713	0.9475

*0.05>p≥0.01; **p<0.01
RC: reference category
HR: hazard ratio

Figure 7.4: Survival plots of various covariates for testing proportional hazard assumption of waiting time to second conception, 2006-07 Pakistan Demographic and Health Survey (PDHS)

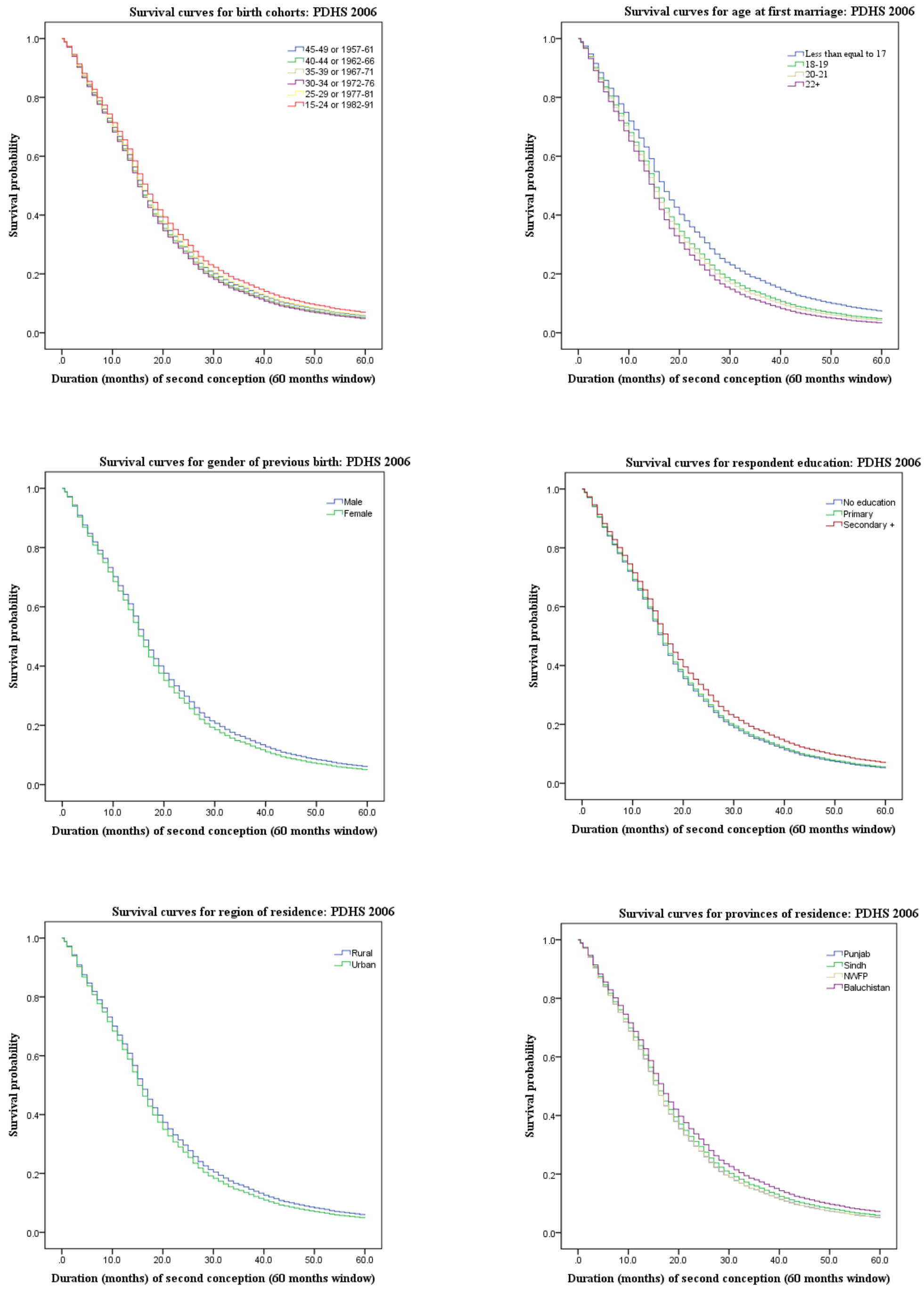


Table 7.5: Cox regression estimates with hazard ratios (HR) of the factors associated with duration of second conception of currently married women in Pakistan, 1990 and 2006

Characteristics	2006 Stratified Cox model (n=7833)			1990 Stratified Cox model (n=5427)		
	Coefficients (SE)	HR	P(PH)	Coefficients (SE)	HR	P(PH)
			Demographic			
Birth cohort (age cohort)						
For 1990 data	**not applicable**					
1941-45 (45-49) (RC)	-					
1946-50 (40-44)	-			-0.02 (0.06)	0.98	0.93
1951-55 (35-39)	-			0.04 (0.06)	1.04	0.20
1956-60 (30-34)	-			0.12 (0.05)	1.12	0.21
1961-65 (25-29)	-			0.11 (0.05)	1.11	0.08
1966-75 (15-24)	-			-0.13* (0.06)	0.88	0.88
For 2006 data				**not applicable**		
1957-61 (45-49) (RC)	**Stratified by birth cohorts**			-		
1962-66 (40-44)				-		
1967-71 (35-39)				-		
1972-76 (30-34)				-		
1977-81 (25-29)				-		
1982-91 (15-24)				-		
Age at first marriage						
≤17 (RC)						
18-19	0.10** (0.03)	1.10	0.37	0.00 (0.04)	1.00	0.94
20-21	0.20** (0.05)	1.22	0.24	0.11* (0.06)	1.12	0.72
22+	0.19** (0.05)	1.21	0.77	0.14** (0.06)	1.14	0.19
Gender of the index child						
Female (RC)						
Male	-0.06** (0.02)	0.94	0.16	-0.04 (0.03)	0.96	0.11
			Socioeconomic			
Education						
No (RC)						
Primary	-0.02 (0.04)	0.98	0.36	0.07 (0.05)	1.08	0.30
Secondary +	-0.11** (0.04)	0.90	0.34	-0.04 (0.03)	0.96	0.05
Husband education						
No or <=10 year schooling (RC)						
Higher	-0.02 (0.04)	0.98	0.94	-0.03 (0.06)	0.97	0.22
Place of residence						
Rural (RC)						
Urban	0.08** (0.03)	1.08	0.06	**Stratified by provinces and Place of residence**		
Province of residence						
Punjab (RC)						
Sindh	-0.04 (0.03)	0.96	0.29			
NWFP	0.00 (0.03)	1.00	0.92			
Baluchistan	-0.14** (0.04)	0.87	0.22			
			Biological			
Age (years) of mother at previous pregnancy						
≤20 (RC)						
21+	-0.22** (0.00)	0.80	0.06	-0.18** (0.05)	0.83	0.98

*0.05>p≥0.01; **p<0.01

RC: reference category

HR: hazard ratio

P(PH): probability (proportional hazard) assumption

Most of the birth cohort's categories have insignificant effect on waiting time to second conception in 1990. AFM has a highly significant effect on the length of the interval between first birth and second conception. In 2006 data women who had married at ages 20 or 21 years are at 22 per cent higher risk of second conception than those who marry less than or equal to 17 years of age, hence the waiting time to second pregnancy would be shorter as the age at marriage increases. It is quite possible that women in more fecund in age 20 -24 than under 17 or it could also be a catching up of modern form of family building. For women in 2006 who marry over 22 at 21% greater risk was 14% for same age group in 1990. There is no great reduction in the amount of risk for second conception from 1990 to 2006 however; the result is consistent with the expectation of hypothesis formulated in section 7.3.

Gender preference is observed to be significant in 2006. As expected the risk to second conception is 6 per cent lower if the first child is male rather than female. A woman with secondary or above level of education is at 10 per cent lower risk of second conception than those who have no education in 2006. Women's education is not found to have a statistically significant effect on second conception in 1990. In 2006, women level of education significantly increases the waiting time: those women having secondary or higher level of education are 10 per cent at lower risk of conception compared to those having no education. Husband`s education has no significant effect on waiting time to second conception. This might explains the couple level of agreement where husband seeks to make up his family according to the norms set in society and woman might cooperate for her stability in the family. Women living in urban areas are slightly more likely to conceive their second baby compared to those living in rural areas in both 1990 and 2006 samples. Among provinces only Baluchistan in 2006 sample has a statistical effect on the waiting time to second conception—women 11 per cent at lower risk than those women living in Punjab. Women`s age at previous pregnancy is highly significant covariate influencing waiting time to second conception. As expected women whose age is over 20 years at previous pregnancy are associated with a 0.20 times decreases in the hazard second conception than those who are less than or equal to 20 years. Given the understanding of the multivariate model of second conception in 2006, we can speculate that greater concentration of long pregnancy intervals found among those women having a moderate or above level of education, being the resident of Balochistan and their age at last female pregnancy is above 21 years.

7.6.1.2 Third conception model

Stratified Cox models for waiting time to third conception are estimated. Table 7.6 and 7.6 present the estimated regression coefficients with hazard ratios for waiting time to third conception model for 1990 and 2006 sample women. For birth cohorts, as expected, waiting time to pregnancy increases as the age of the women increases however, the hazard ratios for all categories of birth cohorts is less than 1.0. Women under 35 years of age in 2006 and women under 30 year of age in 1990 have the significant effect on waiting time to third conception. Risk of third conception is marginally decreased (only 3 per cent) from 1990 to 2006 for women aged 25-29.

Women who had married at ages 22 years or above are at 61 per cent higher risk of third pregnancy than those who marry less than or equal to 17 years of age. As expected risk of third conception is 8 per cent lower if the second child is male. The relative impact of women`s secondary or above level of education on fertility is same in both 2006 and 1990 survey: the risk for third conception is 23 per cent lower than those who have no education. Husband education started to play its role significantly from third conception. Highly educated husbands are at 8 per cent less risk for the third conception than those who have 10 year schooling. There is no statistical difference for third conception of women living in urban or rural areas. Duration from marriage to first birth is highly significant covariate affecting waiting time to third conception. An increase of one year in duration of marriage to first birth is associated with 1.04 fold increase in risk of third conception. As expected an increase of one year in women age at previous pregnancy is associated with 0.07 fold decrease in risk of waiting time to third conception.

What is different in understanding the long third pregnancy interval compared to the second pregnancy interval model in 2006? This is the effect of husband level of education and women primary level of education.

7.6.1.3 Fourth conception model

Stratified Cox models for waiting time to fourth conception are estimated and Table 7.6 and 7.6 presents the estimated regressions estimated regression coefficients with hazard ratios. For birth cohorts waiting time to pregnancy increases as the age of the women increases however, the hazard ratios for all categories of birth cohorts is less than 1.0. Women under 39 in 2006 and women aged 25-29 in 1990 have the significant effect on waiting time to fourth conception. Risk of fourth conception is 17 per cent decreased from 1990 to 2006 for women aged 25-29. As expected women who had married at ages 22 years or above are at 55 per cent higher risk of fourth pregnancy than those who marry less than or equal to 17 years of age in 2006. For 1990 a model stratified by age at first marriage and province is estimated. For fourth pregnancy gender preference is significantly observed in both 2006 and 1990 sample. As expected risk to fourth conception is 14 per cent lower if the first child is male in 2006 and 8 per cent lower in 1990. Comparing with non- educated women, women with secondary or above level of education are 25 per cent lower risk for fourth conception in 1990 and 31 per cent lower in 2006. The high level of education of the husband is more important in influencing for the fourth birth interval—13 per cent in 2006 and 23 per cent in 1990 less likely for spouse fourth pregnancy. There is no statistical difference for fourth conception of women living in Sindh, NWFP and Baluchistan in 2006 sample. An increase of one year in duration of marriage to first birth is associated with 1.05 fold increase in risk of third conception. An increase of one year in women age at previous pregnancy is associated with 0.09 fold decrease in risk of waiting time to fourth conception.

Table 7.6: Cox regression estimates of the factors associated with third through sixth pregnancy interval of currently married women in Pakistan, 2006-07 Pakistan Demographic and Health Survey

Characteristics	Third (n=6766) Coefficients (SE)	Fourth (n=5579) Coefficients (SE)	Fifth (n=4390) Coefficients (SE)	Sixth (n=3376) Coefficients (SE)
		Demographic factors		
Birth cohort (age cohort)				
1957-61 (45-49) (RC)				
1962-66 (40-44)	-0.05 (0.05)	-0.12* (0.05)	-0.19** (0.05)	-0.13* (0.06)
1967-71 (35-39)	-0.06 (0.04)	-0.19** (0.05)	-0.22** (0.05)	-0.27** (0.06)
1972-76 (30-34)	-0.14* (0.04)	-0.30** (0.05)	-0.36** (0.06)	-0.43** (0.07)
1977-81 (25-29)	-0.22** (0.05)	-0.47** (0.06)	-0.52** (0.07)	-0.60** (0.11)
1982-91 (15-24)	-0.45** (0.07)	-0.66** (0.11)	Not included (n=76)	Not included (n=20)
Age at first marriage				
≤17 (RC)				
18-19	0.17** (0.04)	0.20** (0.05)	0.18** (0.05)	0.13* (0.06)
20-21	0.26** (0.05)	0.30** (0.06)	0.30** (0.07)	0.27** (0.08)
22+	0.47** (0.07)	0.44** (0.07)	0.54** (0.08)	0.60** (0.09)
Gender of the index child				
Female (RC)				
Male	-0.09** (0.03)	-0.15** (0.03)	-0.12** (0.03)	-0.06 (0.04)
		Socioeconomic factors		
Education				
No (RC)				
Primary	-0.01 (0.04)	-0.15** (0.05)	-0.10 (0.06)	-0.21* (0.07)
Secondary +	-0.27** (0.05)	-0.37** (0.05)	-0.44** (0.07)	-0.43** (0.09)
Husband education				
No or <=10 year schooling (RC)				
Higher	-0.09* (0.04)	-0.14** (0.05)	-0.11 (0.06)	-0.10 (0.07)
Place of residence		**Stratified**		
Rural (RC)				
Urban	0.01 (0.03)		-0.17** (0.04)	-0.19** (0.05)
Province of residence	**Stratified**			
Punjab (RC)				
Sindh		0.01 (0.04)	0.08 (0.04)	0.20** (0.05)
NWFP		0.02 (0.04)	0.09 (0.05)	0.09 (0.05)
Baluchistan		-0.01 (0.05)	0.16* (0.06)	0.19* (0.07)
Duration (years) from first marriage to first birth	0.04** (0.01)	0.05** (0.01)	0.04** (0.01)	0.06** (0.01)
		Biological factors		
Age (years) of mother at previous pregnancy	-0.08** (0.01)	-0.09** (0.01)	-0.10** (0.01)	-0.10** (0.01)

*0.05>p≥0.01; **p<0.01
RC: reference category
HR: hazard ratio

Table 7.7: Cox regression estimates of the factors associated with third through sixth pregnancy interval of currently married women in Pakistan, 1990-91 Pakistan Demographic and Health Survey

Characteristics	Third (n=4710) Coefficients (SE)	Fourth (n=4015) Coefficients (SE)	Fifth (n=3153) Coefficients (SE)	Sixth (n=2520) Coefficients (SE)
		Demographic factors		
Birth cohort (age cohort)				
1941-45 (45-49) (RC)				
1946-50 (40-44)	-0.05 (0.06)	-0.03 (0.06)	0.03 (0.07)	-0.11 (0.07)
1951-55 (35-39)	-0.04 (0.06)	-0.03 (0.06)	-0.04 (0.06)	-0.16* (0.07)
1956-60 (35-39)	-0.08 (0.06)	-0.09 (0.06)	-0.28** (0.07)	-0.26** (0.08)
1961-65 (25-29)	-0.18* (0.06)	-0.28** (0.07)	-0.37** (0.08)	-0.71** (0.11)
1966-75 (15-24)	-0.43** (0.08)	-0.56** (0.11)	Not included (n=90)	Not included (n=34)
Age at first marriage		**Stratified by**	**Stratified by**	
≤17 (RC)		**age at first**	**age at first**	
18-19	0.21** (0.05)	**marriage and**	**marriage and**	0.23** (0.07)
20-21	0.31** (0.07)	**province of**	**province of**	0.38** (0.09)
22+	0.52** (0.08)	**residence**	**residence**	0.61** (0.10)
Gender of the index child				
Female (RC)				
Male	0.01 (0.03)	-0.08* (0.04)	-0.04 (0.04)	-0.05 (0.05)
		Socioeconomic factors		
Education				
No (RC)				
Primary	-0.05 (0.06)	-0.06 (0.07)	-0.13 (0.07)	-0.12 (0.09)
Secondary +	-0.20** (0.06)	-0.29** (0.07)	-0.42** (0.08)	-0.28* (0.10)
Husband education				
No or <=10 year schooling (RC)				
Higher	-0.10 (0.07)	-0.27** (0.08)	-0.17 (0.10)	-0.16 (0.12)
Place of residence	**Stratified**			
Rural (RC)				
Urban		0.08* (0.04)	0.02 (0.04)	0.05 (0.05)
Province of residence	**Stratified**	**stratified**	**stratified**	
Punjab (RC)				
Sindh				-0.08 (0.06)
NWFP				-0.01 (0.06)
Baluchistan				-0.09 (0.08)
Duration (years) from first marriage to first birth	0.03* (0.01)	0.04** (0.01)	0.06** (0.01)	0.06** (0.01)
		Biological factors		
Age (years) of mother at previous pregnancy	-0.07** (0.01)	-0.08** (0.01)	-0.10** (0.01)	-0.10** (0.01)

*0.05>p≥0.01; **p<0.01
RC: reference category
HR: hazard ratio

7.6.1.4 Fifth and sixth conception model

Cox modeling of fifth and sixth birth interval is confined to 25-49 year women. For modeling purposes exclusion of age cohort 15-24 helps in two ways, first it avoids the problem of small sample sizes (2006 data: 76 cases in fifth birth interval and 20 cases in sixth birth interval, 1990 data: 90 cases for fifth birth interval and 34 cases in sixth birth interval), and second it seems plausible that fifth and sixth birth would happen usually after age 24 years if the age at first birth is about 20 years (age at first birth in 2006: 20.89 years, 1990: 20.37 years—please see Chapter 6, Table 6.1).

Stratified Cox models for waiting time to fifth conception are estimated (Table 7.6 and Table 7.7). Apart from husband`s education results for fifth conception models are same as those for fourth conception. Impact of age at first marriage on sixth birth interval is similar in both surveys—women who marry at age 22 or above have 82% greater risk of conception than those women who marry at ages 17 or less. In Asian countries gender preference is known as the engine of fertility and this covariate became non-significant for sixth birth. Comparing with non- educated women, women with secondary or above level of education are at 9 per cent lower risk for sixth conception from 1990 to 2006.

> **Box 5: Main drivers of pregnancy intervals in Pakistan**
> The aim of multivariate statistical models presented in section 7.6.1 is to reach on a fresh speculation about the concentration of pregnancy intervals in Pakistan. We confine these remarks for an interest to understand the middle order pregnancy intervals—second, third and fourth.
> Among the multivariate models of pregnancy intervals, we can speculate that three is a greater concentration of long pregnancy intervals among those women having some level of education as well as their husbands have some level of education, being the resident of Balochistan and urban areas of Pakistan in general, and their age at last female pregnancy is above 21 years.

7.6.2 Pregnancy intervals models with time varying covariates

This section presents the results of the estimated extended Cox models because an extended Cox model could be used as alternative to the standard or stratified Cox model when one or more covariates do not satisfy the PH assumption. Death of the immediate previous child is considered as the time varying covariate in this analysis. Two Heaviside step functions are created and used for the time varying covariate to apply the extended Cox model. Heaviside step functions allow for the hazard ratio to be constant with in different time intervals. Heaviside function is of the form $g(t)$ which takes on the values 1 if t is greater than or equal to some specified value of t, and takes on the value 0 if t is less than specified time. A time varying covariate equal to death status of immediate previous child times the waiting time to pregnancy is less than 17 months and death status of immediate previous child times waiting time to pregnancy is greater than or equal to 17 months. The divide at 17 months for heavy side function is not arbitrary—shape of hazards for pregnancy intervals is different for 16 months. This function is an alternate approach to capture the effect of breastfeeding and child replacement on pregnancy intervals. After 17 months Heaviside function measures the child replacement. The parameter estimates for both heavy side functions can be used to obtain the estimated hazard ratios before and after 17 months. The results of the stratified and extended Cox model for time independent covariates are similar therefore the discussion is confined to time varying covariates only.

Table 7.8 through 7.9 presents the estimated regression coefficients with hazard ratios for second through sixth pregnancy intervals using two survey samples. For example in 2006 women whose immediate previous child is died under 17 months are 1.43 times more likely to have second conception than those who do not experience death of immediate previous child less than 17 months (Table 7.8). This finding is consistent with the hypothesis formulated in section 7.3.

Apart from time varying covariate (death of previous child) results for second through sixth birth interval models are same as for those models using time independent covariates. Death of previous child in first 17 months women raises risk of conception—in 2006 1.52 times more likely (to have third conception), 1.62 times more likely (to have fourth conception), 1.63 times more likely (to have fifth conception), and 1.71 times more likely to have sixth conception than those who do not experience death of immediate previous child less than 17 months (Table 7.9). For 1990 survey time varying covariate is not statistically significant in third through sixth birth interval models.

