INDIRECT ESTIMATION OF PARITY PROGRESSION RATIOS FROM BIRTH INTERVAL DATA

BY

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DECLARATION

This project is my own original work and has not been presented to any university for an award of a degree.

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DEDICATION

I dedicate this piece of work, with a lot of sincerity to my parents Joseph Monari and Jemimah Monari for encouraging me to pursue this degree and paying for my studies. To my brothers: Bernard and Charles, thanks for your support and encouragement throughout the entire study period.

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ABSTRACT

The main objective of this study was to examine Kenya's tempo of fertility through birth interval dynamics and the parity progression schedule. The specific objectives of the study were three fold. The first was to estimate parity progression ratios for each parity using birth intervals. The second was to examine the differentials in parity progression ratios according to educational level, place of residence and region of residence. The third was to examine differentials in birth interval distributions according to educational level, place of residence and region of residence.

The study utilized the 2003 KDHS data set. Yadav-Bhattacharya modification to Srinivasan parity progression model was used to obtain the parity progression ratios estimates. The model requires information on closed birth interval specifically the last birth interval and open birth interval distribution respectively. The last birth interval was considered since it is more recent thus fairly reliable.

The main findings of this study revealed that at national level, the values of PPR's ranged between 0.9319 at parity (3) and 0.6780 at parity (9). Approximately 92.6% of those women who had the first child progressed to have a second child. Moreover, the proportion of women who progressed to parity three increased to 93%. On the contrary, the proportion of women progressing to parity four, dropped to 89.7 % and the decline pattern was observed to continue through parities 5 and 6.This was followed by a slight increase in the proportion of women who progressed to parity seven which was 84 % percent. Later on at higher parities, proportion of women who progressed to the eighth and the ninth child declined i.e. 79% and 67% respectively. The results of the estimates of the parity progression ratios and their behaviour across the parities strongly indicated the existence of fertility declines though the pace and quantum of childbearing was still high. These high figures (approximately 68 percent at parity 9) at higher parities suggest that many women still have propensity to give birth even at higher parities. The level of fertility measured by MCEB was 5.7 per woman. Measures obtained by selected background characteristics i.e educational level, place of residence and type of place of residence showed consistent results as the ones given by conventional methods.

The results of this study recommended the following. First, the relationship between ACBI and level of fertility suggest that the long length of LCBI and low value of MCEB among the

secondary women may be due to limiting practices encouraged by family planning programmes or shorter time spent during childbearing. Thus the longer inter-birth spacing implies that the family size for those with secondary and above level of education will necessarily be low. Education of women then still remains one of the principal ways at which low fertility can be achieved but this is only possible when it is up to secondary level and above thus policies should be formulated to increase educational opportunities for girls to secondary level and above. Secondly, the results depicted a continuous decline in proportion of women progressing from parity 4 through 6 and an upsurge in parities 3 and 7. Thus, further research in those particular parities needs to be conducted to establish the reasons for the upsurge. Thirdly, trends in parity progression ratios could not be established as one data set was used. Further research is recommended to establish the patterns and trends of parity progression ratios using all the data sets that is, (KFS, KDHS 1993, KDHS 1998 and KDHS 2003).

LIST OF ABBREVIATIONS

ASFR – Age Specific Fertility Rate

CBI – Closed Birth Interval

CEB – Children Ever Born

IPPR – Instantaneous Parity Progression Ratio

KDHS – Kenya demographic and Health Survey

MCEB – Mean Children Ever Born

OBI – Open Birth Interval

PPPR – Period Parity Progression Ratio

PPR – Parity Progression Ratios

TFR – Total Fertility Rate

MTFR – Maternal Total Fertility Rate

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CHAPTER ONE

INTRODUCTION AND PROBLEM STATEMENT

1.1 Background

The conventional age-based measures of fertility are age-specific fertility rate and their sum over all ages, the Total Fertility Rate (TFR). Early fertility analyses were mainly concerned with the determinants of total fertility size (Rindfuss et.al, 1987). The studies concentrated primarily on aggregate measures of fertility such as the TFR (UN, 1997). Although TFR is familiar and easy to understand, it has been argued that TFR is a hypothetical measure, which under certain circumstances can give distorted results. This distortion results from changes in the timing of child bearing, which can inflate or deflate the total fertility rate, that is, the TFR is depressed during years in which women delay childbearing and inflated in years when childbearing is accelerated (Bongaarts, 1999). Moreover, TFR does not distinguish the various components of observed change in fertility: It does not reveal whether an increase or decrease in fertility is due to change in timing of the start of reproduction, in the spacing of births and/or in the proportion of women reaching higher parities. Hence, it has become increasingly clear that different factors are likely to be important at different ages of family formation. What determines the length of time between marriages and first birth might be quite different from the determinants of the length of the interval between two successive births (Rindfuss et al., 1987). Due to the growing contention, alternative approaches to estimate fertility have been developed. This study proposes the use of Parity Progression Ratios (PPR) for removing the distortions caused by tempo changes from the total fertility rate.