Across all five pregnancy interval models, hazard ratios show an increasing trend for women experiencing the death of immediate previous child that was on breastfeeding. It seems there is no child replacement tendency for the first 17 months; however, this is a pure breastfeeding effect (biological effect).

Table 7.8: Extended Cox regression estimates of the factors associated with duration of second conception of currently married women in Pakistan, 1990 and 2006

Determinant	Characteristics	2006 Extended Cox model (n=7833) Coefficients (SE)	HR	1990 Extended Cox model (n=5427) Coefficients (SE)	HR
Demographic	**Birth cohort (age cohort)**				
	For 1990 data	**not applicable**			
	1941-45 (45-49) (RC)	-			
	1946-50 (40-44)	-		-0.01 (0.06)	0.99
	1951-55 (35-39)	-		0.05 (0.06)	1.05
	1956-60 (30-34)	-		0.12* (0.05)	1.12
	1961-65 (25-29)	-		0.11 (0.05)	1.11
	1966-75 (15-24)	-		-0.13* (0.06)	0.88
	For 2006 data			**not applicable**	
	1957-61 (45-49) (RC)	**Stratified**		-	
	1962-66 (40-44)			-	
	1967-71 (35-39)			-	
	1972-76 (30-34)			-	
	1977-81 (25-29)			-	
	1982-91 (15-24)			-	
	Age at first marriage				
	≤17 (RC)				
	18-19	0.10* (0.03)	1.11	0.01 (0.04)	1.01
	20-21	0.20** (0.05)	1.23	0.12* (0.06)	1.13
	22+	0.19** (0.05)	1.21	0.14* (0.06)	1.15
	Gender of the index child				
	Female (RC)				
	Male	-0.06* (0.02)	0.94	-0.05 (0.03)	0.96
Socioeconomic	**Education**				
	No (RC)				
	Primary	-0.01 (0.04)	0.99	0.07 (0.05)	1.08
	Secondary +	-0.10** (0.04)	0.90	-0.03 (0.05)	0.97
	Husband education				
	No or <=10 year schooling (RC)				
	Higher	-0.02 (0.04)	0.97	-0.02 (0.06)	0.98
	Place of residence				
	Rural (RC)			**Stratified by provinces and**	
	Urban	0.08* (0.03)	1.09	**Place of residence**	
	Province of residence				
	Punjab (RC)				
	Sindh	-0.05 (0.03)	0.95		
	NWFP	0.00 (0.03)	1.00		
	Baluchistan	-0.13** (0.04)	0.88		
Biological	**Age (years) of mother at previous pregnancy**				
	≤20 (RC)				
	21+	-0.21** (0.04)	0.81	-0.18** (0.06)	0.83
Time dependent Covariate	**Death of previous children**				
	< 17 months	0.36** (0.05)	1.44	0.23** (0.06)	1.26
	≥17 months	-0.03 (0.07)	0.97	0.12 (0.09)	1.13

*0.05>p≥0.01; **p<0.01
RC: reference category
HR: hazard ratio

Table 7.9: Cox regression estimates of the factors associated with third through sixth pregnancy interval of currently married women in Pakistan, 2006-07 Pakistan Demographic and Health Survey

Characteristics	Third (n=6766) Coefficients (SE)	Fourth (n=5579) Coefficients (SE)	Fifth (n=4390) Coefficients (SE)	Sixth (n=3376) Coefficients (SE)
		Demographic factors		
Birth cohort (age cohort)				
1957-61 (45-49) (RC)				
1962-66 (40-44)	-0.05 (0.05)	-0.11* (0.05)	-0.19** (0.05)	-0.13* (0.06)
1967-71 (35-39)	-0.06 (0.04)	-0.18** (0.05)	-0.21** (0.05)	-0.27** (0.06)
1972-76 (30-34)	-0.13* (0.04)	-0.29** (0.05)	-0.35** (0.06)	-0.43** (0.07)
1977-81 (25-29)	-0.21** (0.05)	-0.46** (0.06)	-0.51** (0.07)	-0.60** (0.11)
1982-91 (15-24)	-0.43** (0.07)	-0.66** (0.11)	Not included (n=76)	Not included (n=20)
Age at first marriage				
≤17 (RC)				
18-19	0.17** (0.04)	0.20** (0.05)	0.17** (0.05)	0.12* (0.06)
20-21	0.25** (0.05)	0.29** (0.06)	0.29** (0.07)	0.27** (0.08)
22+	0.46** (0.07)	0.43** (0.07)	0.53** (0.08)	0.59** (0.09)
Gender of the index child				
Female (RC)				
Male	-0.09** (0.03)	-0.16** (0.03)	-0.12** (0.03)	-0.06 (0.04)
		Socioeconomic factors		
Education				
No (RC)				
Primary	-0.01 (0.04)	-0.14** (0.05)	-0.10 (0.06)	-0.21* (0.07)
Secondary +	-0.27** (0.05)	-0.39** (0.05)	-0.43** (0.07)	-0.43** (0.09)
Husband education				
No or <=10 year schooling (RC)				
Higher	-0.09* (0.04)	-0.14** (0.05)	-0.11 (0.06)	-0.10 (0.07)
Place of residence		**Stratified**		
Rural (RC)				
Urban	0.01 (0.03)		-0.17** (0.04)	-0.19** (0.05)
Province of residence	**Stratified**			
Punjab (RC)				
Sindh		0.01 (0.04)	0.08 (0.04)	0.20** (0.05)
NWFP		0.02 (0.04)	0.09 (0.05)	0.08 (0.05)
Baluchistan		-0.01 (0.05)	0.17* (0.06)	0.19* (0.07)
Duration (years) from first marriage to first birth	0.04** (0.01)	0.04** (0.01)	0.04** (0.01)	0.06** (0.01)
		Biological factors		
Age (years) of mother at previous pregnancy	-0.08** (0.01)	-0.09** (0.01)	-0.10** (0.01)	-0.10** (0.01)
		Time dependent covariate		
Death of previous children				
< 17 months	0.42** (0.06)	0.5** (0.07)	0.50** (0.08)	0.53** (0.10)
≥ 17 months	0.01 (0.09)	0.01 (0.11)	-0.04 (0.13)	0.11 (0.14)

*0.05>p≥0.01; **p<0.01
RC: reference category
HR: hazard ratio

Table 7.10: Cox regression estimates of the factors associated with third through sixth pregnancy interval of currently married women in Pakistan, 1990-91 Pakistan Demographic and Health Survey

Characteristics	**Third (n=4710) Coefficients (SE)**	**Fourth (n=4015) Coefficients (SE)**	**Fifth (n=3153) Coefficients (SE)**	**Sixth (n=2520) Coefficients (SE)**
		Demographic factors		
Birth cohort (age cohort)				
1941-45 (45-49) (RC)				
1946-50 (40-44)	-0.05 (0.06)	-0.03 (0.06)	0.03 (0.07)	-0.11 (0.07)
1951-55 (35-39)	-0.04 (0.06)	-0.03 (0.06)	-0.04 (0.06)	-0.16* (0.07)
1956-60 (35-39)	-0.08 (0.06)	-0.09 (0.06)	-0.28** (0.07)	-0.26** (0.08)
1961-65 (25-29)	-0.18* (0.06)	-0.28** (0.07)	-0.37** (0.08)	-0.71** (0.11)
1966-75 (15-24)	-0.42** (0.08)	-0.56** (0.11)	Not included (n=90)	Not included (n=34)
Age at first marriage		**Stratified by age at first marriage and province of residence**	**Stratified by age at first marriage and province of residence**	
≤17 (RC)				
18-19	0.21** (0.05)			0.23** (0.07)
20-21	0.31** (0.07)			0.38** (0.09)
22+	0.51** (0.08)			0.61** (0.10)
Gender of the index child				
Female (RC)				
Male	0.01 (0.03)	-0.08* (0.04)	-0.04 (0.04)	-0.05 (0.05)
		Socioeconomic factors		
Education				
No (RC)				
Primary	-0.05 (0.06)	-0.06 (0.07)	-0.13 (0.07)	-0.12 (0.09)
Secondary +	-0.20** (0.06)	-0.29** (0.07)	-0.42** (0.08)	-0.28* (0.10)
Husband education				
No or <=10 year schooling (RC)				
Higher	-0.10 (0.07)	-0.27** (0.08)	-0.17 (0.10)	-0.16 (0.12)
Place of residence	**Stratified**			
Rural (RC)				
Urban		0.08* (0.04)	0.02 (0.04)	0.05 (0.05)
Province of residence	**Stratified**	**Stratified**	**Stratified**	
Punjab (RC)				
Sindh				-0.08 (0.06)
NWFP				-0.01 (0.06)
Baluchistan				-0.09 (0.08)
Duration (years) from first marriage to first birth	0.03* (0.01)	0.04** (0.01)	0.06** (0.01)	0.06** (0.01)
		Biological factors		
Age (years) of mother at previous pregnancy	-0.07** (0.01)	-0.08** (0.01)	-0.10** (0.01)	-0.10** (0.01)
		Time dependent covariate		
Death of previous children				
< 17 months	0.14 (0.08)	0.13 (0.08)	0.12 (0.10)	-0.04 (0.12)
≥17 months	-0.06 (0.10)	-0.04 (0.11)	-0.09 (0.12)	0.08 (0.13)

*0.05>p≥0.01; **p<0.01
RC: reference category
HR: hazard ratio

7.7 Person-month data and discrete time hazard models

The Demographic and Health Survey data consist of matrix of rows and columns. By default each row represent a particular case (ever-married women) and each column represents an attribute of the case for example currently married or not, urban resident or rural, has first child or not and so on. When studying the determinants of birth intervals in this study if the emphasis is placed on the effect of duration of breastfeeding, and duration of amenorrhea, the standard DHS format of data does not permit us to include information of breastfeeding and amenorrhea in the birth interval analysis. This analysis requires a special arrangement of data by focusing on additional questions (breastfeeding, abstinence, and amenorrhea) about the reproductive history of ever-married women. For 2006-07 Pakistan Demographic and Health Survey the additional questions were asked since 2001. The information available for the period of 65 months starting from September 2001 to the survey date could be utilized to determine the effect of breastfeeding and amenorrhea on birth interval length. We selected currently married women who had their first birth after the beginning of the calendar (Century month code: 1221), a total of 5194 currently married women. The survey date in century month code (CMC) format was 1281 through 1287. By observing the variation in survey date, we prepared the retrospective history (calendar) of 65-months starting from 1222 (CMC) through 1287.

Table 7.11 presents the distribution of women with birth order in the 65-months calendar.

Table 7.11: Distribution of women who contribute to the 65-months calendar prior to survey date, PDHS 2006

Birth order when first entering observations	number of currently married women
0	675
1	827
2	830
3	719
4	605
5	475
6	359
7	278
8	173
9	114
10	65
11	35
12	21
13	10
14	5
15	2
16	1
Total	**5194**

PDHS: Pakistan Demographic and Health Survey

The event of the interest is the conception leading to the second live birth or third live birth. Women with birth order 1 will either proceed to second live birth (827 women: Table 7.11) or will not experience the event of interest. Mathematically 827 women would potentially contribute 53,755 person data lines (827 times 65 month). Theoretically there could be four possibilities: the second conception is not observed throughout the calendar, the second birth is conceived from the fixed censoring time (9 months prior to survey date) and conception leads to a live birth before the survey date (Group 2), the second conception occurs within the calendar period before the censoring time (Group 3), and the second birth occurs after the survey date (Group 4: no information available for conception time). A value of 1 is assigned in a particular month if the event (second conception) occurred otherwise event variable takes value of 0 if conception did not occur in the month.

A discrete time hazard model for the waiting time between first birth and second conception and between second birth and third conception is used. The waiting time is broken into several categories: 0-2, 3-6, 7-14, 15-20, 21-30, 31-40, and 41-50 months. The risk of pregnancy during each duration time is assumed to be constant for women with the same values of covariates. The discrete time hazard rate is defined as:

$$\mathrm{h_{it}} = \Pr(\mathrm{T}_i = t | \mathrm{T}_i \geq t, z_{it}) \qquad (1)$$

Where z_{it} is a vector of covariates (fixed and time varying), T_i is a discrete random variable representing the time at which the end of spells occurs. The hazard is estimated by applying a discrete time hazard model using a logistic functional form on the person-month data.

7.8 Effect of breastfeeding and amenorrhea on birth intervals

We estimated three different models. Model 1includes only waiting time to conception—duration variable and tests whether the raw hazard varies with duration since index birth (second or third). Model 2 includes both duration, demographic and socio-economic (fixed time covariates) covariates. Model 3 includes both duration, demographic and socio-economic (fixed time covariates) as well as three time-varying covariates: breast feeding, amenorrhea, and child survival status. In addition three models are estimated for second and third conception as well as for pooled sample (either second or third conception). Three models on three variants are shown in Table 7.12. The regression coefficients with standard errors are presented for predicting the hazard of second and third conception.

Consider first, Model 1 (Table 7.12) with only duration as a covariate. Figure 7.5 shows the shape of the hazard for second and third conception demonstrates that the risk of conceiving second child is higher than third child. The risk of conceiving second or third child increases until 15 months and then decreases. Statistically speaking, results of Model 1 shows that coefficients for duration 0.5 – 14 months are highly significant (P-values are less than 0.01). The odds of conception increase as the waiting time to conception increases. Women wait until 2 months are 87% less likely (odds ratio: 0.13) to conceive second baby compared to those wait until 15-20 months.

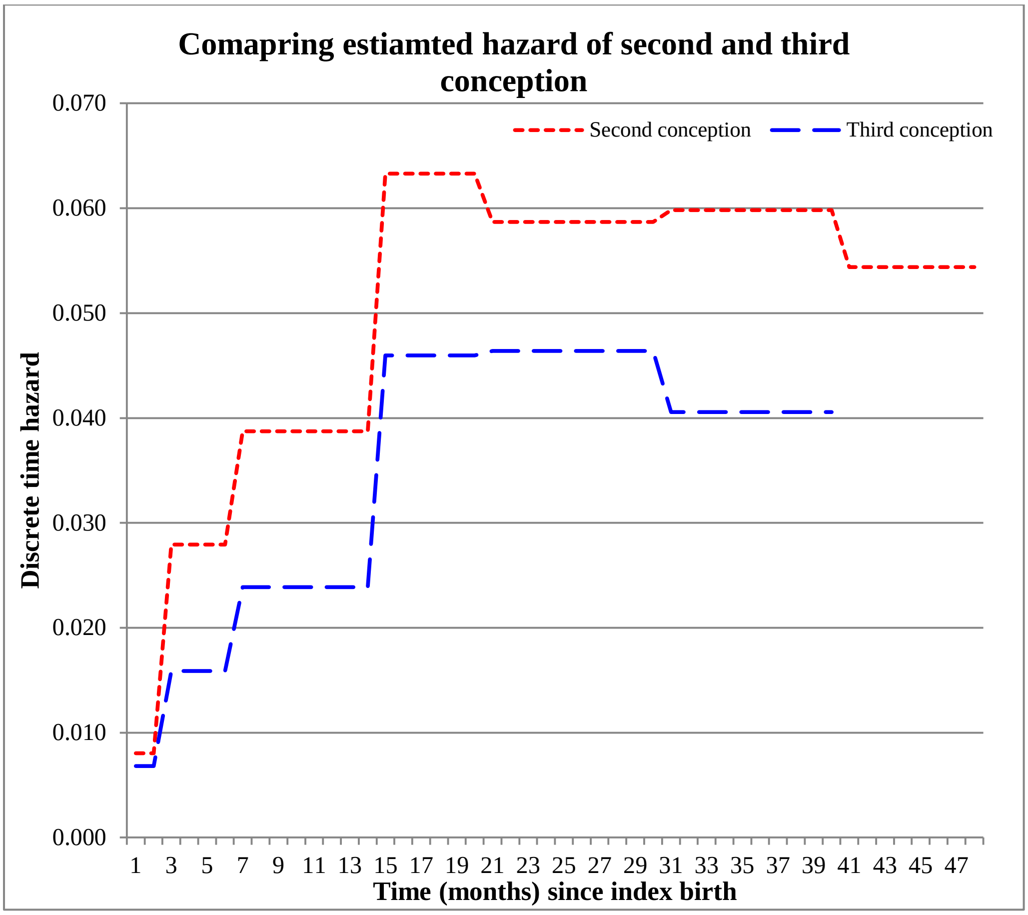


Figure 7.5: Estimated discrete time hazard of conception for duration variable only

By comparing Model 1 and Model 2 demonstrates that adding fixed time covariates improve some fit of the model. Applying a likelihood ratio test it could be observed from the following presentation:

Sample	**Likelihood ratio test**	
	-2loglikelihood (Model 1) – {-2loglikelihood (Model 2)}	-2loglikelihood(Model 2)–{-2loglikelihood(Model3)}
Second conception	56	1544
Third conception	33	844
Pooled	73	2408

Model 2 of second conception performs a little better than Model 1 (a likelihood value of 56 with 8 degrees of freedom, $p < 0.000$). In particular among fixed time covariates of Model 2, Baluchistan and respondent education level significantly reduces the risk of conception (Baluchistan: 40% less likely to conceive second child compared to Punjab, respondent education: 60% less likely to conceive third child to those having secondary or higher education compared to those having no education).

Table 7.12: Parameter estimates of discrete time hazard models for second and third conception, 2006, Pakistan Demographic and Health Survey

Covariates	Second conception Model 1 Duration Variable only Coefficient (SE)	Second conception Model 2 Duration &fixed time variables Coefficient (SE)	Third conception Model 1 Duration Variable only Coefficient (SE)	Third conception Model 2 Duration &fixed time variables Coefficient (SE)	Pooled sample Model 1 Duration only Coefficient (SE)	Pooled sample Model2 Duration & fixed time Coefficient (SE)
Intercept	-2.76**	-3.63**	-3.08**	-4.11**	-2.91**	-4.37**
	(0.07)	(1.06)	(0.08)	(0.75)	(0.05)	(0.61)
Duration since first birth (months)						
0.5-2	-2.08**	-2.11**	-1.92**	-1.96**	-2.00**	-2.05**
	(0.22)	(0.22)	(0.26)	(0.26)	(0.17)	(0.17)
3-6	-0.84**	-0.87**	-1.08**	-1.11**	-0.91**	-0.95**
	(0.11)	(0.11)	(0.15)	(0.15)	(0.09)	(0.09)
7-14	-0.51**	-0.53**	-0.67**	-0.69**	-0.57**	-0.59**
	(0.09)	(0.09)	(0.12)	(0.12)	(0.07)	(0.07)
15-20 (RC)	0	0	0	0	0	0
21-30	-0.08	-0.05	0.01	0.04	-0.05	-0.01
	(0.11)	(0.11)	(0.12)	(0.12)	(0.08)	(0.08)
31-40	-0.06 (0.15)	-0.01	-0.13	-0.09	-0.10	-0.05
	(0.15)	(0.15)	(0.17)	(0.17)	(0.11)	(0.11)
41-50	-0.16 (0.29)	-0.11	0.03	0.07	-0.09	-0.02
	(0.29)	(0.29)	(0.27)	(0.27)	(0.20)	(0.20)
Fixed-time factors						
Birth cohort (age cohort) 1957-66 (40-49) (RC)			-	0	-	0
1967-71 (35-39)	-	0.54	-	0.88	-	0.84
		(1.04)		(0.74)		(0.60)
1972-76 (30-34)	-	1.11	-	0.99	-	1.18*
		(1.02)		(0.72)		(0.59)
1977-81(25-29)	-	1.12	-	1.26	-	1.45*
		(1.02)		(0.73)		(0.59)
1982-91(15-24)	-	1.12	-	1.30		1.69**
		(1.04)		(0.74)		(0.59)
Age at first marriage ≤ 17 (RC)		0	-	0	-	0
18-19	-	0.10	-	-0.05	-	0.13
		(0.10)		(0.13)		(0.08)
20-21	-	-0.08	-	0.06	-	0.18
		(0.14)		(0.16)		(0.09)
22+	-	-0.10	-	0.12	-	0.29*
		(0.17)		(0.19)		(0.11)
Education						
No (RC)	-	0	-	0	-	0
Primary	-	0.19		-0.21	-	-0.01
		(0.10)		(0.12)		(0.08)
Secondary +	-	-0.01	-	-0.41**	-	-0.18*
		(0.09)		(0.13)		(0.08)
Husband education						
No or <=10 year schooling (RC)		0	-	0	-	0
Higher	-	0.06	-	-0.07	-	-0.01
		(0.10)		(0.12)		(0.08)
Place of residence						
Rural (RC)	-	0	-	0	-	0
Urban	-	-0.06	-	0.09	-	0.02
		(0.08)		(0.09)		(0.06)
Province of residence						
Punjab (RC)	-	0	-	0	-	0
Sindh	-	-0.11	-	-0.05	-	-0.09
		(0.09)		(0.10)		(0.07)
NWFP	-	-0.11		0.05	-	-0.04
		(0.09)		(0.11)		(0.04)
Baluchistan	-	-0.51**	-	-0.26	-	-0.39**
		(0.13)		(0.16)		(0.09)
Duration (years) from marriage to first birth						
	-	-0.05*	-	-0.02	-	-0.01
		(0.02)		(0.03)		(0.02)
Nagelkerke R Square	0.03	0.04	0.03	0.04	0.03	0.04
-2Loglikelihood	7244.02	7188.60	5388.02	5355.42	12686.40	12613.74

*0.05>p ≥ 0.01; **p<0.01

RC: reference category

Table 7.11 continued

Covariates	Second conception Model 3 Duration, fixed & time-varying variables Coefficient (SE)	Third conception Model 3 Duration, fixed & time-varying variables Coefficient (SE)	Pooled sample Model 3 Duration, fixed & time-varying variables Coefficient (SE)
Intercept	-1.96 (1.06)	-3.67** (0.76)	-3.51** (0.61)
Duration since first birth (months)			
0.5-2	-1.68** (0.36)	-0.75* (0.33)	-1.21** (0.24)
3-6	-0.62** (0.14)	-0.62** (0.17)	-0.61** (0.11)
7-14	-0.32** (0.11)	-0.44** (0.13)	-0.36** (0.08)
15-20 (RC)	0	0	0
21-30	-0.22 (0.12)	-0.24 (0.13)	-0.23* (0.09)
31-40	-0.33* (0.17)	-0.58** (0.19)	-0.44** (0.13)
41-50	-0.46 (0.32)	-0.45 (0.30)	-0.43 (0.22)
Fixed-time factors			
Birth cohort (age cohort)			
1957-66 (40-49) (RC)		0	0
1967-71 (35-39)	-0.56 (1.05)	0.74 (0.76)	0.43 (0.61)
1972-76 (30-34)	0.01 (1.03)	0.97 (0.73)	0.82 (0.59)
1977-81 (25-29)	-0.04 (1.03)	1.28 (0.73)	1.09 (0.59)
1982-91 (15-24)	-0.05 (1.05)	1.34 (0.75)	1.32* (0.60)
Age at first marriage			
≤17 (RC)	0	0	0
18-19	-0.01 (0.12)	0.10 (0.14)	0.12 (0.09)
20-21	-0.09 (0.16)	0.01 (0.17)	0.14 (0.11)
22+	-0.27 (0.20)	0.18 (0.20)	0.20 (0.13)
Education			
No (RC)	0	0	0
Primary	0.21 (0.12)	-0.12 (0.13)	0.02 (0.09)
Secondary +	-0.06 (0.11)	-0.42** (0.14)	-0.22* (0.09)
Husband education			
No or <=10 year schooling (RC)		0	0
Higher	0.10 (0.11)	-0.02 (0.14)	0.04 (0.09)
Place of residence			
Rural (RC)	0	0	0
Urban	-0.08 (0.09)	0.02 (0.09)	-0.02 (0.07)
Province of residence			
Punjab (RC)	0	0	0
Sindh	-0.13 (0.10)	-0.07 (0.11)	-0.11 (0.07)
NWFP	-0.11 (0.32)	0.15 (0.13)	0.02 (0.08)
Baluchistan	-0.71** (0.16)	-0.33 (0.19)	-0.54** (0.12)
Duration (years) from marriage to first birth	-0.07** (0.03)	0.01 (0.03)	-0.01 (0.02)
Time-varying factors			
Breastfeeding (No: RC)		0	0
Yes	-0.69** (0.10)	-0.99** (0.11)	-0.81** (0.07)
Amenorrhea (No: RC)		0	0
Yes	-0.83** (0.16)	-0.98** (0.19)	-0.91** (0.12)
Child survival status (No: RC)		0	0
Yes	0.26 (0.20)	0.23 (0.23)	0.22 (0.15)
Nagelkerke R Square	0.07	0.07	0.07
-2Loglikelihood	5634.08	4511.54	10205.66

*0.05>p ≥ 0.01; **p<0.01
RC: reference category

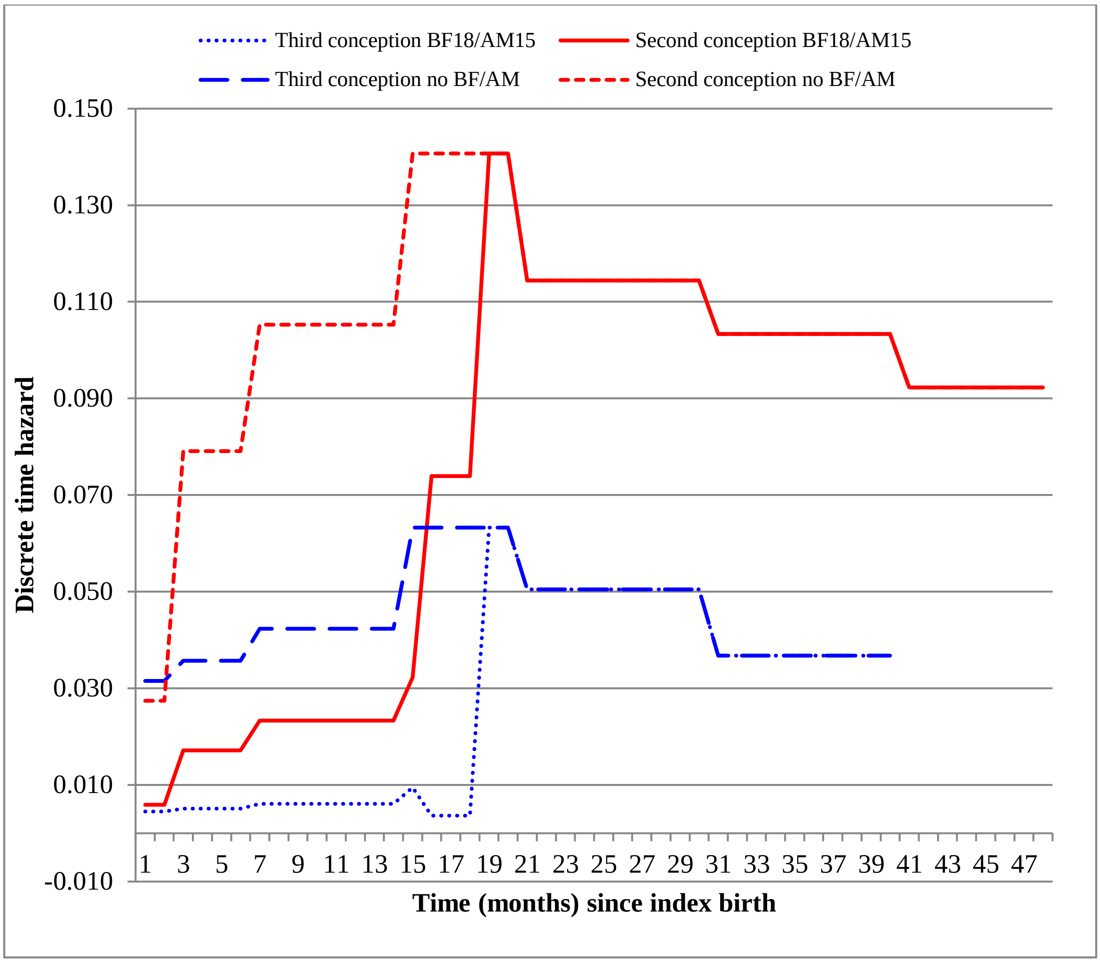


Figure 7.6: Estimated hazard of conception for selected women, 2006 Pakistan Demographic and Health Survey

BF18: breastfeeding up to 18 months; AM15: amenorrhea up to 15 months

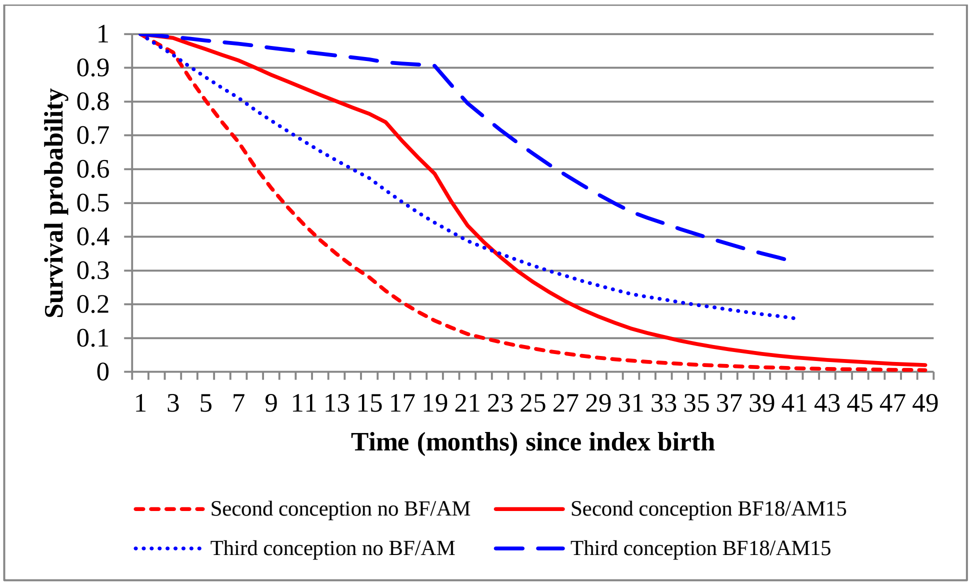


Figure 7.7: Estimated survival function of conception for selected women, 2006 Pakistan Demographic and Health Survey

BF18: breastfeeding up to 18 months; AM15: amenorrhea up to 15 months

Adding time varying covariates (Model 3: breastfeeding, amenorrhea and child survival status) significantly improve the fit of the model. Performing a likelihood-ratio test gives the level of improvement (value of test statistic equals 1544 for second conception model and 844 for third conception model with 11 degrees of freedom: $p < 0.000$). The results of model 3 clearly show the effect of breastfeeding and amenorrhea significantly reduces the risk of conception. The effect of child death seems insignificant on the hazard of conception (Table 7.12).
Figure 7.6 and 7.7 shows the estimated shape of the hazard and survivor functions for two groups of women: (i) women were both not breastfeeding and amenorrhea after the birth of second or third child—this group is titled on the figures as ‘Second conception no BF/AM’, ‘Third conception no BF/AM’, (ii) women were breastfeeding until 18 months and amenorrhea until 15 months after the birth of second or third birth (this group presented as ‘second conception BF18/AM15’, ‘Third conception BF18/AM15’). Figure 7.6 and 7.7 helps to reveal the effectiveness of breastfeeding and amenorrhea. Both figures demonstrate that there is a great difference in hazard for the conception between women who are not breastfeeding compared to those breastfeeding. For example, after the 10 months of first child the risk of second conception is only 2% if woman is breastfeeding. In the second group of women, breastfeeding ended after 15 months but amenorrhea continued until 18 months and figure 7.6 demonstrate that after the 17 month of the first child the risk of second conception is significantly lower (only 6%) if woman is in amenorrhea compared to that woman who has no amenorrhea (14% chances of conceiving a second baby).

7.9 Birth intervals: summary

This chapter presented the analysis of birth intervals in Pakistan using PDHS data on two time periods. Mean and median time to conception are used a summary measure for second through six pregnancy intervals. From 1990 to 2006 urban and Punjab resident women generally have higher waiting times to conception than those from other regions. Regression modeling was based on the conceptual framework for the pregnancy interval analysis. A careful examination of the standard parametric models suggests that none of the fitted parametric models capture the behavior of waiting time to conception. The fastest and greatest hazard takes place between 12 and 16 months waiting time to pregnancy. To model the hazard values three different version of Cox models are estimated—standard, stratified and extended. Regression modeling identified some important covariates of waiting time to conception. The key findings of birth interval modeling can be presented in terms of the relationships of the characteristics of women with their waiting time to conception (Table 7.13). Table 7.13 also indicates the direction of association among different covariates suggested in the conceptual framework. Table 7.13 reveals that woman`s increase in age extends birth interval duration. With an increase in woman`s age at first marriage (AFM) decrease the waiting time to conception. From socioeconomic factors primary education does not seem to have any effect on lengthening the birth interval. Husband education played a positive role to increasing birth interval duration in middle order conceptions particularly in 2006. Place of residence has a mixed relationship with waiting time to conception: for higher order pregnancies urban women are at lower risk of conception but the converse is true with low order pregnancy times

With an increase in duration from marriage to first birth reduces birth interval duration and this covariate has significant effect in all birth interval models. From biological factors, age of women at previous pregnancy is also found to be highly significant covariate in all models. Across all five birth interval models, hazard ratios are found to be increasing for women experiencing the death of immediate previous child as the time varying covariate. The results of stratified and extended Cox models are almost identical. From biological determinants it seems that there is no child replacement effect for the first 17 months and thus could be considered as the breastfeeding effect. Finally, the modelling using month by month information (up to 65 months) on breastfeeding and amenorrhea mark a significant effect on birth interval length.

Table 7.13: Regression estimates of the factors associated with third through sixth pregnancy interval of currently married women in Pakistan, 1990 and 2006

Characteristics	Second 1990	Second 2006	Third 1990	Third 2006	Fourth 1990	Fourth 2006	Fifth 1990	Fifth 2006	Sixth 1990	Sixth 2006
Demographic factors										
Birth cohort (age cohort)										
1957-61 (45-49) (RC)										
1962-66 (40-44)	NS		NS		NS		NS		NS	
1967-71 (35-39)	NS		NS		NS		NS	↑	↑	↑
1972-76 (30-34)	NS	↑	NS	↑	NS	↑	↑			
1977-81 (25-29)	↑		↑		↑					
1982-91 (15-24)							NA	NA	NA	NA
Age at first marriage										
≤17 (RC)					ST		ST			
18-19										
20-21	↓	↓	↓	↓		↓		↓	↓	↓
22+										
Gender of the index child										
Female (RC)										
Male	NS	↑	NS	↑	↑	↑	NS	↑	NS	NS
Socioeconomic factors										
Education										
No (RC)										
Primary	NS	NS	NS	NS	NS		NS	NS	NS	
Secondary +	NS	↑	↑	↑	↑	↑	↑	↑	↑	↑
Husband education										
No or <=10 year schooling (RC)										
Higher	NS	NS	NS	↑	↑	↑	NS	NS	NS	NS
Place of residence										
Rural (RC)			ST							
Urban	NS	↓		NS	↓	NS	NS	↑	NS	↑
Province of residence										
	ST		ST	ST	ST		ST			
Punjab (RC)										
Sindh		NS				NS		NS	NS	↓
NWFP		NS				NS		NS	NS	NS
Baluchistan		↑				NS		↓	NS	↓
Duration (years) from first marriage to first birth	NA	NA	↓	↓	↓	↓	↓	↓	↓	↓
Biological factors										
Age (years) of mother at previous pregnancy	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Time dependent covariate										
Death of previous children										
< 17 months	↓	↓	NS	↓	NS	↓	NS	↓	NS	↓
≥ 17 months	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Breastfeeding (No: RC)										
Yes		↑		↑	-	-	-	-	-	-
Amenorrhea (No: RC)										
Yes		↑		↑	-	-	-	-	-	-

Note: RC, NS, NA and ST stand for reference category, non-significant, not applicable and stratified respectively. The direction of the arrow sign indicates the direction of the association of the covariate with birth interval: ↓ shows decrease in waiting time to conception and ↑ indicates increase in waiting time to conception.

8 DISCUSSION AND CONCLUSIONS

What did this study add?

Discrepancy in age misreporting has significant effect on estimated fertility levels in all seven geographical regions of Pakistan

The analysis of proximate determinants demonstrates clear evidence that Pakistan is in the early stages of phase III of fertility transition, with considerable geographic variations

Timing of marriage and female education play a significant role in explaining the fertility transition, especially in urban areas, Punjab and Balochistan and women are adopting a 'western' form of first childbearing

Breastfeeding and amenorrhea have contributed significantly to lengthening the inter-birth intervals

8.1 Introduction

Pakistan is a country that has for over three decades experienced a persistently fertility decline. There is a definite decline in fertility since 1990 but the strategies to lower the fertility at set targets have yielded little results. Unfortunately previous research has kept little focus on age distortions, role of proximate determinants, timing of marriage and births in understanding the fertility transition of Pakistan especially at the regional level. Indeed there is lack of systematic analyses of fertility change in Pakistan: published evidence in this regard in mainstream demographic journals has been week. Through an in-depth analysis this thesis has addressed the gap in literature. This concluding chapter is set out into nine sections. Concluding remarks are framed to answer each of the research questions of the study which are summarised in section 8.2 -8.5. Section 8.2 offers conclusions about the effect of age misreporting on the measurement of fertility levels in Pakistan. Section 8.3 highlights the contribution of proximate determinants of fertility. Section 8.4 and 8.5 provides the remarks for age at first marriage and birth as well as birth interval lengths Section 8.6 presents an overview of conclusions after amalgamating the answers of the 'four neglected dimensions' listed above. The policy implications of findings are suggested in section 8.7. The chapter concludes with sections on the limitations of this study and directions for future research.

8.2 Do age distortions influence fertility levels in Pakistan?

In this study theoretically it is postulated that a different picture could be emerged when fertility estimates are accounted for distortions in age reporting. The question of data errors potentially affecting the measurement of fertility trends is not a new one. Our hypothesis is consistent with the Potter`s explanations for the analysis of birth history information (Potter 1977). According to the Potter recent births are remembered fairly in reported birth histories and to some extent accurate when compared to more distant births. This may lead to erroneous measurement of the trend in fertility over time. Our particular concern was the potential influence of age misreporting on the total fertility rate. Previous research on age misreporting has identified Pakistan as a country with particularly serious age-heaping (Pullum 1991, Pullum 2006, Pullum 2008). The exact way in which this might affect the measurement of fertility trends is not easy to specify a priori, and the extent of the effect is likely to depend on the nature of the age heaping (for example ages are more commonly exaggerated or rounded down). Thus age misreporting may lead to inflated fertility in Pakistan but there could also be situations where fertility rates might be depressed when adjusted for the error of age misreporting.

Total marital fertility rates have been estimated using a new easy-to-use method to adjust for age misreporting. Each of the three demographic surveys examined here indicates a fertility decline during the past two decades in Pakistan which confirms the hypothesis that fertility transition is under way in Pakistan. The analysis presented in Chapter 4 suggest that fertility without accounting for misreporting of age and fertility with adjustment of age misreporting are two sides of a same coin, although previous research puts emphasis on the former side of a coin. The impact of age exaggeration on fertility estimation in Pakistan is reviewed so far suggests that fertility levels would be underestimated when no adjustments are made for age distortions. Adjusted fertility rates are slightly higher than unadjusted fertility rates. This result was obtained using one model of age misreporting, namely ‘least distance digit shift’ used for the estimation of fertility rates. However, there could be some other routines available to make these adjustments, for example shift only upward could be used.

The result of this investigation is that the effect of age misreporting is not sufficient to modify the conclusion that over time, fertility in Pakistan is declining, though the pace of decline is very slow. It is possible that when distortions in age reporting are incorporated the pace of decline is even slower. There were also larger discrepancies in the TFRs estimate for certain population sub-groups, which suggest that caution should be exercised when comparing sub-groups of the population without adjusting for age misreporting.

8.3 What is the contribution of proximate determinants of fertility in Pakistan?

Since the 1990s, Pakistani fertility has gradually started to decline. In late 1990s, the end of martial law regime under the cover of Islamic laws and the transition to democracy with a rigorous publicity of FP acted as a main initiator to the decline of Pakistani fertility. Applications of the Bongaarts model to the 1990 Pakistan Demographic and Health Survey

(PDHS), 2000 Pakistan Reproductive Health and Family Planning Survey and 2006 PDHS allowed examination of the changes influencing Pakistani women in the late 2000s to control their fertility. The fertility inhibiting effect of contraception (expressed in terms of number of children per woman) is more than double from one child per woman in 1990 to 2.7 in 2000. Clearly this was the end of democratic regime when General Mushraf had taken over the Government with a military action. The fertility inhibiting effect of marriage affected the outcome of fertility in Punjab and urban areas. In 1990, increase in age at first marriage contributed to reduce the TF (total fecundity rate of 13.4 children per woman) by 2.4 children per woman in Punjab. Within the next 16 years, the contribution of marriage decreased fertility from its theoretical maximum by 3.1 children per woman. By combining contraception and marriage, it could be concluded that contraceptive practice is primarily responsible for the wide range of the levels of fertility within marriage in Pakistan. The results from this study provide evidence that from 1990 to 2000 Pakistani women increasingly used contraception to control their reproduction and to extent increase in age at first marriage as a primary fertility regulation method. Another interesting conclusion could be drawn when comparing to previous periods: from 1974 to 1990, lactational infecundability has been found the most-significant fertility inhibiting effect. However, this effect attenuated from 1990 to 2006 (Aziz 1994). Our conclusion is consistent in case of Bangladesh (formerly part of Pakistan) till the early 1990s that the postpartum infecundability was observed to be the strongest fertility reducing factor .The influence of abortion in reducing fertility seems to be negligible. The Bongaarts model estimated TFR for period 1990 (5.2), 2000 (4.8), and 2006 (4.1) were marginally higher in 1990 survey (0.2 births per woman) and 2006 survey (0.4). It can be concluded that the difference between survey and estimated TFR could be attributed to induced abortion.