Parity progression model makes two contributions: First, we find that when birth-interval analysis is suitably formulated, the technical problems of censoring and selection turn out to have rather simple solutions by invoking standard formal demographic concepts (Feeney, 1983). Secondly, the parity progression model provides a framework for integrating micro-level birth interval analyses into macro-level studies of fertility (Feeney, 1983). The essential idea of the model is that, total $(i + 1)$-th births in a closed population during any short period may be expressed as the sum of the $(i + 1)$-th births contributed by the cohorts of women who had an i^{th} birth previously. Several researchers (Ní Bhrolcháin, 1992; Hobcraft, 1993) have suggested that duration since the previous birth should also be included in period fertility indicators. Feeney (1983) observes that the "parity progression schedules which incorporate parity progression rates and birth-interval distributions are the most natural approach to the measurement of fertility." We regard the proportion of women in a birth cohort who become mothers as a parity progression ratio of order zero and the distribution of mothers in the cohort by age at first birth as a birth interval distribution.

In the parity progression model, the control used is not age but the number of children that a woman has already had, in association with the time since the most recent birth (Feeney, 1983; Feeney and Yu, 1987; Ní Bhrolcháin, 1987; Rallu and Toulemon, 1994; Hinde, 1998). Parity Progression Ratio (PPR) is an important measure of fertility dynamics and family building process.

Parity Progression Ratios (PPRs) were invented independently by Norman B. Ryder (1951) and by Louis Henry (1953) in the early 1950s. The general idea is to ask what proportions of women proceed from one event in the childbearing sequence to the next? Of all women born, what proportion ever become mothers? Of those who have a first child, what proportion goes on to have a second? Of those who have a second child, what proportion progress to a third, and so on? Parity progression ratios, like other fertility measures, may be calculated either on a cohort or on a period basis. Cohort calculations typically use census or survey data on number of children ever born, classified by age or by duration of marriage. Period calculations are made by using birth probabilities specific for parity and for one other characteristic or more. Parity Progression Ratio is claimed to be a sensitive index of birth spacing pattern of population and reflects the tempo of fertility. Models on parity progression ratio may be used in evaluating family planning programmes and in the analysis of the determinants of fertility (Feeney, 1983: 1988).

Srinivasan (1967a, 1967b, 1968) introduced the idea of instantaneous parity progression ratio (IPPR).Yadava and Saxena (1989) later obtained an interrelationship between IPPR and PPR. Later, modified form of Srinivasan method was developed by Yadav and Bhattacharya and is refined to as Yadav-Bhattacharya modification to Srinivasan model. The procedure is based on the assumption that, *i*-th order births are uniformly distributed over time and there is no mortality among females of parity *i* till the end of the reproductive period.

1.2 Problem Statement

Kenya's fertility behaviour has been widely studied using conventional age specific fertility rates based models such as Coale-Trussel and Brass and Gompertz relational model. TFR values calculated from these models have therefore provided major estimation approach. While the conventional methods of fertility estimation have been considered realistic, the approach of the procedures fail to address components of tempo of reproduction as measured by the proportion of women from a given parity, moving from one parity to another at a particular period which is very important in the analysis and understanding of childbearing behavior (Njogu,1991). Moreover, age-specific birth rates are only familiar, but do not relate in any obvious way to the process of childbearing (Feeney, 1983). TFR is affected by the changes in the timing of childbearing: in years when women's ages at childbearing rise the TFR is depressed; and in years when timing of childbearing is advanced, the TFR is inflated relative to the level that would have been observed without such timing changes thus causing the distortions in the TFR caused by these tempo effects (Bongaarts, 1999). TFR might not therefore give a measure of tempo of fertility and particularly at this time when there is fertility stall.

Conventional age-based measures of fertility estimates using the 2003 KDHS survey data indicate that fertility has stalled in mid-transition. The unexpected interruption of an established trend is a problem worth studying by re-examining methodology used in estimating fertility level.

Although fertility based on parity progression ratios are available in Kenya, the studies address different gaps. For instance, Feeney (1988) used parity progression models to evaluate family planning programmes for a period of 1962, 1969 and 1979. Ochieng (1996) applied parity progression model utilizing data from 1993 KDHS as an alternative measure of fertility to address the gap on the rate of fertility decline. Kimani (2005) utilized parity progression approach to estimate fertility levels and then compared the estimates with estimated fertility based on conventional approaches, for the period 1998-2003. Thus this study applies parity progression model as an alternative measure of fertility utilizing data from 2003 KDHS with an attempt to validate fertility stall as depicted by conventional measures of fertility. In studying fertility transition it is important to examine the family building process which can be disegregated by series of stages, beginning with marriage and followed by first, second and successive births. The pace of childbearing, measured in closed birth intervals, should not be overlooked as it provides an insight in the change of fertility which is the gap this study intends to address.

1.3 Objectives of the Study

The general objective of this study is to examine the Kenya's tempo of fertility through birth interval dynamics and the parity progression schedule. The specific objectives are:-

1. To estimate parity progression ratios for each parity using birth intervals.
2. To examine the differentials in parity progression ratios according to educational level, place of residence and region of residence.
3. To examine differentials in birth interval distribution according to educational level, place of residence and region of residence.

1.4 Justification of the Study

This study disegregates the overall fertility, which is normally aggregated over parity and birth order, into parity specifics. It considers the family building process as consisting of a series of stages which begin with marriage followed by first, second and successive births. This approach of fertility analysis is therefore capable of measuring the pace of childbearing through birth intervals and parity progression ratios (PPRs). PPRs measures marital fertility while birth intervals measure the speed of occurrence of births.

The disegregation of fertility by parity is useful as well for comparing the observed with the expected pattern of fertility behavior, particularly where data quality is suspect. This study focuses on the parity distribution among the ever- married aged 15-49 years and examines the fertility behaviour in terms of the proportion of women who progress from one parity to the next and the tempo of childbearing which refers to the speed with which a woman moves from one parity to the next parity. Analysis by parity facilitates interpretation of fertility trends because people make their decisions about having a child on the basis of the number of children they already have, rather than simply upon how old they are.

The birth interval is a sensitive measure of the parity progression ratios which is a crucial factor in the explanation of the fertility levels and differentials. This approach of fertility estimation is more natural as it avoids the application of age-specific birth rates which is easily affected by age misreporting. Birth interval lengths also have implications for maternal and childcare and family planning programmes in Kenya: birth interval measures may indicate short run programme success in enabling women and couples to implement their reproductive preferences. The length of birth intervals may be a more sensitive signal of changing fertility behaviour than conventional summary fertility measures.

The PPRs provides a more refined perspective on fertility trends than the use of measures of cumulative births or total fertility rates, enabling differences in trends by order of birth to be examined. The rates used are correctly measured in relation to the population at risk i.e. exposure is exactly measured and matched to events. Finally, Parity Progression Ratios (PPRs) can provide a better evaluation technique for the family programme efforts.

1.5 Scope and Limitation of the Study

The study will be based on the data collected from the 2003 Kenya Demographic and Health Survey (KDHS). The survey selected a total of 8195 households in which 2751 were in urban and 5444 were in rural area. A sample of 8,195 women of age 15-49 was interviewed. Household data, including date of birth and age at first marriage, are available for all members of each household. Information on the reproductive health was obtained for all ever-married women aged 15-49, including the timing of all live births. This study focuses on the parity distribution among 5594 ever-married women aged 15-49 years. The study covers the whole country. Since the sample size is large, the results are generalized to give the picture of the country's fertility pattern.

The study will also attempt to focus on the educational level, type of place of residence and the age group of the respondents differentials, since the pace of childbearing is known to be associated with these factors. This will provide an explanation as which groups have influenced the fertility level.