Based on the TFR values using proximate determinants model Bongaarts and Potter (P.104) categorized the population into one of the four stages of transition (Bongaarts and Potter 1983). The first group with TFR greater than 6.0, indicates Phase 1, the second group with TFR value from 4.5 through 6 in phase II, phase III with TFR ranging from 3.0 to 4.5, and phase IV with TFR less than 3.0 children per woman. Based on the results estimated using Bongaarts and Potter`s criteria, this study confirms that: Pakistan has entered the early phase III of transition.

The proximate determinants model also allows a regional understanding of fertility transition in Pakistan. To understand the regional differentials in terms of fertility transition in Pakistan, regions are ranked from lowest to highest values of TFR in 2006 and the information is presented in Table 8.1. The regional results show that none of the region has currently reached at the advance stage of transition, although urban, Punjab and Balochistan are heading towards the phase III of transition.

Table 8.1: Stage of fertility transition in different regions of Pakistan, 2006

Region	Phase of transition	Total fertility rate
Urban	III	3.7
Punjab	III	4.2
Balochistan	III	4.4
NWFP	II	4.5
Rural	II	5.0
Sindh	II	5.1

8.4 Timing of first marriage and parenthood

We split the concluding remarks between those factors that appear to have no or inverse effect on the age at first marriage as well as waiting time to first conception. Those that appear to have some influence but not consistently with the highest level of statistical significance and those that do appear to be main and statistically significant drivers. The factors that appear to have little or inverse effect are several. They include birth cohort, urban areas, Sindh, North West Frontier Province (NWFP), and ethnicity (only 2006 data). There are no major contradictions here given our understanding of age at first marriage in multivariate perspective.

One factor that changes the marriage effect between 1990 and 2006 offers evidence that is of interest. Respondent`s self-claimed labour force participation before marriage in particular the 2006 data play some positive role to increase the age at first marriage. The findings also suggest some variations across regions. For example, a woman living in Balochistan and had worked before marriage would marry at about 21 years. Conversely, a woman from Sindh and had economically participated in labour force before marriage would marry two year earlier than a corresponding Balochistani woman.

By far the strongest factor driving increase at first marriage in our analysis is the woman`s education. If you are a Pakistani woman and have achieved a college level education in Pakistan, you will marry at least four year later compare to one who has no education and will probably marry at the age of 19. More interestingly; if you decide to marry with similar educational qualifications, then you are likely to further delay your marriage by at least one additional year.

The timing of marriage is strongly related to the entry into motherhood. A general agreement is available in literature that increase in woman`s age at first marriage affect her reproductive lifetime fertility. The taboo of immediate childbearing following marriage at all ages exists in the Pakistani society, and surrounded by many complex relationships with social and economic variables—family and social networks in particular pre-occupied pressure of husband`s mother (the woman`s mother in law).

Regarding duration between marriage and the first conception woman`s age at first marriage and her achieved level of education are the main driving factors to lengthen her first pregnancy time. The analysis of duration between marriage and first conception for women who conceive their first child after marriage revealed a complex hazard function shape with two peaks: the first at duration 1 month and a second duration around 15 months.

8.5 Birth interval

The factors potentially associated with second through sixth birth interval analysis were grouped into two classes: fixed or time independent and time varying variables. Separate multivariate modelling was performed for each class of variables in order to maximize the transparency and rigour of our investigation of what is driving to increase birth interval duration in Pakistan. We split the concluding remarks between those significant variables that appear to increase birth interval length and those variables decreasing birth interval in Pakistan. The three strongest factors driving the short birth intervals are: respondent age at first marriage, duration from marriage to first birth and the time of death of immediate previous children. First two variables are fixed and third factor is time varying covariate. If you are a Pakistani woman whose first child is alive and you marry at age 22 or above you will 1.2 times more likely to have third conception compared to one who has married under age 17 years. The effect age at marriage in shortening birth intervals remains strong and goes upward for higher order birth intervals—the difference between the two women is nearly two times for the sixth conception. We advance the discussion on variables appears to drive long birth intervals in Pakistan. Great concentration of long birth intervals are from those women who have some level of education as well as their husband has some level of education, being the resident of Balochistan and urban areas in general in Pakistan. These are identified as time independent variables. Previous research shows the duration of breast feeding has strongest effect on length of birth interval in Pakistan (Sathar 1988). To capture the effect of breastfeeding on birth interval duration since death of the immediate previous child as time varying covariate is used. Death of immediate previous child in first 17 months leads to a short birth interval for next birth in Pakistan. The social and economic factors affecting birth intervals are several. They include birth cohort, the gender of index child, education level of respondent, spouse level of education, and age of mother at previous pregnancy. These factors show the effects in the expected direction.

However, what is surprising is the limited effect of contraceptive use. There are good theoretical and empirical reasons for not including contraceptive use in the analysis of birth intervals particularly in Pakistan. It has been reflected in the literature that contraception is used for limiting family size and not for birth spacing in Pakistan (Shah and Shah 1984, Sathar 1988). Separate multivariate models incorporating the use of contraception to influence birth intervals were estimated. An unexpected observation was noted that women who have ever used contraception had short birth intervals than the never users (see multivariate models shown in Appendix J). The finding is the converse of what would be traditionally expected. This might indicate users had higher fertility. It could possibly be the causality issue that users have short birth intervals and therefore results of these models are shown in Appendix. Our impression of causality is consistent with a previous study of birth spacing in Pakistan which used the 1975 Pakistan Fertility Survey data (Sathar 1988).

8.6 Amalgamations of findings

It is clear that age misreporting can potentially affect the measurement of fertility rates, though probably not sufficiently and consistently enough to affect overall conclusions about fertility trends in the country as a whole. This concludes that fertility levels could be underestimated when no adjustments are made for age distortions. Our analysis of the proximate determinants reaches on the conclusion that fertility transition in Pakistan is currently at the earlier stage of phase III. This conclusion raises an important question: will fertility transition in Pakistan ever complete or will the Pakistani nation achieve replacement level of fertility in the near future and what policy inputs and programme interventions would be required?

Marriage in Muslim populations at early age is widely practiced than their non-Muslim counterparts. Pakistan belongs to a group of countries in which, by tradition, fertility before marriage is rare and the conception of the first child proceeds as soon as possible after marriage. In such a population the analysis of the duration between marriage and first birth would be less interesting since there is little behavioural variation among sub-populations. Yet, this study reveals unexpected complexity in reproductive behaviour towards the transition to first birth. The observed hazard is a mixture of two different functions applying to different groups of women.

(1) A group adhering to the traditional pattern in which conception takes place as soon as possible after marriage. These women have a hazard of first conception which declines monotonically with duration because of a selection effect operating within the group by which the biologically most fecund conceive early.

(2) A group which delays conception after marriage. This group is, in turn divided into two groups: (a) women marrying at very young ages who delay sexual activity or remain infecund for some time after the marriage; (b) women adopting a more ‘western’ form of reproduction in which some delay after marriage is normal. We hypothesise that, over time, Groups 1 and 2a will form a smaller proportion of Pakistani women and Group 2b will form a larger proportion. An initial comparison of the samples in the 1990 and 2006 DHSs suggests that Group 1 is declining in importance over time in favour of Group 2, suggesting that Pakistani women are adopting more ‘western’ forms of childbearing.

To highlight the regional differentials in terms of first childbearing in Pakistan, regions are arranged in descending order of group identification in 2006 and the information is shown in Table 8.2.

Table 8.2: Form of first childbearing in different regions of Pakistan, 2006

Region	Group Identification	Form of childbearing
Balochistan	2b	Western
Punjab	2b	Western
Urban	2b	Western
NWFP	2a	Some delay
Rural	1 and 2a	Some delay
Sindh	1	Traditional (Immediate)

The pattern of first childbearing in regions could be linked with the stage of fertility transition. The conclusion looks consistent that urban areas, Balochistan and Punjab leading in phase of fertility transition are more likely to adopt a western form of childbearing in Pakistan. Second through sixth birth interval durations were longer among women from Punjab and urban areas in Pakistan. Age at marriage seemed to play an important role in determining the length of birth intervals. Those who married at higher ages have relatively short birth intervals compared to those who married at very young ages in Pakistan. It seems there is no child replacement for the first 17 months due to effect of breastfeeding. We used the calendar data to capture the variation in fertility on the proximate determinants (breastfeeding and amenorrhea). We found that when month-by-month data on breastfeeding and amenorrhea are incorporated into the model of birth interval, fixed time (demographic and socio-economic) variables become insignificant compared to breastfeeding and amenorrhea which are strongly affecting the length of birth intervals. The roles of contraception on birth interval durations had indicated unexpected evidence since 1980s and suggest that contraception is used after the achievement of family size.

8.7 Policy Implications

A number of policy implications could be identified on the basis of the analysis conducted in this thesis. The analysis dealt with a number of questions on the levels, trends and determinants of fertility in Pakistan previously neglected in demographic research. A clear conclusion from this study is that fertility in Pakistan has indeed showed a decline over time, but the decline is not at the expected level. The focus should be on several fronts but we will confine our discussion of policy recommendations taking into account of neglected dimensions mentioned in this study. In addition the recommendations are categorized into following two groups.

Programmatic

It is quite obvious that if the age distribution of any population is distorted the estimates of demographic parameters will be adversely affected. The analysis of provincial urban-rural split in terms of age distortions provide a basis for intervention in specific regions for example, rural Sindh and NWFP needs more attention compared to urban Balochistan. Knowing the pattern of distortions two kind of inputs would be worth pointing out. First, a long term policy input to increase educational facilities because it is presumed that inaccurate age reporting is largely related to literacy. Hence, more vocational training and evening schools should be provided in those regions that are in second phase of fertility transition. On short term basis, radio broadcast could also be the medium to increase the literacy levels at community levels and in particular with the focus on family planning information. The strategy of radio broadcasting is in vogue in some other developing countries for example in Kenya (total fertility rate 4.2 per woman) and Philippines (total fertility rate 3.2 per woman). For example, the literatures presented in second chapter of thesis provide evidence that fear of side effects as a main factor associated with non-use of contraception. Radio broadcast strategy could be used to bridge this gap for providing rigorous information on the side effects of contraceptive use.

The analysis presented in this thesis also provide policy guidelines to minimize age misreporting during field work or prior to data collection. Demographic and Health Survey collects information from ever married women age 15 to 49 years. If the lower biological limit (age 15 years) is shifted upward (starting from 18, a compulsory age for National Identity card in Pakistan) and the information from the Computerized National Identity Card (CNIC) of ever-married women is considered for inclusion in survey sample, it could be expected that age distortions would be minimised. The birth history comparison of two samples (one starting with the biological minimum age and other from CNIC minimum age) would be interesting. The other traditional approaches of data collection could be amalgamated with these suggestions, for example careful training of interviewers.

Pakistan being the Islamic faith population, some attention to be given to two dimensions: contraceptive use and age at marriage. Lessons should be learnt from the previous strategies to lower the fertility levels in the form of set targets for the increase of contraceptive use in Pakistan actually has not motivated the mind of people. We recommend the indirect approaches to bridge this gap. For example, in formal education programs some portion of educational syllabus should include the introduction to contraception as well as information on sexually transmitted diseases. A similar kind of strategy was adopted in neighbouring country of Pakistan namely Iran where the fertility levels have tremendously reached at below replacement after the Islamic directive came in 1980s (Aghajanian 1994, Aghajanian and Merhyar 1999). Age at first marriage is expected to be high through the women`s active participation in economy. Opportunities to offer women entrepreneurship would be an edge and the government finances to these businesses should require the minimum age limit with added restriction of no entry into marital status. The legislation on rising age at first marriage would be impractical; however increasing the use of contraceptive immediately after marriage could play a positive role in delaying first birth. Delay in age at first birth would effect overall fertility. No monetary incentives are offered to delay first baby and it is suggested that on pilot basis monetary incentive policy should be introduced to low income couple. Lessons should be learnt from previous research of providing monetary funds to government for the effecting implementation of the family planning program has not been successful. A policy shift is suggested to offer in the form of offering monetary rewards for first two births. For follow up purposes, the National Health System should be centralized for unique registration identification such as the National Database and Registration Authority (NADRA). Vital registration system should be linked and its control should come under National Health. These policy inputs would inline the scattered information and are workable in timely manners. One other strategy could be advantageous: focus on to encourage mothers to complete at least two year breastfeeding practice for a positive effect to reduce overall fertility.

The study has also shown that three regions (urban, Punjab and Balochistan) are at the forefront phase of fertility transition in Pakistan, a different policy input to reduce fertility would be better in those regions lacking behind in transition.

Methodological

Second policy input to deal with age misreporting issue seems more practical in short term: compensatory adjustments to minimize age distortions should be made— for adjustment one possibility could be the use of method of digit shifts proposed in this dissertation. Where age misreporting is prevalent, both adjusted as well as unadjusted estimates of fertility could be presented. This strategy would clearly be available after the collection of data set. A similar approach could be adopted with other variables for which misreporting are common, such as age at death of infants and young children. In so doing, we need to aware of the consequences of the data imputation procedures used in the DHS data.

8.8 Study limitation

Data quality issues

Demographic and Health Surveys are designed to produce a representative sample of households by employing a representative sample of women in childbearing ages (15-49). There is always a strong dire for the accurate information. Accurate information about people's behaviour in general is very rare to get particularly in developing countries. Pakistan Demographic and Health Surveys have some data quality issues some of them are highlighted throughout the thesis. The study is limited given the reflection of the data quality issues.

Linking demographic theory

Demographic transition theory has passed through various dimensions since its inception. Theories of fertility decline have been proposed under many formulations. For example, classical demographic transition theory is based on the fertility decline experiences of the Western populations between the eighteenth and twentieth centuries. The other commonly known theories are designated as the 'social structural theory', 'crisis theory', 'ideational change, interaction and diffusion theories', 'micro-economic theory', and 'social psychological theory' of fertility decline. The classical theory is linked with the industrial development in Europe. Despite the fact that this thesis is not designed to link with the theories of fertility transition, it helps to provide a basis to see further insights rather the limitations of the study. No doubt, intensive demographic research particularly in economically developed nations has been revealing complex patterns that do not fit into the existing theoretical schema. Pakistan is one of the developing countries of South Asia and its demographic revolution is in progress. The present study has not explored or categorized the fertility transition of Pakistan towards the theories of fertility decline. It does provide some additional information about the course of fertility decline in Pakistan which could then be used to test theories of fertility transition. This study relied on cross-sectional population data which restricts our understanding of the underlying processes related to reproductive decision making and timing of events.

8.9 Future directions

There are various areas which need further research, broadly categorized into two groups.

Analytical work

This group outlines the work from the supply side factors of fertility transition in Pakistan. The first formal or standard document providing the methodological guidelines to measure the impact of FP program input on fertility is perhaps the United Nation's manual IX covering the eight different approaches (United Nations 1979). Later on some informal approaches including cause-specific analysis', 'situation analysis', 'cost recovery analysis of contraception', 'cost-effect analysis' have been in vogue to measure the impact of FP inputs. Nevertheless any approach whether formal or informal for evaluating FP program poses a problem of data constraint quite in general and acceptors or users service statistics in specific. There is a real need for more work in this field. There seems to be heavy reliance on the use of service statistics (supply side) in previous research for the evaluation of family planning program. We intend to develop a framework using a response statistics to evaluate a family planning program particular in Pakistan. The cohort analysis of the survey sample since 1990s using intended framework would be worth exploring.

According to Bongaarts ‘all important variation in fertility’ is captured through the differences in marriage, breastfeeding, contraception, and induced abortion and theoretically there would be no direct effect of demographic and social-economic factors on fertility (Bongaarts 1982). The analysis of birth intervals accounting for person-period data have found a minor empirical evidence of direct effect of socio-economic variables (Balochistan and respondent level of education) on birth interval after controlling for breastfeeding and amenorrhea. This is identified as the model specification bias (exclusion of important covariate). This could be assumed an issue for a reason as no month by month information on contraceptive is available. This issue is generally handled by introducing error term for unobserved heterogeneity in the duration models. Birth interval analysis could be extended for example using a discrete time hazard model with a probability distribution error term—a gamma-distribution in particular.

Methodological work

For methodological contribution, following areas could be identified for future work.

There exists a wide class of design of experiments, using an integrated approach, the statistical model to deal with the method of digit shifts could be explored including the design properties and formulation with a possibility of missing cases.

The hazard shape for first birth interval seems to be complex and the present study identified two groups of women at their age at first birth, it is outlined that Group 1 hazard may be modelled with a parametric survival model, a class of survival models including Weibull, Gamma, Gompertz, Inverse Guassian, Pareto, and generalized gamma distribution is available to explore the appropriate fit.

Group 2b: The hazard for these women may be modelled by a log-logistic or similar distribution and for both a mixture distribution can be considered.

APPENDICES

Appendix A: Calculating Myer`s index for PDHS 2006-07

For the application of the Myer`s index, the data of Pakistan Demographic and Health Survey 2006-07 is utilized. The age distribution of ever married women (15-49) is shown in Table A1. The computational details of Myer`s index are shown in the columns of Table A2.

Table A1: Age distribution of ever-married women in 2006-07 Pakistan Demographic and Health Survey

Age	Number	Age	Number	Age	Number	Age	Number	Age	Number
15	39	22	353	29	301	36	335	43	191
16	69	23	270	30	593	37	227	44	196
17	96	24	347	31	236	38	351	45	360
18	203	25	513	32	366	39	236	46	258
19	171	26	392	33	242	40	434	47	177
20	358	27	344	34	279	41	233	48	245
21	232	28	460	35	500	42	228	49	188

Table A2: Computational details of Myer`s index

Terminal digit	Sum of population (10-39)	Sum of population (20-49)	Weights (Coefficient) (10-39)	Weights (Coefficient) (20-49)	Blended population (BP)	% BP	Deviation from 10 %
0	951	1385	1	9	13416	16.4	6.4
1	468	701	2	8	6544	8.0	2.0
2	719	947	3	7	8786	10.8	0.8
3	512	703	4	6	6266	7.7	2.3
4	626	822	5	5	7240	8.9	1.1
5	1013	1373	6	4	11570	14.1	4.1
6	727	985	7	3	8044	9.9	0.1
7	571	748	8	2	6064	7.4	2.6
8	811	1056	9	1	8355	10.2	0.2
9	537	725	10	0	5370	6.6	3.4
Total					81655	100	**23.0**

Appendix B: Algorithm for assigning imaginary women at true digits using least distance shifting

For any terminal digit i, 0 through 9, all possible adjacent or neighbour digits would be:

$$i - d, i + d$$

For $d = 1, 2, 3, 4, 5$.

The first least possible distance would occur at $d = 1$; and the next least possible distance would be $d = 2$, and so on.

The first step is to identify the digit preference (i^P) and digit avoidance (i^A) using the following criteria:

$$i = \begin{cases} i^A \text{ if } \widehat{P_i} < 0.10 \text{ or } W_i^R < N \\ i^P \text{ if } \widehat{P_i} > 0.10 \text{ or } W_i^R > N \end{cases}$$

Where $\widehat{P_i}$ are the estimated probabilities using multinomial logistic regression model with no covariates for unit digit preference or avoidance and N is fixed,

usually$N = 100, \text{or } 1000, \text{or } 10{,}000$.

Rank the avoided digit (i_R^A) from the most avoided to the least avoided digit. Find out the least distance digit(s) shift by working on $[i - d, i + d]$ all possible shifts. Construct a matrix of digits by filling out the main diagonal values first. Adjust the most avoided digit first i_R^A using the least distance shift(s) $[i - d, i + d]$; similarly proceed in a similar manner for the remaining avoided digits. Construct the matrix of digit weights A.

Where

$$A = [\alpha_{ij}]$$

Where

$$\alpha_{ij} = \frac{d_{ij}}{W_i^R}$$

Such that the rows of this matrix all sum to 1.0;

$$\sum_{j=0}^{9} \alpha_{ij} = 1 \ \forall_j$$

Finally, the true digit age distribution is obtained using equation (50) of Chapter 3:

$$W_y^T = \sum_{k=15}^{49} \alpha_{xy} W_x^{obs}$$

Where W_x^{obs} in equation (?) is the observed number of women at each age

Example: PDHS 2006-07

For the application of the proposed algorithm, the data of Pakistan Demographic and Health Survey 2006-07 is utilized. The estimated probabilities of terminal digit preference or avoidance are shown in the second column of Table B1.