Since the survey was conducted by retrospective interviewing, the data has some limitations which are likely to affect the outcome of the study. The following are likely to be the major sources of limitation:

1. **Age misreporting**: The data indicate age heaping in the ages which end with the digits 0 or 5.This digit preferences is likely to push some respondents into or out of the group under focus (CBS et.al. 2004).
2. **Birth interval misreporting**: The analysis of digit preferences in the birth intervals gives a strong indication of the existence of digit preference in either intervals which are multiples of one year or half a year.
3. **Omission or overstating of children ever born**: This arises due to memory lapse and it is very common among the older women.
4. **Poor knowledge about exact date of births**: The data on date of birth gives evidence on birth spacing which is not exact. Data on date remains poorly reported in developing countries (Feeney, 1988).Since the data is inaccurate, it is likely to provide a wrong pattern of the PPRs as a measure of fertility.
5. **Limitation of the approach adopted:** Since at parity one there is no information on the last closed birth interval, it is not possible to ascertain the proportion of women who progress to parity one. Moreover, the model considers parities truncated at a specific parity beyond which number of women progressing from the truncated parity (i) to parity (i + 1) is very negligible. In addition, the model excludes the sample of the never married women who had children in estimation of the parity progression ratios.

CHAPTER TWO

LITERATURE REVIEW ON PARITY PROGRESSION MODELS

2.1 Introduction

This section focuses on the literature on the measurement techniques, particularly the parity progression models as tools of analysis in this study. The section also reviews other studies which have been based on parity progression models.

2.2 Models for Estimating Parity Progression Ratios

Parity Progression model embodies an approach to the measurement of fertility which is based on parity progression schedules. Parity progression schedules which incorporate parity progression rates and birth interval distributions are arguably the most natural approach to the measurement of fertility (Feeney, 1983). The essential idea of the parity progression model is that total $(i+1)$ th births in a closed population during any short period may be expressed as the sum of the $(i+1)$ th births contributed by the cohorts of women who had an ith birth previously. The models are categorized into two forms referred to as life-table and Instantaneous Parity Progression Ratios (IPPRs).

The concept of parity progression ratio as a useful measure of fertility was first introduced by Henry (1953). His method failed to gain wide applications due to various problems associated with its measurement, data needs and also of conceptualization with regard to period and cohort measures. Feeney (1983), Feeney and Rose (1984) have also proposed methods for estimating PPR utilizing birth interval data. Srinivasan (1967a, 1967b, 1968) introduced the idea of instantaneous parity progression ratio (IPPR). Later, Yadav and Saxena (1989) obtained an interrelationship between IPPR and PPR. The procedure developed by Srinivasan (1967a, 1967b, 1968) as well as Yadav and Saxena (1989) have limited applications as they need data on the interval between the date of birth of the last child and the terminal point of the reproductive period in addition to data on open and closed birth interval. Since in most surveys, data are collected only for those women who are within the reproductive period, such data are often not available. The information on the interval between the date of the last child and the terminal point of the reproductive period can be obtained if the data have been collected in the survey on age at last birth for the females who have crossed their reproductive life. To overcome this problem, a modified form of Srinivasan method was developed by Yadav and Bhattacharya and is referred to as Yadav-Bhattacharya modification to Srinivasan model considering the birth intervals.

2.2.1 Life Table Approach

Henry (1953) developed a life-table technique for the analysis of fertility distribution. According to Henry, a cohort of women who marry or have a birth of a given order are followed until the first or the next birth, if any, occurs. Their retention in the given parity, or their progression to the next child, is described by a set of probabilities specific for parity and time elapsed since last birth. These probabilities take numbers of (i + 1^{st}) birth to women with a given time elapsed since i^{th} birth as their denominator. According to this approach in a period t which for the sake of exposition, may be considered to be just one month long. Suppose $B_{i, x, t}$ represent births of order (i) occurring during (t) at (x) months since the previous birth, then altogether there are in (t) $\Sigma B_{i, x, t}$ births of order (i).

The sources of data can be censuses, fertility surveys and vital registration. The data must contain information on dates of marriage with all their successive live births and the last vital event must be below 45 years of age. From the data, information on the number of births of order i occurring during t at x months since the previous birth, number of women having an i-th birth at duration j in period k must be obtained easily. One of the limitations of this method is the unavailability of a complete vital registration system in developing countries thus making the period unreal in indication of the true extent of temporal changes.