Table B1: Digit avoidance and preference

$\boldsymbol{i}$	$\widehat{\boldsymbol{P_\iota}}$	$\boldsymbol{W_i^R}$	**Digit avoided**
0	0.1519	1519	
1	0.0755	755	i^A
2	0.0975	975	i^A
3	0.0729	729	i^A
4	0.0831	831	i^A
5	0.1438	1438	
6	0.1038	1038	
7	0.0780	780	i^A
8	0.1133	1133	
9	0.0802	802	i^A

Source: author own elaborations

Table B2: Ranked digit avoided

Rank	$\boldsymbol{i_R^A}$	$\boldsymbol{W_i^R}$
1	3	729
2	1	755
3	7	780
4	9	802
5	4	831
6	2	975

Source: author own elaborations

For most avoided digit, $i_R^A = 3$; all possible adjacent digits would be:

Design	**Shifts**	**Least distance shift**
[2 3 4]	[1, 1]	
[1 3 5]	[2, 2]	[-, 2]
[0 3 6]	[3, 3]	
[9 3 7]	[4, 4]	
[8 3 8]	[5, 5]	

Similarly; for the remaining avoided digits the least distance shifts would be:

[0 1 2]	[1, 1]	[1, -]
[6 7 8]	[1, 1]	[-, 1]
[5 7 9]	[2, 2]	[2, -]
[8 9 0]	[1, 1]	[1, 1]
[3 4 5]	[1, 1]	[-, 1]
[0 2 4]	[2, 2]	[2, -]

Matrix of digit shifts

		N	N	N	N	N	N	N	N	N	N
i/j		0	1	2	3	4	5	6	7	8	9
0	1519	1000	245	25	0	51	0	0	0	0	198
1	755	0	755	0	0	0	0	0	0	0	0
2	975	0	0	975	0	0	0	0	0	0	0
3	729	0	0	0	729	0	0	0	0	0	0
4	831	0	0	0	0	831	0	0	0	0	0
5	1438	0	0	0	271	80	1000	0	87	0	0
6	1038	0	0	0	0	38	0	1000	0	0	0
7	780	0	0	0	0	0	0	0	780	0	0
8	1133	0	0	0	0	0	0	0	133	1000	0
9	802	0	0	0	0	0	0	0	0	0	802
Total		N	N	N	N	N	N	N	N	N	N

Source: author own elaborations

Matrix of digit weights

		N	N	N	N	N	N	N	N	N	N
i/j		0	1	2	3	4	5	6	7	8	9
0	1519	0.66	0.16	0.02	0.00	0.03	0.00	0.00	0.00	0.00	0.13
1	755	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	975	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	729	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
4	831	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
5	1438	0.00	0.00	0.00	0.19	0.06	0.70	0.00	0.06	0.00	0.00
6	1038	0.00	0.00	0.00	0.00	0.04	0.00	0.96	0.00	0.00	0.00
7	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
8	1133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.88	0.00
9	802	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Total											

Source: author own elaborations

Matrix of reported and true ages (age group: 20-29)

True/adjusted												
Age	*Reported*	19	20	21	22	23	24	25	26	27	28	29
20	358	47	236	58	6		12					
21	232			232								
22	353				353							
23	270					270						
24	347						347					
25	513					97	29	357		31		
26	392						14		378			
27	344									344		
28	460									54	406	
29	301											301
Total			**236**	**290**	**359**	**367**	**402**	**357**	**378**	**429**	**406**	

Source: author own elaborations

For the demonstration of algorithm, the matrix of true age distribution for ages (20-29) only have been shown. However; following the algorithm, one can generate the complete matrix of reported and true ages and would obtain the following age distribution adjusted for age reporting (Table B3).

Table B3: Reported and adjusted age distribution for Pakistan Demographic and Health Survey 2006-07

Age	Reported	Adjusted
13		7
14		5
15	39	27
16	69	66
17	96	122
18	203	179
19	171	218
20	358	236
21	232	290
22	353	359
23	270	367
24	347	402
25	513	357
26	392	378
27	344	429
28	460	406
29	301	378
30	593	390
31	236	332
32	366	376
33	242	336
34	279	339
35	500	348
36	335	323
37	227	298
38	351	310
39	236	293
40	434	286
41	233	303
42	228	235
43	191	259
44	196	240
45	360	250
46	258	249
47	177	228
48	245	216
49	188	188
Total	10023	10023

Appendix C: Age specific fertility rates adjusted for age heaping

Let f_x is the observed age specific fertility rate (ASFR) of Pakistani women at their reported ages and is defined as follows:

$$f_x = \frac{B_x^{obs}}{W_x^{obs}}$$

By cross multiplication, the above expression could be written as:

$$W_x^{obs} = \frac{B_x^{obs}}{f_x} \tag{1}$$

Using equation (30) of Chapter 3:

$$W_y^T = \sum_{x=15}^{49} \alpha_{xy} W_x^{obs} \tag{2}$$

Substituting equation (1) in equation (2)

$$W_y^T = \sum_{x=15}^{49} \frac{\alpha_{xy} B_x^{obs}}{f_x} \tag{3}$$

Suppose that

$$B_y^T = \sum_{x=15}^{49} \alpha_{xy} B_x^{obs} \tag{4}$$

Then

$$f_y^T = \frac{B_y^T}{W_y^T} \tag{5}$$

Substituting equations (3-4) into equation (5):

$$f_y^T = \frac{\sum_{x=15}^{49} \alpha_{xy} B_x^{obs}}{\sum_{x=15}^{49} \frac{\alpha_{xy} B_x^{obs}}{f_x}} \tag{6}$$

This is equivalent to the following expression by using equation (1):

$$f_y^T = \frac{\sum_{x=15}^{49} \alpha_{xy} W_x^{obs} f_x}{\sum_{x=15}^{49} \frac{\alpha_{xy} W_x^{obs} f_x}{f_x}}$$

Simplifying the denominator of above equation for f_x would give expression (53) of Chapter 3 and is reproduced here:

$$f_y^T = \frac{\sum_{x=15}^{49} \alpha_{xy} W_x^{obs} f_x}{\sum_{x=15}^{48} \alpha_{xy} W_x^{obs}}$$

$$f_y^T = \frac{\sum_{x=15}^{49} f_x W_{xy}}{\sum_{x=15}^{48} W_{xy}}$$

$$f_y^T = \frac{\sum_{x=15}^{49} f_x W_{xy}}{W_y^T}$$

Appendix D: Digit specific indices for age heaping

Table D1: Digit specific indices for age heaping for total ever married women in three surveys, Pakistan, 1990 and 2006

Time and index		Total									
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2006	Whipple`s	1.382	0.699	0.945	0.701	0.820	1.409	1.052	0.842	1.256	0.894
	Modified Whipple`s	1.456	0.789	1.039	0.773	0.851	1.460	0.978	0.772	1.158	0.881
	Further modified Whipple`s	1.370	0.895	1.149	0.728	0.775	1.280	1.002	0.844	1.067	0.901
	Myer`s	0.164	0.080	0.108	0.077	0.089	0.142	0.099	0.074	0.102	0.066
2000	Whipple`s	1.156	0.381	0.719	0.475	0.458	1.077	0.576	0.504	0.780	0.438
	Modified Whipple`s	1.729	0.606	1.128	0.769	0.708	1.743	0.848	0.747	1.129	0.672
	Further modified Whipple`s	1.537	0.726	1.306	0.718	0.674	1.498	0.929	0.878	0.986	0.665
	Myer`s	0.202	0.065	0.118	0.077	0.072	0.167	0.083	0.068	0.093	0.054
1990	Whipple`s	1.244	0.326	0.643	0.435	0.429	1.375	0.571	0.474	0.742	0.357
	Modified Whipple`s	1.964	0.550	1.044	0.684	0.636	2.094	0.795	0.673	1.095	0.568
	Further modified Whipple`s	1.687	0.697	1.279	0.591	0.561	1.705	0.958	0.904	0.950	0.556
	Myer`s	0.218	0.056	0.108	0.070	0.069	0.212	0.080	0.063	0.087	0.038

Source: author own elaborations

Table D2: Digit specific indices for age heaping for ever married women in urban areas three surveys, Pakistan, 1990 and 2006

Time and index		Urban									
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2006	Whipple`s	0.493	0.288	0.353	0.282	0.326	0.537	0.410	0.344	0.452	0.335
	Modified Whipple`s	1.399	0.849	1.013	0.794	0.868	1.413	0.991	0.828	1.111	0.876
	Further modified Whipple`s	1.303	0.936	1.102	0.745	0.787	1.247	1.020	0.913	1.059	0.901
	Myer`s	0.151	0.084	0.104	0.079	0.090	0.141	0.097	0.083	0.096	0.074
2000	Whipple`s	0.459	0.162	0.316	0.203	0.226	0.414	0.255	0.232	0.344	0.208
	Modified Whipple`s	1.615	0.607	1.158	0.769	0.808	1.555	0.867	0.800	1.148	0.739
	Further modified Whipple`s	1.470	0.713	1.273	0.724	0.769	1.377	0.921	0.889	1.022	0.752
	Myer`s	0.185	0.063	0.120	0.075	0.081	0.148	0.091	0.071	0.102	0.063
1990	Whipple`s	0.557	0.184	0.346	0.224	0.252	0.646	0.320	0.261	0.382	0.204
	Modified Whipple`s	1.742	0.615	1.107	0.682	0.715	1.894	0.860	0.721	1.108	0.641
	Further modified Whipple`s	1.537	0.730	1.262	0.604	0.635	1.578	0.997	0.926	1.003	0.647
	Myer`s	0.188	0.060	0.112	0.069	0.078	0.193	0.090	0.070	0.095	0.045

Source: author own elaborations

Table D3: Digit specific indices for age heaping for total ever married women in rural areas in three surveys, Pakistan, 1990 and 2006

Time and index		Rural									
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2006	Whipple`s	0.889	0.411	0.592	0.419	0.494	0.872	0.642	0.498	0.804	0.559
	Modified Whipple`s	1.490	0.751	1.055	0.760	0.840	1.491	0.969	0.738	1.186	0.884
	Further modified Whipple`s	1.410	0.867	1.180	0.717	0.768	1.301	0.990	0.803	1.071	0.902
	Myer`s	0.173	0.078	0.110	0.075	0.088	0.142	0.099	0.069	0.106	0.061
2000	Whipple`s	0.697	0.219	0.403	0.272	0.231	0.662	0.320	0.271	0.436	0.230
	Modified Whipple`s	1.814	0.605	1.105	0.770	0.632	1.884	0.833	0.706	1.115	0.621
	Further modified Whipple`s	1.585	0.736	1.333	0.713	0.601	1.585	0.935	0.868	0.959	0.603
	Myer`s	0.215	0.067	0.117	0.078	0.065	0.181	0.077	0.066	0.087	0.048
1990	Whipple`s	0.687	0.143	0.296	0.211	0.177	0.729	0.250	0.213	0.360	0.154
	Modified Whipple`s	2.190	0.485	0.979	0.686	0.549	2.309	0.724	0.623	1.082	0.494
	Further modified Whipple`s	1.831	0.659	1.301	0.577	0.481	1.835	0.913	0.878	0.900	0.469
	Myer`s	0.250	0.051	0.103	0.071	0.058	0.233	0.070	0.054	0.079	0.031

Source: author own elaborations

Table D4: Digit specific indices for age heaping for ever married women in Punjab in three surveys, Pakistan, 1990 and 2006

Time and index		Punjab									
		0	1	2	3	4	5	6	7	8	9
2006	Whipple`s	0.556	0.297	0.431	0.286	0.385	0.605	0.485	0.350	0.516	0.342
	Modified Whipple`s	1.415	0.819	1.102	0.718	0.891	1.432	1.036	0.762	1.147	0.830
	Further modified Whipple`s	1.298	0.879	1.173	0.678	0.800	1.260	1.077	0.870	1.095	0.859
	Myer`s	0.153	0.079	0.115	0.072	0.095	0.142	0.106	0.074	0.102	0.061
2000	Whipple`s	0.401	0.211	0.335	0.235	0.247	0.450	0.267	0.251	0.372	0.237
	Modified Whipple`s	1.341	0.750	1.172	0.799	0.816	1.550	0.842	0.796	1.217	0.806
	Further modified Whipple`s	1.271	0.808	1.229	0.762	0.786	1.393	0.900	0.876	1.105	0.839
	Myer`s	0.151	0.077	0.118	0.082	0.083	0.151	0.086	0.075	0.105	0.071
1990	Whipple`s	0.347	0.130	0.241	0.170	0.150	0.429	0.206	0.165	0.225	0.140
	Modified Whipple`s	1.671	0.639	1.163	0.761	0.633	1.918	0.875	0.707	1.041	0.694
	Further modified Whipple`s	1.450	0.720	1.292	0.685	0.583	1.610	1.035	0.932	0.950	0.680
	Myer`s	0.181	0.065	0.120	0.080	0.069	0.201	0.088	0.069	0.079	0.048

Source: author own elaborations

Table D5: Digit specific indices for age heaping for ever married women in Sindh in three surveys, Pakistan, 1990 and 2006

Time and index		Sindh									
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2006	Whipple`s	0.394	0.192	0.270	0.185	0.218	0.379	0.272	0.224	0.327	0.247
	Modified Whipple`s	1.486	0.774	1.074	0.750	0.850	1.482	0.958	0.774	1.116	0.893
	Further modified Whipple`s	1.381	0.889	1.204	0.721	0.790	1.298	0.992	0.843	1.013	0.891
	Myer`s	0.173	0.082	0.114	0.077	0.089	0.141	0.097	0.070	0.093	0.065
2000	Whipple`s	0.371	0.082	0.203	0.129	0.114	0.302	0.148	0.128	0.203	0.109
	Modified Whipple`s	1.983	0.460	1.128	0.789	0.656	1.843	0.826	0.718	1.057	0.610
	Further modified Whipple`s	1.699	0.594	1.365	0.727	0.637	1.570	0.927	0.873	0.890	0.581
	Myer`s	0.240	0.052	0.126	0.078	0.069	0.172	0.076	0.061	0.084	0.042
1990	Whipple`s	0.60	0.090	0.167	0.110	0.115	0.362	0.158	0.134	0.215	0.085
	Modified Whipple`s	2.058	0.560	0.991	0.654	0.642	2.063	0.802	0.702	1.128	0.480
	Further modified Whipple`s	1.752	0.736	1.278	0.565	0.557	1.663	0.935	0.926	0.976	0.476
	Myer`s	0.229	0.056	0.101	0.066	0.069	0.202	0.083	0.065	0.095	0.035

Source: author own elaborations

Table D6: Digit specific indices for age heaping for ever married women NWFP in three surveys, Pakistan, 1990 and 2006

Time and index		NWFP/Khyber									
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2006	Whipple`s	0.262	0.142	0.145	0.144	0.160	0.246	0.201	0.167	0.230	0.162
	Modified Whipple`s	1.501	0.860	0.849	0.871	0.921	1.344	0.999	0.828	1.128	0.839
	Further modified Whipple`s	1.435	0.988	0.969	0.800	0.828	1.205	1.007	0.895	1.056	0.857
	Myer`s	0.169	0.087	0.090	0.086	0.096	0.134	0.098	0.079	0.099	0.062
2000	Whipple`s	0.233	0.071	0.126	0.068	0.069	0.195	0.118	0.086	0.143	0.057
	Modified Whipple`s	1.918	0.638	1.109	0.644	0.613	1.819	0.966	0.718	1.121	0.482
	Further modified Whipple`s	1.629	0.804	1.437	0.616	0.561	1.466	1.020	0.902	0.988	0.472
	Myer`s	0.233	0.070	0.117	0.061	0.063	0.169	0.095	0.070	0.086	0.036
1990	Whipple`s	0.370	0.060	0.159	0.103	0.087	0.392	0.128	0.090	0.192	0.082
	Modified Whipple`s	2.257	0.393	1.019	0.649	0.518	2.453	0.719	0.508	1.112	0.516
	Further modified Whipple`s	1.886	0.559	1.367	0.538	0.452	1.930	0.937	0.742	0.893	0.480
	Myer`s	0.262	0.041	0.108	0.066	0.056	0.240	0.065	0.044	0.087	0.031

Source: author own elaborations

Table D7: Digit specific indices for age heaping for ever married women in Baluchistan in three surveys, Pakistan, 1990-2006

Time and index		Baluchistan									
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2006	Whipple`s	0.170	0.069	0.099	0.087	0.057	0.179	0.094	0.101	0.183	0.143
	Modified Whipple`s	1.460	0.645	1.027	0.895	0.562	1.728	0.765	0.721	1.324	1.074
	Further modified Whipple`s	1.509	0.812	1.222	0.821	0.533	1.436	0.746	0.710	1.107	1.123
	Myer`s	0.177	0.068	0.097	0.080	0.050	0.156	0.076	0.078	0.131	0.089
2000	Whipple`s	0.151	0.018	0.056	0.043	0.028	0.130	0.043	0.039	0.063	0.035
	Modified Whipple`s	2.484	0.300	0.946	0.790	0.484	2.297	0.710	0.629	0.952	0.572
	Further modified Whipple`s	2.013	0.462	1.323	0.652	0.442	1.840	0.890	0.854	0.759	0.515
	Myer`s	0.288	0.034	0.101	0.076	0.045	0.225	0.064	0.051	0.072	0.042
1990	Whipple`s	0.167	0.047	0.076	0.053	0.078	0.192	0.080	0.086	0.111	0.051
	Modified Whipple`s	1.920	0.609	0.903	0.609	0.844	1.963	0.731	0.827	1.121	0.552
	Further modified Whipple`s	1.728	0.801	1.101	0.510	0.703	1.609	0.866	1.040	1.012	0.577
	Myer`s	0.205	0.057	0.091	0.061	0.089	0.208	0.083	0.075	0.093	0.038

Source: author own elaborations

Appendix E: Mean age first marriage and birth

Table E1: Mean age at marriage and at first birth for various birth cohorts of Pakistani currently- married women (1990-91 Pakistan Demographic and Health Survey)

Birth cohort (Age at interview)	age at first marriage (Standard deviation)	age at first birth (Standard deviation)	Correlation (Sample size)
Total			
1941-45 (45-49)	19.42 (5.42)	22.10 (5.13)	0.77** (563)
1946-50 (40-44)	18.46 (4.82)	21.00 (4.88)	0.79** (750)
1951-55 (35-39)	18.45 (4.45)	20.86 (4.41)	0.81** (958)
1956-60 (30-34)	17.90 (4.02)	20.04 (3.92)	0.83** (1125)
1961-65 (25-29)	17.77 (3.66)	19.18 (3.33)	0.89** (1311)
Urban			
1941-45 (45-49)	19.24 (5.41)	21.65 (5.10)	0.83** (286)
1946-50 (40-44)	18.84 (4.89)	20.82 (4.76)	0.84** (362)
1951-55 (35-39)	18.46 (4.47)	20.59 (4.45)	0.87** (525)
1956-60 (30-34)	18.05 (3.99)	19.91 (3.89)	0.86** (598)
1961-65 (25-29)	18.11 (3.66)	19.36 (3.37)	0.90** (691)
Rural			
1941-45 (45-49)	19.59 (5.40)	22.56 (5.12)	0.73** (277)
1946-50 (40-44)	18.09 (4.72)	21.16 (4.98)	0.76** (388)
1951-55 (35-39)	18.39 (4.42)	21.14 (4.35)	0.75** (433)
1956-60 (30-34)	17.81 (4.09)	20.18 (3.97)	0.81** (527)
1961-65 (25-29)	17.45 (3.65)	19.00 (3.29)	0.88** (620)
Punjab			
1941-45 (45-49)	19.43 (4.79)	21.91 (4.66)	0.82** (181)
1946-50 (40-44)	19.10 (4.80)	21.36 (4.92	0.87** (273)
1951-55 (35-39)	19.00 (4.47)	21.16 (4.41)	0.87** (319)
1956-60 (30-34)	18.75 (3.93)	20.64 (3.92)	0.88** (368)
1961-65 (25-29)	18.40 (3.60)	19.79 (3.20)	0.89** (430)
Sindh			
1941-45 (45-49)	17.07 (4.56)	21.16 (5.13)	0.63** (158)
1946-50 (40-44)	17.27 (4.67)	20.50 (4.78)	0.65** (207)
1951-55 (35-39)	17.48 (4.23)	20.51 (4.32)	0.71** (269)
1956-60 (30-34)	17.51 (4.10)	19.93 (3.92)	0.72** (309)
1961-65 (25-29)	16.99 (3.63)	18.76 (3.29)	0.85** (366)
NWFP			
1941-45 (45-49)	20.66 (5.79)	22.22 (5.18)	0.93** (160)
1946-50 (40-44)	18.83 (5.01)	20.96 (5.18)	0.86** (189)
1951-55 (35-39)	18.79 (4.52)	20.60 (4.64)	0.90** (241)
1956-60 (30-34)	18.29 (4.11)	19.91 (4.01)	0.93** (295)
1961-65 (25-29)	18.30 (3.75)	19.33 (3.44)	0.93** (297)
Baluchistan			
1941-45 (45-49)	21.16 (6.49)	23.86 (5.96)	0.58** (64)
1946-50 (40-44)	17.94 (4.06)	21.13 (4.18)	0.62** (81)
1951-55 (35-39)	17.96 (4.18)	20.77 (4.04)	0.70** (129)
1956-60 (30-34)	16.94 (3.49)	19.13 (3.59)	0.77** (153)
1961-65 (25-29)	17.03 (3.34)	18.43 (3.28)	0.89** (218)

Table E1: Mean age at first marriage and at first birth for various birth cohorts of Pakistani currently-married women (2006-07 Pakistan Demographic and Health Survey)