The synthetic life table approach was used by Ni Bhrolchain (1987) in the study on "parity progression ratios and birth intervals in England and Wales for the period 1941-1971.The data analyzed was taken from a sample of a one per cent of single and ever married women in the census of England and Wales of 1971. Dates of first marriage and of all subsequent live births were collected for women aged 16-59 at census date. The data related to 122,644 single and ever-married women (marriage tables) and 102,547 ever-married women (birth interval tables). The parity progression ratio was evaluated as the proportion of women who go on to have an additional birth within ten years and the calculation of median time to next birth was correspondingly confined to those progressing within ten years. Progression ratios up to the sixth birth order were examined. Multiple births were identified separately and births recorded as second or later in a multiple birth event were treated as having occurred at duration of one month. The records were truncated at a woman's 45th birthday thus no exposure or events were entered for any period after that date.

Conditional probabilities of transition of the first birth showed increase at durations of 0-8 months compared to later durations up to the mid 1960's and then fell more rapidly at the duration between 9 and 17 months. Conditional probabilities of the second birth also showed differentials rates of rise and fall; shifting up rapidly at duration 12-48 months and falling off at duration 1-2 years. Third conditional birth probabilities specific to duration show less pronounced movement with respect to rate of rise and fall.

Birth interval from the period life table were summarized by the median duration of occurrence of next birth obtained by confining attention to those who progress to the next birth within ten years. The time from marriage to first birth fell by 3.1 months from 1951 to 1964 and then rose sharply by 5-6 months in the succeeding 6 years. The second birth interval showed a greater increase than other intervals. The interval declined by 5 months and then rose slightly; however, it leveled off in the later 1960's.The third interval displayed a lesser increase in tempo and concentration, while in the fourth interval there was little movement.

Whelpton (1954) developed a fertility life table. According to Whelpton, a cohort of women is followed from the beginning of the reproductive ages. Their movement through single years of age and their progression to higher parities are described by a set of birth probabilities specific for age and parity. These probabilities take numbers of births by age of mothers and birth order as their numerators and numbers of women by age and parity as their denominators. The method allows for the computation of completed parity distribution and parity progression ratios on a period basis.

The main sources of data for the application of the method are vital registration and population registers. The sources provide details of women birth histories. From these histories, the number of births by age of mothers and birth orders can be directly obtained. Similarly, the number of women by age and parity can also be derived from the data. Major limitations of the method are:

The procedure for calculating Whelpton age-parity specific birth probabilities is awkward in practice because of the volume of numbers involved in magnitude are larger than conventional fertility measures; if the data is not obtained from vital registration or a population register, one easily faces the problem of too small cell sizes per parity and single year age group.

The method was applied in the United States of America to analyze fertility trends as evidenced by distribution of childbearing on a period basis. Whelpton produced a time series for the USA. Comparable statistics have only been produced for Japan.

Henry (1980) modified the original work thus providing interval distributions as well as progression ratios as follows: Given a set of age duration or interval- specific probabilities r_E ,r_0 r_1, ..., for any given year, the expression 1- (1- r_E), (1- r_0)... (1- r_1) represents the proportion of women in a hypothetical cohort experiencing event "C" during any given year, y+x+1. If x = E; the average of this expression for (x) and (x+1) interpolates the proportion of women who experience event "D" within x years, exactly of the occurrence of event "C". Calculations of period mean intervals are done by identifying the cumulative non-progression, (1- r_E), (1- r_0)... with L_0 and L_1,... in the life table describing the interval distribution. The expression [xL_0 – xL_x]/ [1-l_x] is made use of for the mean length of life for individuals who exist the life table before exact duration (x). The first term in the numerator represents all person-years lived in the interval (0, x). Subtraction of the person-years lived by those still present at age (x), the second term in the numerator, gives person-years lived by those who have existed the table by age (x). The division by (1-l_x) is a normalization. Period mean intervals are truncated in the same way as period progression ratios.

The data required for the application of this method can be obtained from fertility surveys and it includes: date of birth, age at first marriage, pregnancy and contraceptive history. From these histories, birth intervals are worked out. The method faces the problem of truncation bias due to age selection. Age selection bias, biases the measured level of progression from first birth to second birth upward. The other limitation is due to reporting of adopted children as natural children thus influencing the parity progression ratios.

The above method was applied to analyze parity progression and birth interval statistics in relation to Chinese government birth planning policies in China (Feeney and Wang, 1993). The results of the study indicated that the period parity progression from marriage to first birth between 1972 and 1981 was very high at 0.986, implying a level of childlessness in marriage of only 1.4 percent. The period values showed an upward trend except between 1970 and 1972 mainly due to the population policy. The period parity progression from the first to the second birth dropped drastically and this perhaps reflected the effectiveness of the one-child policy. The mean birth interval also rose. To understand the levels and trends over time, the period parities were translated in TFR and the results indicated that the level of six children per woman before 1970 dropped to near replacement level in 1990.