Birth cohort (Age at interview)	age at first marriage (Standard deviation)	age at first birth (Standard deviation)	Correlation (Sample size)
Total			
1957-61 (45-49)	18.86 (4.52)	21.63 (4.67)	0.77** (1058)
1962-66 (40-44)	18.68 (4.42)	21.15 (4.55)	0.82** (1147)
1967-71 (35-39)	18.60 (4.31)	21.05 (4.42)	0.82** (1499)
1972-76 (30-34)	18.62 (4.23)	20.73 (4.13)	0.85** (1579)
1977-81 (25-29)	18.70 (3.80)	20.27 (3.36)	0.85** (1747)
Urban			
1957-61 (45-49)	18.90 (4.38)	21.24 (4.31)	0.82** (413)
1962-66 (40-44)	18.58 (4.31)	21.10 (4.49)	0.79** (481)
1967-71 (35-39)	18.88 (4.33)	20.99 (4.39)	0.84** (593)
1972-76 (30-34)	19.32 (4.27)	21.23 (4.10)	0.87** (624)
1977-81 (25-29)	19.28 (3.82)	20.62 (3.26)	0.88** (670)
Rural			
1957-61 (45-49)	18.72 (4.55)	21.82 (4.92)	0.75** (645)
1962-66 (40-44)	18.61 (4.44)	21.08 (4.53)	0.84** (666)
1967-71 (35-39)	18.36 (4.27)	20.99 (4.43)	0.80** (906)
1972-76 (30-34)	18.14 (4.15)	20.38 (4.12)	0.83** (955)
1977-81 (25-29)	18.28 (3.74)	20.02 (3.41)	0.84** (1077)
Punjab			
1957-61 (45-49)	19.10 (4.60)	21.47 (4.56)	0.83** (466)
1962-66 (40-44)	19.09 (4.42)	21.37 (4.49)	0.87** (534)
1967-71 (35-39)	19.11 (4.38)	21.39 (4.41)	0.84** (681)
1972-76 (30-34)	19.23 (4.33)	21.17 (4.25)	0.88** (699)
1977-81 (25-29)	19.28 (3.85)	20.64 (3.36)	0.88** (698)
Sindh			
1957-61 (45-49)	17.47 (3.89)	20.98 (4.63)	0.59** (256)
1962-66 (40-44)	17.78 (4.13)	20.53 (4.45)	0.73** (278)
1967-71 (35-39)	17.75 (3.69)	20.54 (4.29)	0.74** (361)
1972-76 (30-34)	17.85 (3.81)	20.26 (3.80)	0.78** (434)
1977-81 (25-29)	18.02 (3.52)	19.82 (3.29)	0.80** (495)
NWFP			
1957-61 (45-49)	18.75 (4.08)	21.56 (4.34)	0.78** (179)
1962-66 (40-44)	18.19 (4.39)	20.42 (4.11)	0.86** (209)
1967-71 (35-39)	17.99 (4.39)	20.00 (4.30)	0.87** (280)
1972-76 (30-34)	18.28 (4.32)	20.23 (4.21)	0.86** (291)
1977-81 (25-29)	18.15 (3.77)	19.81 (3.36)	0.90** (322)
Baluchistan			
1957-61 (45-49)	20.01 (4.94)	22.98 (5.28)	0.84** (157)
1962-66 (40-44)	19.00 (4.49)	22.27 (5.11)	0.73** (126)
1967-71 (35-39)	19.08 (4.65)	21.95 (4.64)	0.75** (177)
1972-76 (30-34)	18.40 (4.32)	20.79 (4.10)	0.79** (155)
1977-81 (25-29)	18.82 (3.95)	20.56 (3.43)	0.80** (232)

Table E2: Average number of children ever born by age at first birth for various birth cohorts of Pakistani currently-married women (1990-91 Pakistan Demographic and Health Survey), N.A: stands for not applicable for estimation (less than 10 cases)

Birth cohort (Age at interview)	**Age at first birth**									
	$\leq$15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	Total									
1941-45 (45-49)	8.12	7.69	7.27	8.67	7.39	7.17	6.91	6.21	6.94	6.45
1946-50 (40-44)	8.21	8.06	7.49	7.75	7.76	6.55	6.79	6.43	6.14	5.74
1951-54 (35-39)	7.92	6.66	6.89	6.89	6.61	6.12	5.81	5.60	5.32	5.19
1955-59 (30-34)	6.94	5.96	5.92	5.39	5.42	5.06	4.67	4.25	3.53	3.36
1960-64 (25-29)	5.40	4.60	4.15	3.90	3.47	3.25	2.88	2.43	2.03	1.58
	Urban									
1941-45 (45-49)	7.67	7.78	6.69	8.86	7.26	6.73	6.50	5.83	6.83	6.25
1946-50 (40-44)	8.36	7.71	6.84	7.76	7.75	6.89	5.96	6.44	6.13	5.57
1951-54 (35-39)	7.93	6.78	6.98	6.96	6.35	5.78	5.45	5.67	4.88	5.09
1955-59 (30-34)	7.20	5.81	5.84	5.02	5.37	5.29	4.70	4.61	3.64	3.54
1960-64 (25-29)	5.34	4.66	4.40	3.87	3.62	3.32	3.04	2.51	2.09	1.76
	Rural									
1941-45 (45-49)	8.72	7.55	7.93	8.33	7.54	7.48	7.26	6.68	7.04	6.64
1946-50 (40-44)	8.08	8.50	8.32	7.74	7.77	6.14	7.42	6.40	6.14	5.92
1951-54 (35-39)	7.90	6.44	6.74	6.81	6.95	6.58	6.41	5.54	5.68	5.33
1955-59 (30-34)	6.65	6.16	6.02	5.80	5.51	4.79	4.65	3.95	3.41	3.25
1960-64 (25-29)	5.47	4.54	3.92	3.94	3.32	3.14	2.73	2.36	1.92	1.41
	Punjab									
1941-45 (45-49)	8.30	N.A*	N.A*	7.84	6.80	7.38	7.55	5.50	6.60	6.14
1946-50 (40-44)	8.14	7.82	8.33	7.71	7.61	7.50	6.64	6.66	6.19	6.35
1951-54 (35-39)	7.57	6.53	6.53	6.90	6.52	5.88	6.03	5.61	5.88	5.81
1955-59 (30-34)	6.97	6.19	5.65	5.36	5.51	5.29	4.56	4.21	3.72	3.60
1960-64 (25-29)	4.97	4.36	4.27	4.04	3.71	3.13	2.91	2.61	2.08	1.33
	Sindh									
1941-45 (45-49)	8.50	9.40	7.64	9.23	6.69	8.55	6.27	7.20	7.69	6.33
1946-50 (40-44)	8.29	N.A*	7.55	7.13	7.63	5.63	6.58	6.12	6.73	5.55
1951-54 (35-39)	8.10	6.84	6.71	7.11	6.95	6.57	5.33	5.75	4.60	4.41
1955-59 (30-34)	6.86	5.85	6.03	5.86	5.00	5.07	4.63	4.06	3.30	3.12
1960-64 (25-29)	5.65	4.63	3.95	3.71	3.51	3.41	2.96	2.33	2.30	1.79
	NWFP									
1941-45 (45-49)	7.50	N.A*	7.64	N.A*	8.35	5.38	6.60	6.64	5.91	7.18
1946-50 (40-44)	8.62	8.00	6.75	7.55	8.33	6.00	7.64	7.27	5.67	5.33
1951-54 (35-39)	8.49	N.A*	7.00	7.00	6.50	6.07	5.86	5.75	5.35	5.69
1955-59 (30-34)	6.83	6.20	5.82	5.22	5.65	4.30	5.04	4.24	3.45	3.38
1960-64 (25-29)	5.11	4.57	3.97	3.90	3.30	3.25	2.97	2.41	1.73	1.67
	Baluchistan									
1941-45 (45-49)	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*
1946-50 (40-44)	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*	5.45	N.A*	N.A*	6.36
1951-54 (35-39)	N.A*	7.54	7.64	6.00	6.46	6.00	N.A*	4.80	N.A*	4.91
1955-59 (30-34)	7.23	5.50	6.73	4.67	5.60	5.32	4.38	4.78	3.57	3.67
1960-64 (25-29)	5.77	4.82	4.48	3.97	3.13	3.26	2.20	2.09	1.80	1.64

Table E3: Mean age at first birth for various birth cohorts of Pakistani currently-married women by age at first marriage (1990-91 Pakistan Demographic and Health Survey)

Birth cohort (Age at interview)	Age at first marriage									
	$\leq$ 15	16	17	18	19	20	21	22	23	24
	Total									
1941-45 (45-49)	18.45	18.50	19.24	20.25	21.58	23.04	23.34	24.09	24.30	25.57
1946-50 (40-44)	17.36	18.68	19.29	20.38	21.46	22.34	22.51	24.29	25.13	25.61
1951-54 (35-39)	17.28	19.06	19.51	19.97	20.84	22.24	22.40	23.65	24.43	26.00
1955-59 (30-34)	16.82	18.15	19.22	19.81	21.06	21.81	22.39	23.69	24.50	25.39
1960-64 (25-29)	16.00	17.85	18.64	19.43	20.49	21.70	22.21	23.36	24.28	25.43
	Urban									
1941-45 (45-49)	17.85	18.57	19.12	19.97	22.13	22.36	23.39	23.79	24.31	25.64
1946-50 (40-44)	16.78	18.23	19.07	20.36	21.65	21.86	22.20	23.80	24.82	25.44
1951-54 (35-39)	16.72	18.22	19.22	19.85	20.70	22.21	22.18	23.52	24.21	26.23
1955-59 (30-34)	16.57	17.96	18.68	19.55	20.83	21.50	22.31	23.42	24.90	25.44
1960-64 (25-29)	15.87	17.68	18.65	19.37	20.24	21.80	22.32	23.38	23.95	25.29
	Rural									
1941-45 (45-49)	19.08	18.38	19.47	20.50	21.18	23.70	23.25	24.32	24.29	N.A*
1946-50 (40-44)	17.82	19.15	19.52	20.39	21.16	22.81	22.93	24.75	25.32	25.90
1951-54 (35-39)	17.96	19.85	19.85	20.16	21.04	22.27	22.74	23.74	24.75	25.80
1955-59 (30-34)	17.08	18.43	19.71	20.10	21.45	22.08	22.48	24.00	24.00	25.29
1960-64 (25-29)	16.12	17.99	18.62	19.52	20.85	21.61	22.07	23.33	24.63	25.69
	Punjab									
1941-45 (45-49)	18.00	19.27	18.62	20.96	21.63	22.00	23.14	24.27	24.20	N.A*
1946-50 (40-44)	16.53	18.64	18.55	20.52	21.86	22.34	22.71	24.13	25.60	26.08
1951-54 (35-39)	16.95	19.09	20.00	19.97	21.11	21.74	22.00	23.69	24.41	26.17
1955-59 (30-34)	16.45	18.76	19.54	20.05	20.94	21.79	22.43	23.64	24.67	25.38
1960-64 (25-29)	16.48	18.09	18.56	19.47	20.51	21.73	22.21	23.46	24.36	25.33
	Sindh									
1941-45 (45-49)	19.05	N.A*	N.A*	21.00	N.A*	24.40	N.A*	N.A*	N.A*	N.A*
1946-50 (40-44)	18.30	18.89	19.25	20.28	21.40	22.58	N.A*	N.A*	N.A*	N.A*
1951-54 (35-39)	18.09	19.09	19.79	20.15	20.72	22.96	22.00	23.78	24.27	N.A*
1955-59 (30-34)	17.64	18.10	19.30	19.29	21.19	22.12	22.62	24.00	24.00	25.54
1960-64 (25-29)	16.13	18.22	18.81	19.43	20.42	21.66	22.31	23.47	N.A*	N.A*
	NWFP									
1941-45 (45-49)	15.85	17.30	20.08	19.38	21.40	22.21	24.13	23.78	N.A*	25.18
1946-50 (40-44)	16.22	18.86	19.08	20.50	20.73	22.19	N.A*	N.A*	N.A*	24.89
1951-54 (35-39)	15.71	18.91	18.57	19.70	20.61	22.35	23.00	23.28	25.00	N.A*
1955-59 (30-34)	15.99	17.69	18.63	19.43	21.21	21.59	22.32	23.62	24.89	25.25
1960-64 (25-29)	15.64	17.37	18.52	19.50	20.52	21.48	22.05	23.13	24.20	25.40
	Baluchistan									
1941-45 (45-49)	21.83	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*
1946-50 (40-44)	18.36	N.A*	20.92	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*	N.A*
1951-54 (35-39)	18.19	19.23	N.A*	20.00	20.50	21.75	22.60	24.60	24.09	24.67
1955-59 (30-34)	16.69	17.74	18.77	20.33	20.71	21.82	N.A*	N.A*	N.A*	N.A*
1960-64 (25-29)	15.53	17.52	18.69	19.25	20.47	22.40	22.40	23.36	N.A*	N.A*

Appendix F: Bivariate analysis of time independent covariates

Table F1: Percentage distribution of currently married women aged 25-49 by demographic characteristics and age at first marriage (1990-91 Pakistan Demographic and Health Survey)

Characteristics	Cumulative proportion married by exact age			No. of women	MAFM
	$\leq$15	20	25		
Birth cohort					
1941-45	27.1	63.0	88.5	565	19.43
1946-50	30.5	72.2	92.1	751	18.51
1951-55	28.9	72.6	93.6	960	18.47
1956-60	31.6	75.5	94.6	1150	17.95
1961-65	30.2	77.1	98.2	1406	17.76
(F-statistic using ANOVA test = 17.86; P-value = 0.00; degrees of freedom = 4831)					
Place of residence					
Urban	32.3	74.7	94.7	2303	18.06
Rural	27.8	72.2	94.0	2529	18.44
(T-statistic = -3.05; P-value = 0.000; degrees of freedom = 4830)					
Province of residence					
Punjab	22.2	69.7	92.9	1612	18.92
Sindh	41.5	80.4	96.5	1324	17.23
NWFP	26.2	68.5	93.0	1231	18.76
Baluchistan	32.6	77.4	96.2	665	17.79
(F-statistic using ANOVA test = 46.31; P-value =0.000; degrees of freedom =4831)					
Education of respondent					
No	33.6	76.1	95.2	3715	17.88
Primary	26.6	78.1	96.8	406	18.06
Secondary	14.8	61.5	90.4	616	19.83
Higher	1.1	24.2	75.8	95	23.69
(F-statistic using ANOVA test = 90.65; P-value = 0.000; degrees of freedom = 4831)					
Childhood place of residence					
Rural	32.3	74.4	94.8	3006	18.05
Urban	26.1	71.8	93.7	1826	18.60
(T-test = -4.32; P-value = 0.000; degrees of freedom = 4830)					
Husband education					
No	32.9	75.0	94.4	2233	18.03
Primary	37.6	80.8	97.6	760	17.28
Secondary	25.5	71.0	94.3	1462	18.62
Higher	14.3	58.4	87.8	377	20.20
(F-statistic using ANOVA test = 44.51; P-value = 0.000; degrees of freedom = 4831)					

MAFM: Mean age at first marriage

Appendix G1: Plots for the selection of parametric survival model

Figure: G1
PDHS 2006: total sample; exponential model

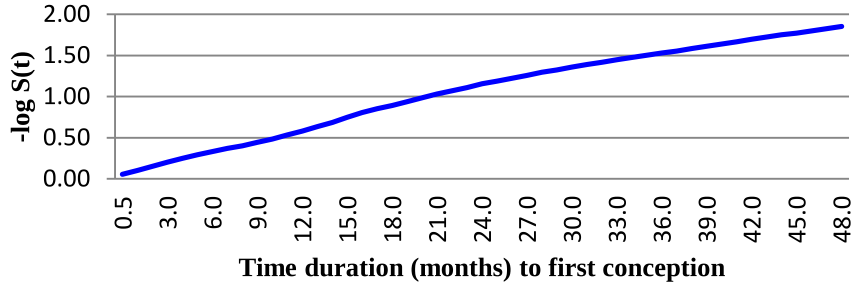


Figure: G2
PDHS 2006: total sample; Weibull model

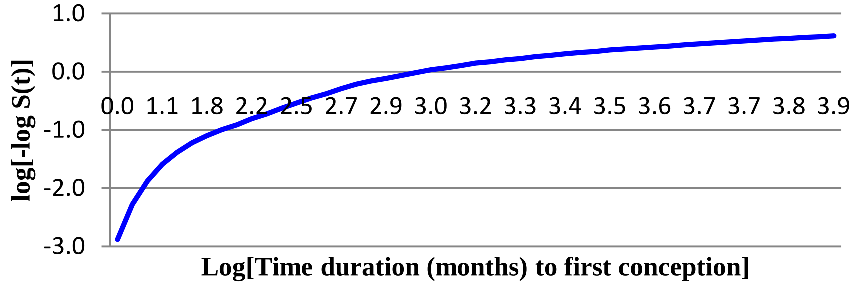


Figure: G3
PDHS 2006: total sample; lognormal model

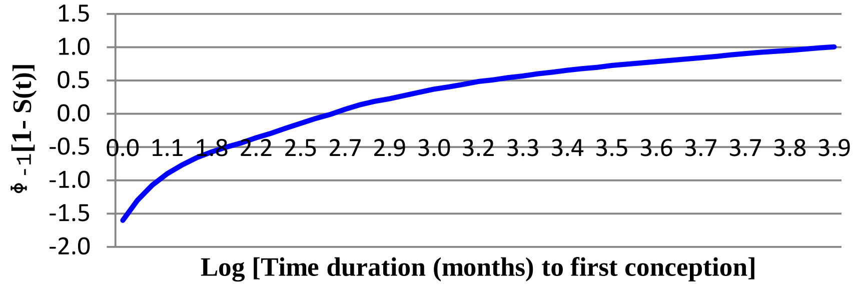
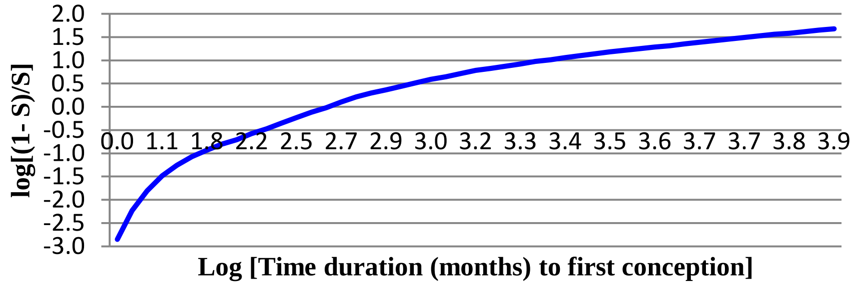
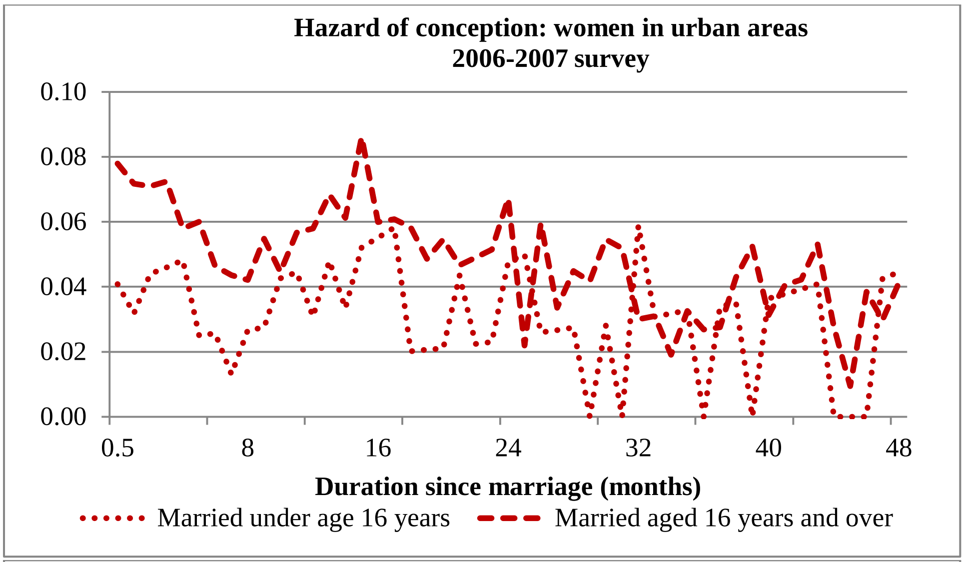
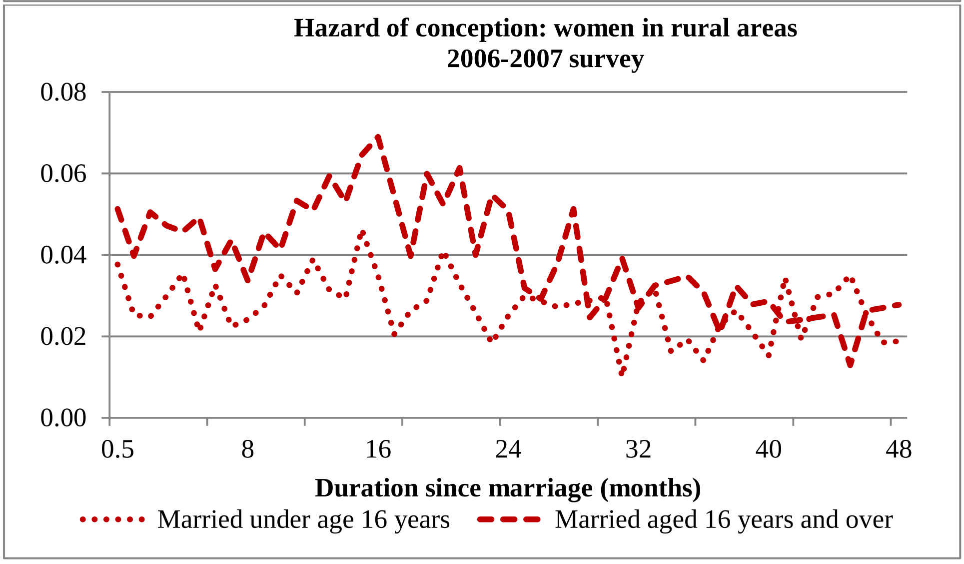