The life table approach was applied by Rashad (1987) on the study on the analysis of recent fertility trends in Egypt with the aim of identifying changes in the collective fertility behavior of Egyptian women. The source of data was the Egyptian Fertility Survey conducted in 1980 (CAPMAS, 1983) as well as special tabulations reproduced using the EFS tape (CAPMAS, 1983b). Results of analysis of trends in quantum show that, both the quantum of marriage and the quantum of fertility within marriage differed considerably between 1974 and 1979. For 1979 9% of women remained unmarried by age 39; while for 1974 only 3% of women were unmarried. For those who ever married, the percentage of women in different parities was quite different in between 1979 and 1974. Comparing 1969 with 1974 some changes was noted in the quantum of marriage; the percentage of unmarried women increased from 1% in 1969 to 3% in 1974- but the difference in quantum marriage was much smaller than that portrayed by the 1974 and 1979 data. Regarding fertility within marriage the percentage of ever married women in different parities showed very little changes as compared 1974 and 1979. The percentage parity distribution was higher in 1979 for lower parity and much smaller for higher order parity.

Specific Parity Progression Ratio SPPR(39) were unanimously lower in 1979 than the corresponding SPPR(39) for 1974 and 1969. The decrease in probability of first marriage for unmarried was very small between 1969 and 1974 as compared to 1974 and 1979. Similarly, there was almost no change between 1969 and 1974 in probability of proceeding to a subsequent birth for women of lower parities; while those changes were much more pronounced between 1974 and 1979. For higher order parities, some decrease in probabilities of proceedings to subsequent births occurred between 1969 and 1974, coupled with an increase in parity progression at certain parities. For 1979, the decrease in SPPR was stronger and occurred in all parities.

On the trends in tempo, the implied data using 1979, 1974 and 1969 rates suggested a change in tempo of fertility between 1974 and 1979 and negligible changes between 1969 and 1974. The major change between 1974 and 1979 was a result of a change in mean age at marriage. Once marriage occurred birth became at a slightly faster pace in the beginning and the gap at mean ages at i-th birth decreased between 1974 and 1979 with increased birth order. At low order parities, mean age of women at event i (for those who proceed to have a subsequent event) was much higher for 1979 than 1974 and 1969 and the difference in mean at birth decreased as the order of birth increased. The difference in tempo between 1974 and 1969 was almost negligible at all parity orders.

Moreno-Navaro (1987) applied the extended life table model of birth intervals to quantify the patterns of childbearing throughout the reproductive careers of Latin American women in five countries. The model was used for studying, on a parity-specific basis, the distributions of birth interval durations and approximating the ultimate proportion of women achieving a new parity group or the parity progression ratio. The data was derived from World Fertility Surveys (WFS) in Colombia in 1976, Costa Rica in 1976, Mexico in 1977, Panama in 1977 and Peru in 1976 which offered reliable evidence on the fertility behavior of their populations. The covariance analysis of birth interval life tables carried out through the specification of a main-effect multiplicative hazards model.

The results indicated that the first phase was characterized by homogeneous and uncorrelated behavior across parities, negligible birth-order-specific effects of duration of marriage, the incidence of age's showing nonvolitonal effects on fertility variations, and substantial heterogeneity generated by the incidence of infant deaths on postpartum periods, among others. Transition to higher parities was accomplished by large proportions of the population and occurred, on average, in less than three years. Onset of phase two was marked by increased heterogeneity in the fourth and/or fifth intervals. Thus "stopping" and "spacing" practices altered the speed of reproduction. The third phase became apparent as the changes described were accentuated markedly at central parities and diffused through the third and second intervals. In addition, women with high birth orders of six and more showed substantial decline in their reproductive tempo and quantum. At all parities, fertility control increased with age and duration of marriage.

2.2.2 Analytical Models

Srinivasan (1967a) developed an Instantaneous Parity Progression Ratio model. This method uses both the closed and open birth interval. Closed birth interval provides the estimation of women moving from parity (i) to parity (i+1), similarly open birth intervals can be used for estimating the incidence of secondary sterility.