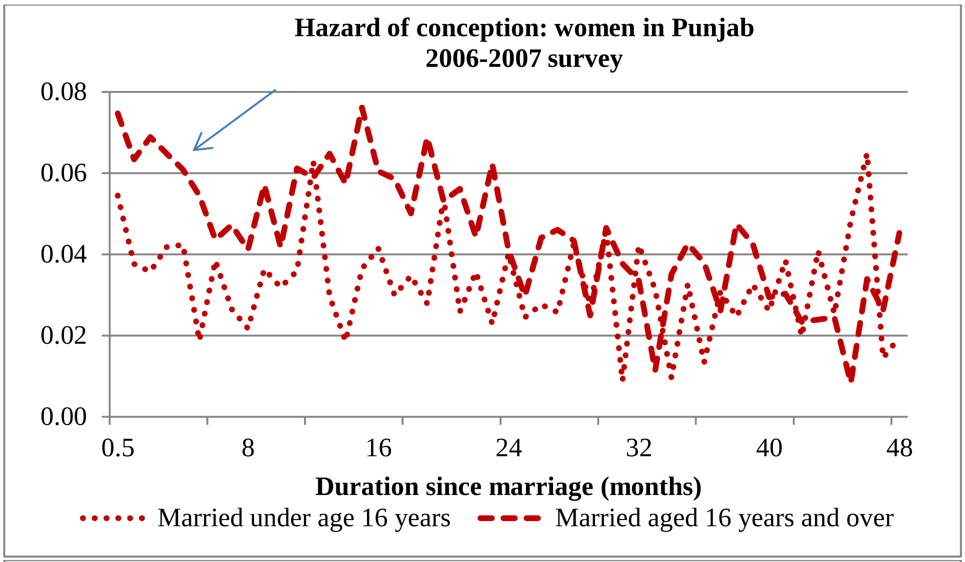
Figure: G4
PDHS 2006: total sample; log logistic model

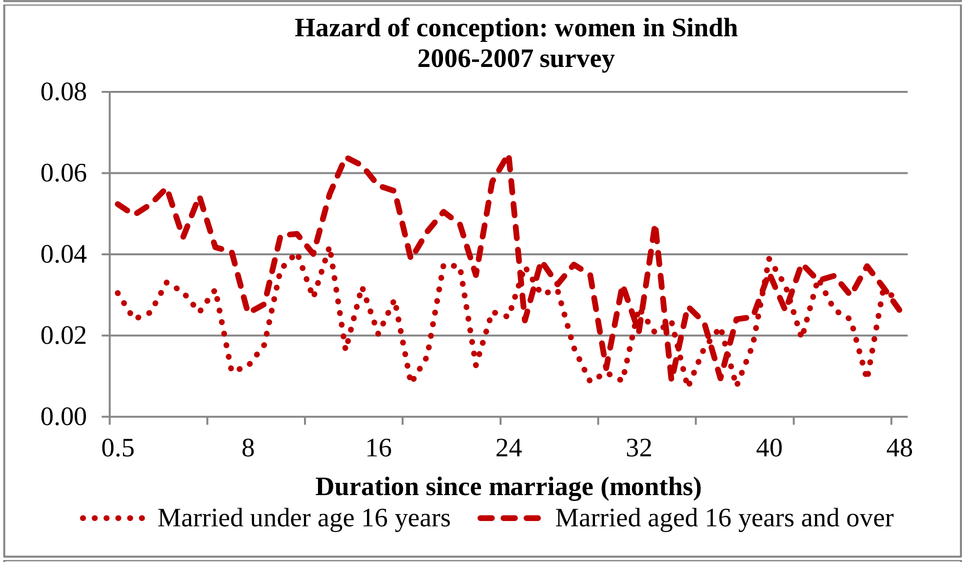


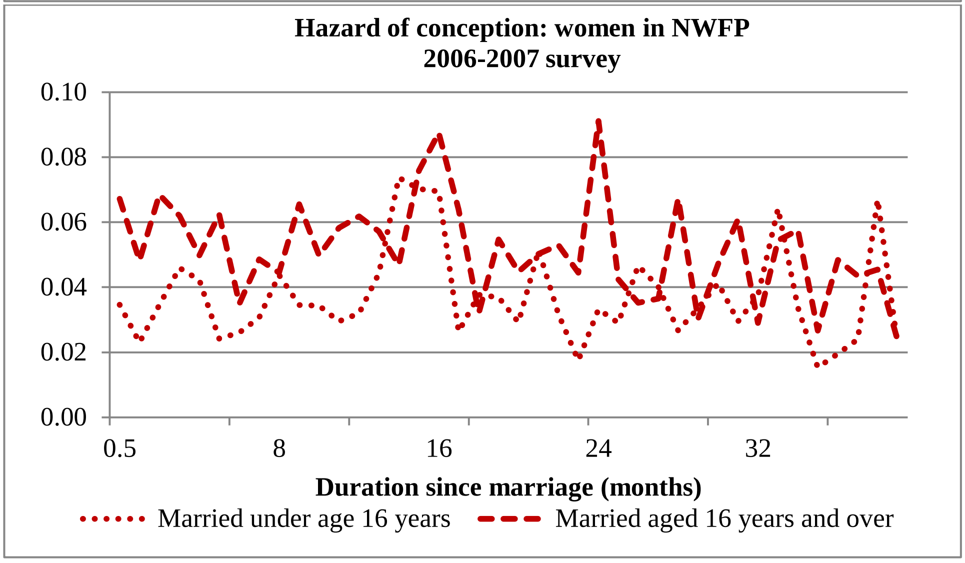
Appendix G2: Hazard plots of women for their first childbearing at very young and young age at marriage in different regions of Pakistan (2006-07 Pakistan Demographic and Health Survey)

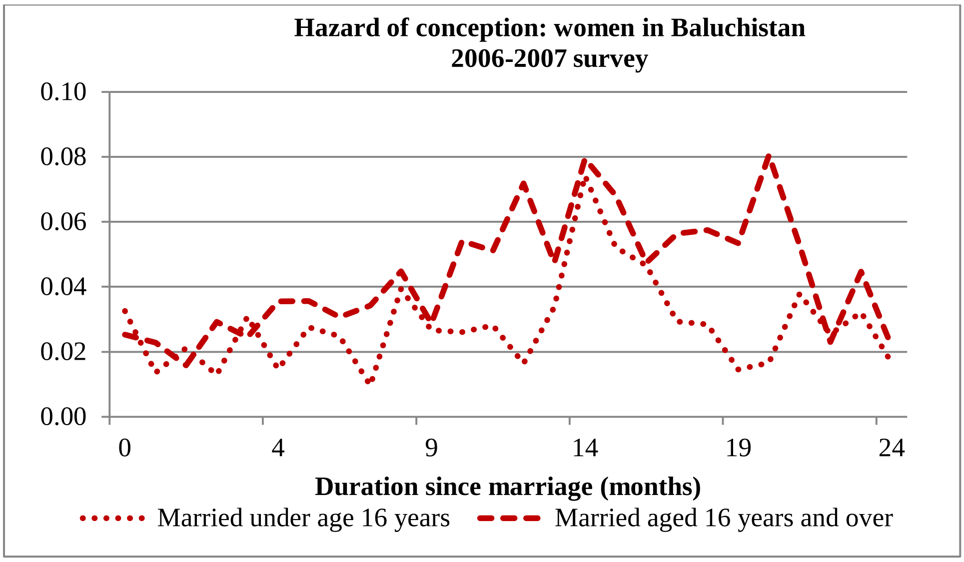





Hazard of conception: women in Punjab
2006-2007 survey
0.08
0.06
0.04
0.02
0.00
0.5
8
16
24
32
40
48
Duration since marriage (months)
Married under age 16 years
Married aged 16 years and over


Hazard of conception: women in Sindh
2006-2007 survey
0.08
0.06
0.04
0.02
0.00
0.5
8
16
24
32
40
48
Duration since marriage (months)
Married under age 16 years
Married aged 16 years and over


Hazard of conception: women in NWFP
2006-2007 survey
0.10
0.08
0.06
0.04
0.02
0.00
0.5
8
16
24
32
Duration since marriage (months)
Married under age 16 years
Married aged 16 years and over


Hazard of conception: women in Baluchistan
2006-2007 survey
0.10
0.08
0.06
0.04
0.02
0.00
0
4
9
14
19
24
Duration since marriage (months)
Married under age 16 years
Married aged 16 years and over

Appendix H: Plots for the selection of selected parametric survival model for second through sixth pregnancy intervals (2006-07 Pakistan Demographic and Health Survey)

Second pregnancy interval

Figure: H1
PDHS 2006: total sample; Lognormal model

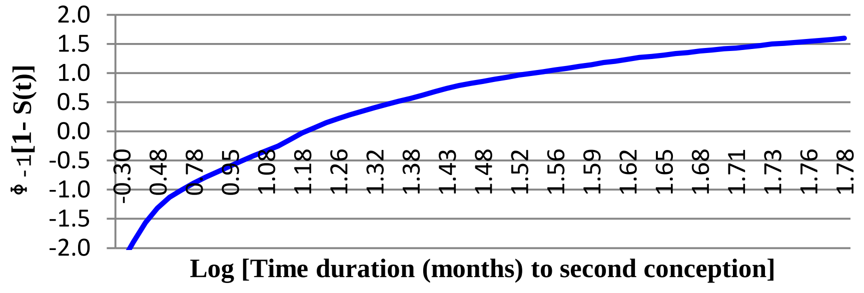
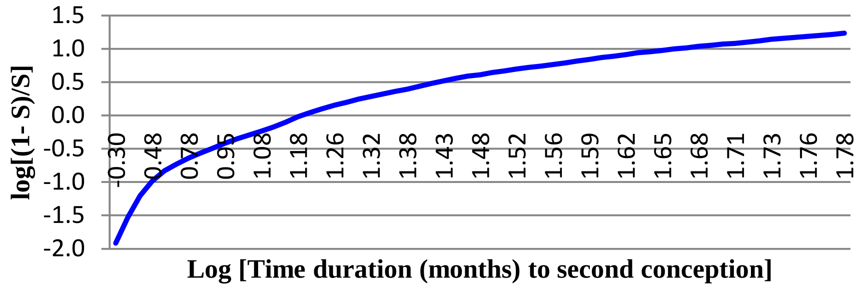


Figure: H2
PDHS 2006: total sample; Log logistic model



Third pregnancy interval

Figure: H3
PDHS 2006: total sample; Lognormal model

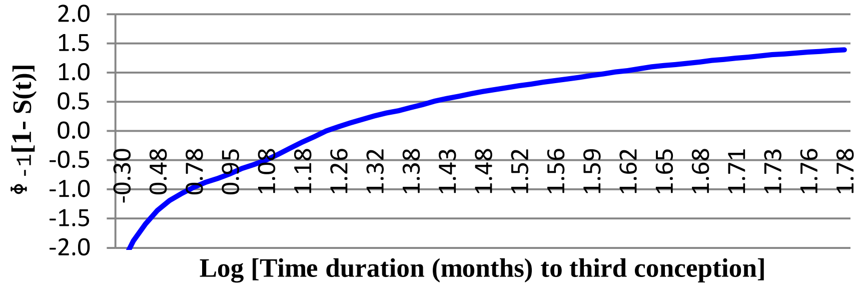
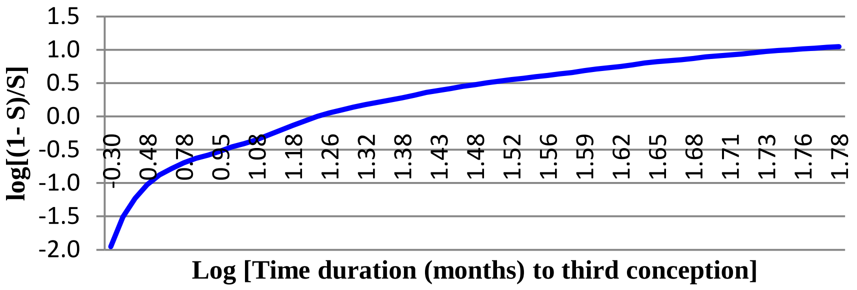


Figure: H4
PDHS 2006: total sample; Log logistic model



Fourth pregnancy interval

Figure: H5
PDHS 2006: total sample; Lognormal model

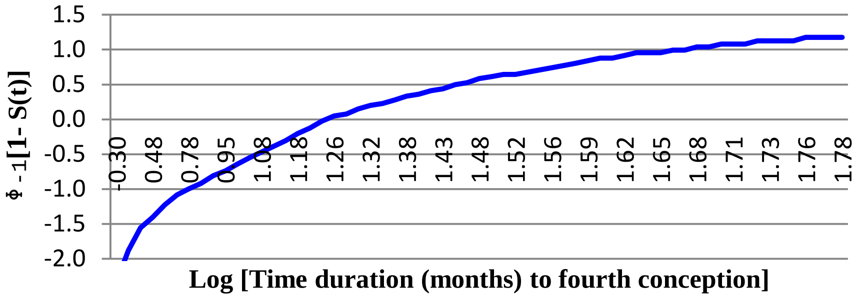
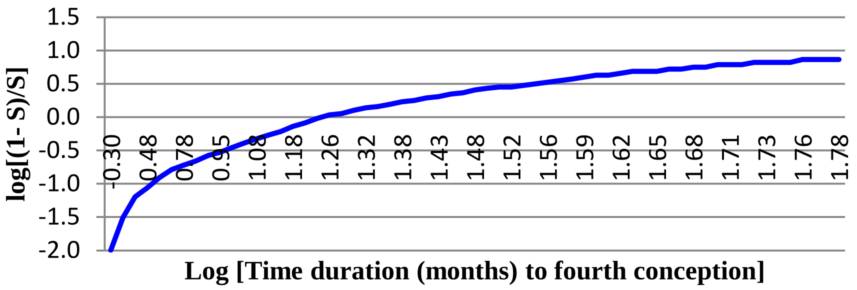


Figure: H6
PDHS 2006: total sample; Log logistic model



Fifth pregnancy interval

Figure: H7
PDHS 2006: total sample; Lognormal model

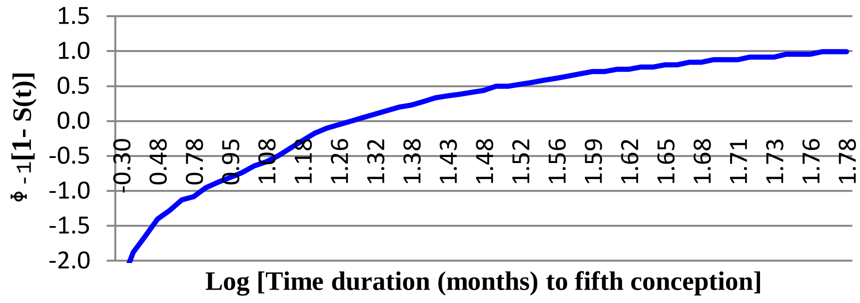
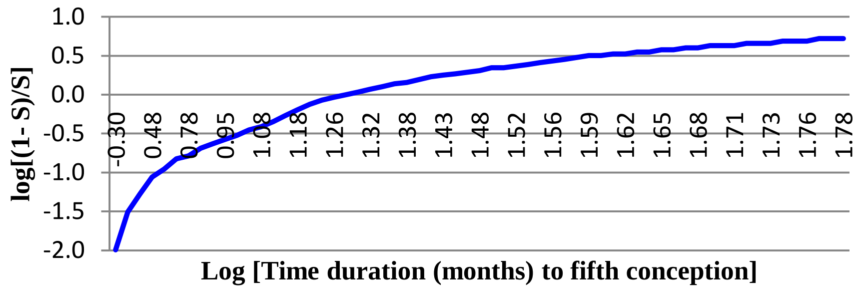


Figure: H8
PDHS 2006: total sample; Log logistic model



Sixth pregnancy interval

Figure: H9
PDHS 2006: total sample; Lognormal model

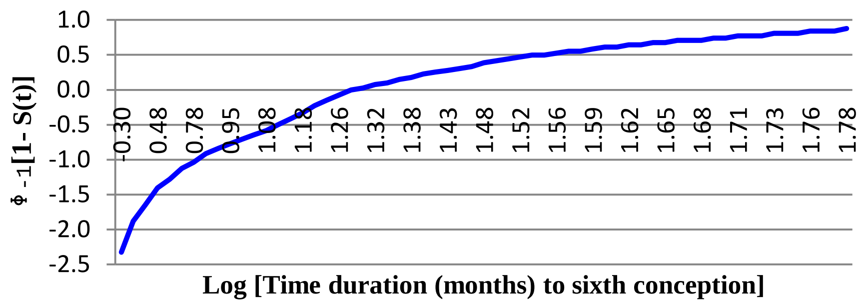
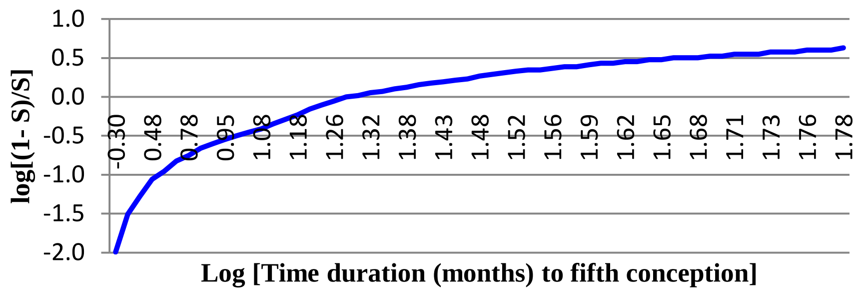
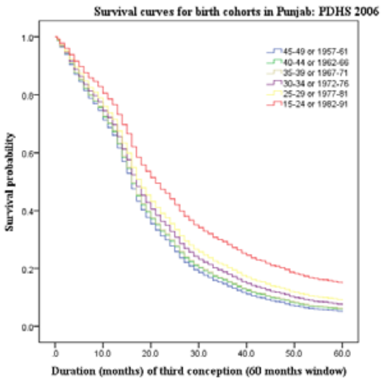


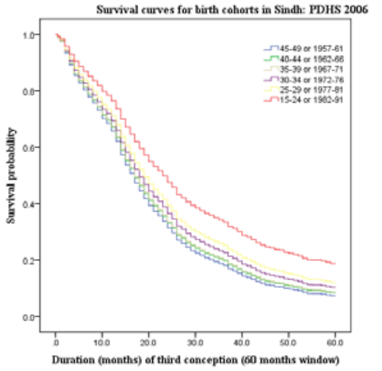
Figure: H10
PDHS 2006: total sample; Log logistic model

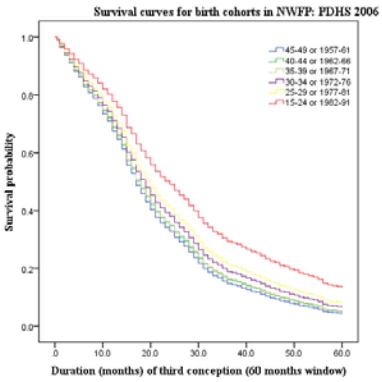


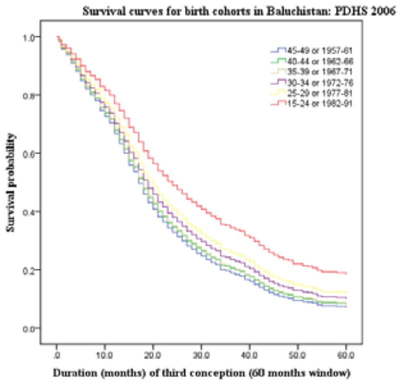
Appendix I: Survival plots of the selected covariates of Cox models for third through sixth pregnancy intervals (2006-07 Pakistan Demographic and Health Survey)

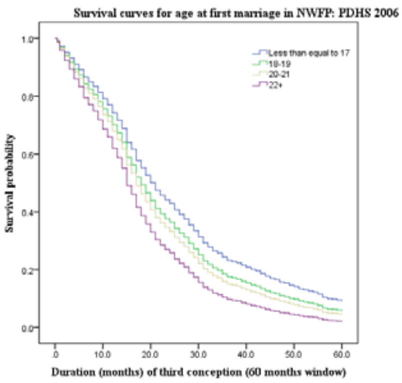
Third pregnancy interval stratified Cox model

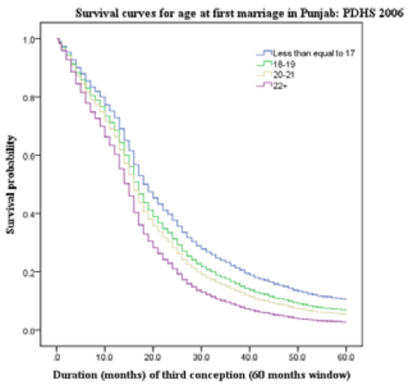


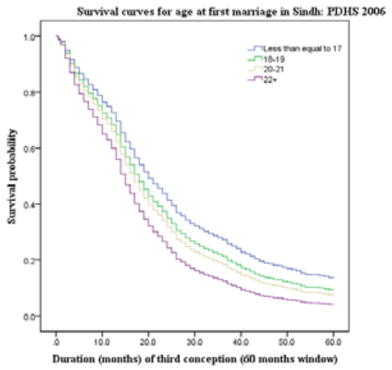


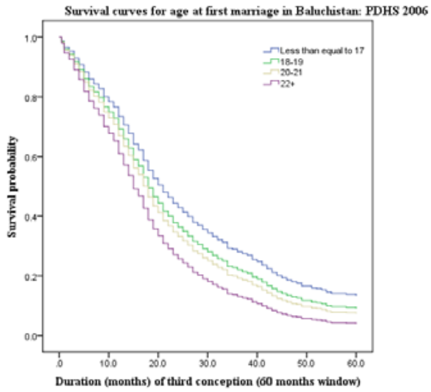


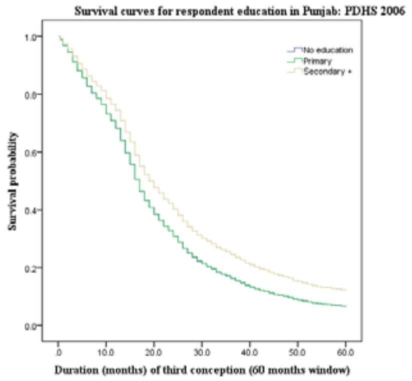


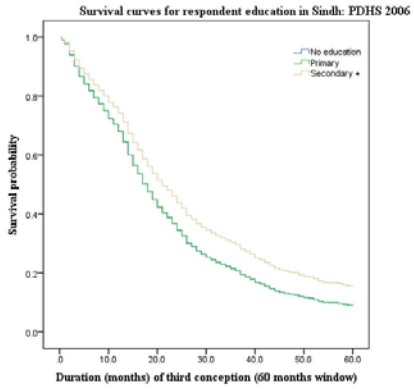


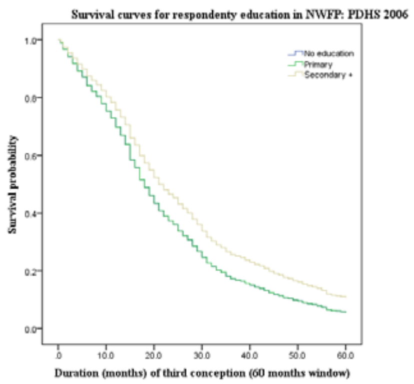


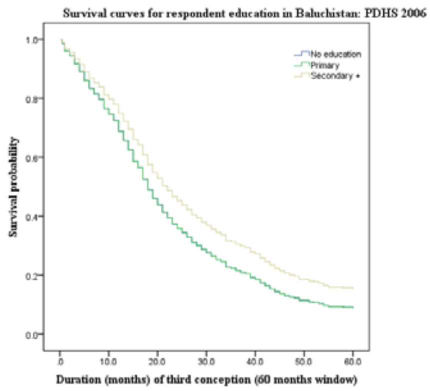

Survival curves for age at first marriage in Sindh: PDHS 2006
Less than equal to 17
18-19
20-21
22+
Survival probability
Duration (months) of third conception (60 months window)


Survival curves for age at first marriage in Baluchistan: PDHS 2006
Less than equal to 17
18-19
20-21
22+
Survival probability
Duration (months) of third conception (60 months window)

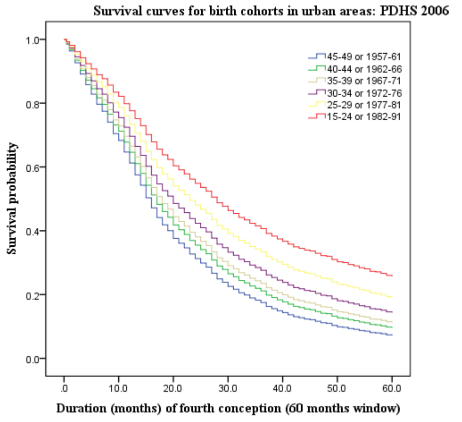

Survival curves for respondent education in Punjab: PDHS 2006
No education
Primary
Secondary +
Survival probability
Duration (months) of third conception (60 months window)

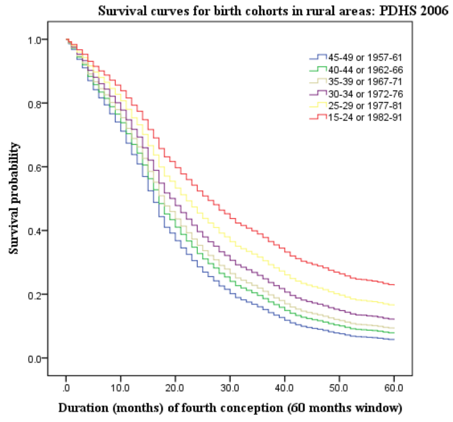

Survival curves for respondent education in Sindh: PDHS 2006
No education
Primary
Secondary +
Survival probability
Duration (months) of third conception (60 months window)

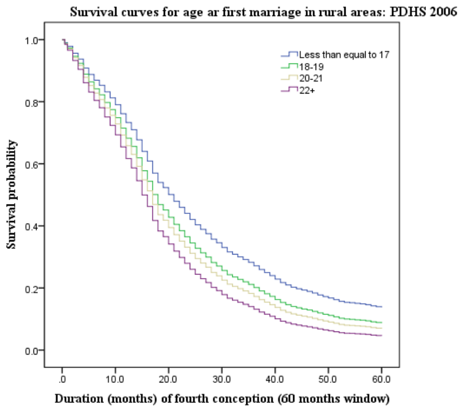

Survival curves for respondenty education in NWFP: PDHS 2006
No education
Primary
Secondary +
Survival probability
Duration (months) of third conception (60 months window)

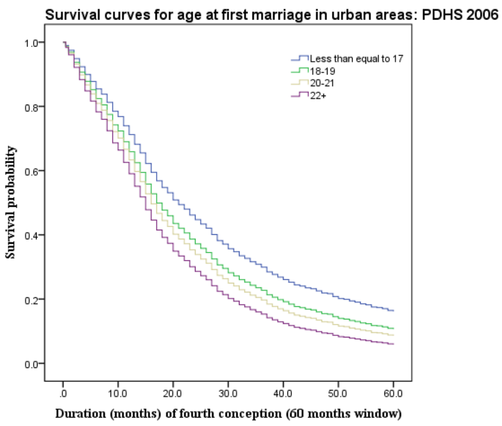

Survival curves for respondent education in Baluchistan: PDHS 2006
No education
Primary
Secondary +
Survival probability
Duration (months) of third conception (60 months window)

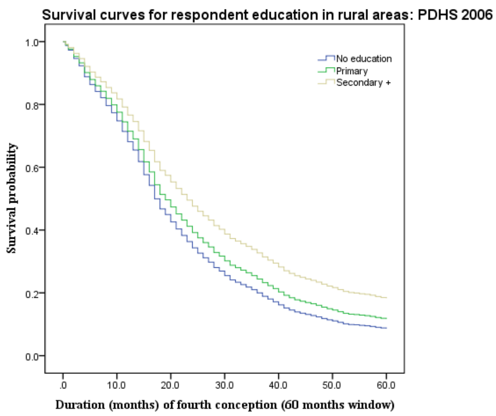
Fourth pregnancy interval stratified Cox model

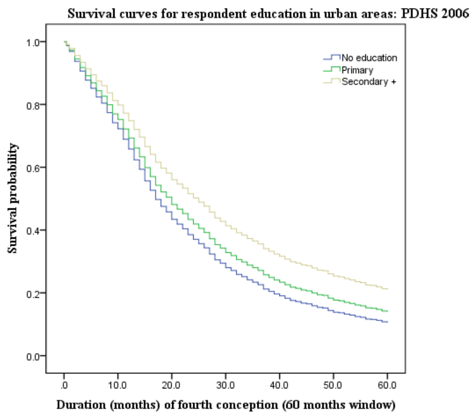




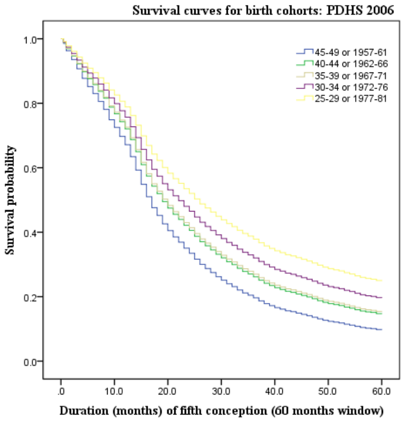


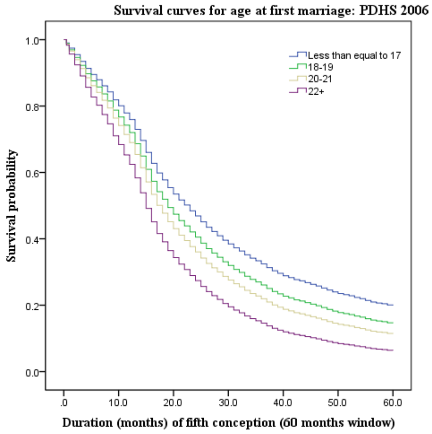


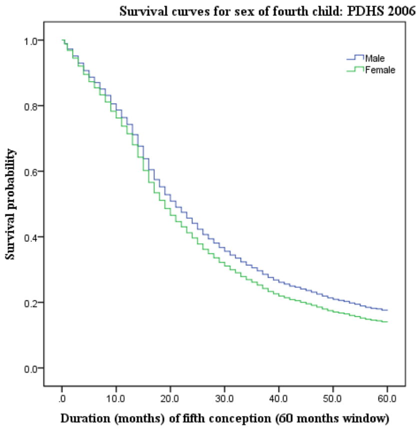


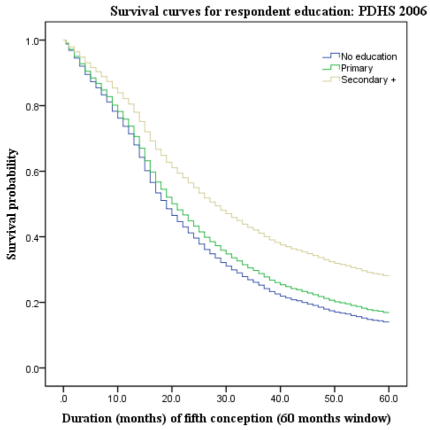


Fifth pregnancy interval stratified Cox model

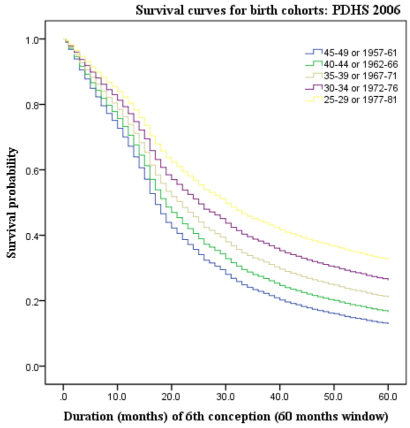


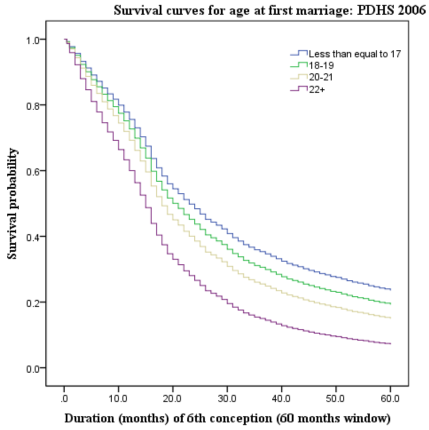


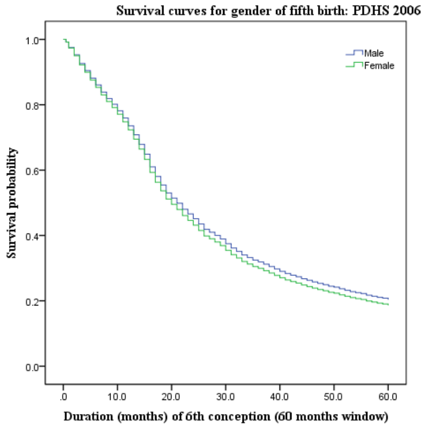


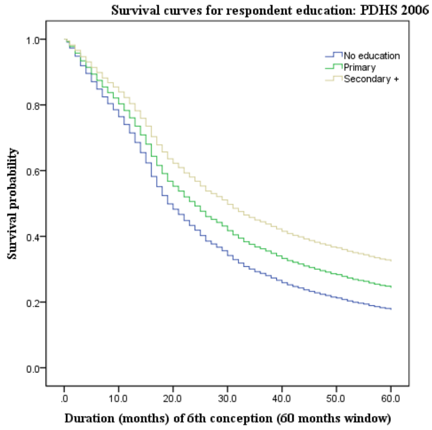


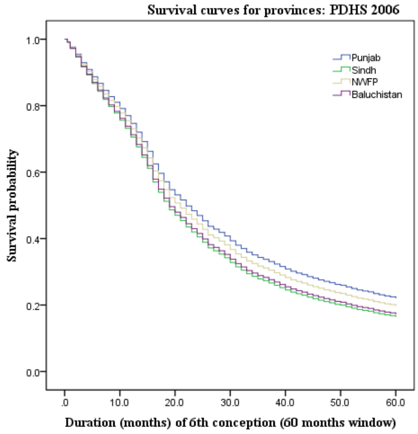
Sixth pregnancy interval Cox model

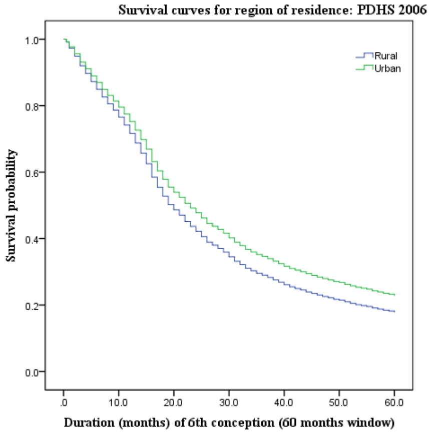












Appendix J: Role of contraceptive use in birth intervals in Pakistan

Table J1: Cox regression estimates of the factors associated with third through sixth pregnancy interval of currently married women in Pakistan, 2006-07 Pakistan Demographic and Health Survey

Characteristics	Third (n=6766) Coefficients (SE)	Fourth (n=5579) Coefficients (SE)	Fifth (n=4390) Coefficients (SE)	Sixth (n=3376) Coefficients (SE)
		Demographic factors		
Birth cohort (age cohort)				
1957-61 (45-49) (RC)				
1962-66 (40-44)	-0.06 (0.05)	-0.13* (0.05)	-0.19** (0.05)	-0.13* (0.06)
1967-71 (35-39)	-0.06 (0.04)	-0.20** (0.05)	-0.21** (0.05)	-0.27** (0.06)
1972-76 (30-34)	-0.14* (0.04)	-0.31** (0.05)	-0.35** (0.06)	-0.43** (0.07)
1977-81 (25-29)	-0.20** (0.05)	-0.46** (0.06)	-0.52** (0.07)	-0.60** (0.11)
1982-91 (15-24)	-0.42** (0.07)	-0.62** (0.11)	Not included (n=76)	Not included (n=20)
Age at first marriage				
≤17 (RC)				
18-19	0.17** (0.04)	0.20** (0.05)	0.18** (0.05)	0.13* (0.06)
20-21	0.25** (0.05)	0.29** (0.06)	0.30** (0.07)	0.27** (0.08)
22+	0.45** (0.07)	0.43** (0.07)	0.54** (0.08)	0.60** (0.09)
Gender of the index child				
Female (RC)				
Male	-0.09** (0.03)	-0.16** (0.03)	-0.12** (0.03)	-0.06 (0.04)
		Socioeconomic factors		
Education				
No (RC)				
Primary	-0.03 (0.04)	-0.18** (0.05)	-0.09 (0.06)	-0.20* (0.07)
Secondary +	-0.27** (0.05)	-0.43** (0.05)	-0.43** (0.07)	-0.43** (0.09)
Husband education				
No or <=10 year schooling (RC)				
Higher	-0.10* (0.04)	-0.15** (0.05)	-0.10 (0.06)	-0.10 (0.07)
Place of residence		***Stratified***		
Rural (RC)				
Urban	0.03 (0.03)		-0.16** (0.04)	-0.19** (0.05)
Province of residence	***Stratified***			
Punjab (RC)				
Sindh		0.03 (0.04)	0.08 (0.04)	0.20** (0.05)
NWFP		0.01 (0.04)	0.09 (0.05)	0.09 (0.05)
Baluchistan		-0.02 (0.05)	0.15* (0.06)	0.19* (0.07)
Duration (years) from first marriage to first birth	0.04** (0.01)	0.05** (0.01)	0.04** (0.01)	0.06** (0.01)
		Biological factors		
Contraceptive use				
Never (RC)				
Ever	0.14** (0.03)	0.18** (0.03)	-0.05 (0.04)	-0.01 (0.04)
Age (years) of mother at previous pregnancy	-0.07** (0.01)	-0.09** (0.01)	-0.10** (0.01)	-0.10** (0.01)

*0.05>p≥0.01; **p<0.01
RC: reference category
HR: hazard ratio

Table J2: Cox regression estimates of the factors associated with third through sixth pregnancy interval of currently married women in Pakistan, 1990-91 Pakistan Demographic and Health Survey

Characteristics	Third (n=4710) Coefficients (SE)	Fourth (n=4015) Coefficients (SE)	Fifth (n=3153) Coefficients (SE)	Sixth (n=2520) Coefficients (SE)
		Demographic factors		
Birth cohort (age cohort)				
1941-45 (45-49) (RC)				
1946-50 (40-44)	-0.06 (0.06)	-0.03 (0.06)	0.03 (0.07)	-0.11 (0.07)
1951-55 (35-39)	-0.05 (0.06)	-0.04 (0.06)	-0.04 (0.06)	-0.15* (0.07)
1956-60 (35-39)	-0.07 (0.06)	-0.09 (0.06)	-0.28** (0.07)	-0.26** (0.08)
1961-65 (25-29)	-0.16* (0.06)	-0.27** (0.07)	-0.36** (0.08)	-0.71** (0.11)
1966-75 (15-24)	-0.41** (0.08)	-0.57** (0.11)	Not included (n=90)	Not included (n=34)
Age at first marriage		***Stratified by age at first marriage and province of residence***	***Stratified by age at first marriage and province of residence***	
≤ 17 (RC)				
18-19	0.20** (0.05)			0.23** (0.07)
20-21	0.30** (0.07)			0.38** (0.09)
22+	0.51** (0.08)			0.61** (0.10)
Gender of the index child				
Female (RC)				
Male	-0.01 (0.03)	-0.08* (0.04)	-0.04 (0.04)	-0.05 (0.05)
		Socioeconomic factors		
Education				
No (RC)				
Primary	-0.08 (0.06)	-0.09 (0.07)	-0.13 (0.07)	-0.11 (0.09)
Secondary +	-0.29** (0.06)	-0.35** (0.07)	-0.42** (0.08)	-0.27* (0.10)
Husband education				
No or <=10 year schooling (RC)				
Higher	-0.12 (0.07)	-0.28** (0.08)	-0.18 (0.10)	-0.15 (0.12)
Place of residence	***Stratified***			
Rural (RC)				
Urban		0.05* (0.04)	0.01 (0.04)	0.07 (0.05)
Province of residence	***Stratified***	***stratified***	***stratified***	
Punjab (RC)				
Sindh				-0.08 (0.06)
NWFP				-0.01 (0.06)
Baluchistan				-0.10 (0.08)
Duration (years) from first marriage to first birth	0.03* (0.01)	0.05** (0.01)	0.06** (0.01)	0.06** (0.01)
		Biological factors		
Contraceptive use				
Never (RC)				
Ever	0.25** (0.04)	0.13** (0.04)	0.02 (0.05)	-0.04 (0.06)
Age (years) of mother at previous pregnancy	-0.07** (0.01)	-0.09** (0.01)	-0.10** (0.01)	-0.10** (0.01)

*$0.05 > p \geq 0.01$; **$p < 0.01$

RC: reference category

HR: hazard ratio

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