The sources of data for the application of the method are fertility survey and complete vital registration. The data must provide information on the occurrence of each of the vital events together with the background characteristics of the woman and her contraceptive and marriage history. The data must have information on open birth intervals by age of mother at survey, all previous closed intervals by total number of intervals at survey date and last closed interval by age of mothers measured at the beginning of interval, the end of interval and the survey date. The major problem with the method is the data which normally lacks the information of the age of the mother at the last birth to attaining age 45 years. This yields error in values of "V_i". The method is also affected by the age which a woman is expected to have completed her fertility since this varies especially in developing countries.

The method has been used both in India and Fiji. It was observed from the result that the probability that a woman of parity (i) progressed to parity (i + 1) ranged from 0.86 to 0.49 and varies with birth order. A comparison between the results from Fiji and India showed that they almost had the same PPRs except for parities 0 and 5+, indicating a higher fertility among the Indian women.

Feeney (1983) developed a parity progression model. The method was used to study population dynamics in China based on birth intervals and parity progression. With respect to the analysis of the determinants of fertility, birth interval and parity progression measures offer advantages in two areas First in analysis of the "intermediate variables", such as the length of breastfeeding and contraceptive use , through which any variable (education, rural-urban residence, and so on) must operate if it is to influence fertility. A second area is the study of differentials by characteristics that undergo substantial change as women reproduce for instance, women's labor-force participation and migration.

Feeney and Ross (1984) also developed parity progression model which was applied to study the relationship between open and closed birth intervals distribution on the basis of analysis of fertility transition. In this method, the open birth interval is considered to be analogous to the age distribution and the closed interval analogous to the distribution of lives by length, as generated by the l_x column and seen directly in the d_x column. It is recognized that progression from one birth to the next is a function of l_x or rather $1 - l_x$ with survival defined as avoidance of the next birth.

If $B_i(t)$ denote the number of births of (i)-th order in a population between time (t) and time (t + dt) and $l_{x,i}$ denotes the proportion of women who remain within the parity (i) for at least (x) unit of time (years) after joining the parity by having the (i)-th birth, $l_{x,i}$ is thus the survivorship schedule for the women in that parity (i).

Similarly, if $k_i (x_i, t)$, $x > 0$ denote the open birth interval distribution for women of parity (i) at time (t) and also that $k_i (x, t)\, dx$ is the number of women who have been at parity (i) for a time between (x) and (x + dx) years, the relationship of the three variables can be written as follows:

$k_i (x_i, t) \;=\; l_{x,i} B_i(t-x), (x > 0)$.

The question that arises is how we obtain the variable $l_{x,i}$ since it is not obtainable from the data set. The answer is that: it relies on the progression and mortality factors of those women who joined parity (i). Thus, $l_{x,i}$ is the parity progression ratio and is algebraically as follows:

$l_{x,i} = k_i (x_i, t) / B_i(t-x)$.

This study was undertaken using Indonesian open birth-interval data to estimate parity progression ratios. It provided a picture of reproductive pattern which could be used to explain the decline in fertility. The result of the study indicated that the fertility level calculated by open birth interval estimates was higher by one birth when compared to fertility calculated from children ever born. This difference favours the open birth-interval estimates.

Yadav-Bhattacharya (1985) developed a modification to Srinivasan model. The model requires no information of the age of the mother at her last birth and uses both open and last closed birth interval's data only and produce a relatively high accurate result. In this model, the knowledge of age at last birth to age 45 years is replaced with a constant time span within which the open birth interval has a high chance of closing prior to the survey date. The sources of data are fertility surveys, censuses and birth registration. The data provides information of women birth histories which provides the truncated distribution of the open birth intervals at point "C" such that $P(T_i > C) = 0$. However, the procedure suffers the problem of birth interval truncation and selection biases which is inherent in the estimates based on interval data.

The method was applied to India's 1985 fertility survey data. The purpose of the study was to check the applicability of the method with the help of three data sets compiled from three large scale sample surveys conducted in their states of Bihar, Rajasthan and among the Parsi community of Bombay. The result indicated that some of the estimate exceeded unity, particularly at lower parities while at higher parities the estimates were exceptionally high. When this method was compared with other methods using the same data set, it was observed that the method gave higher estimates of parity progression ratios than those of other methods.

Feeney, G (1988) computed the parity progression ratios (PPRs) from a distribution of women by children ever born, by accumulating the parity distribution up from the bottom, the numbers N(i) of women with (i) or more children ever born were obtained, i = 0, 1, 2....The PPR, P (i), for progression from (i) – th to (i + 1)-th was computed as N(i + 1)/N(i). This method is based on observed proportion not progressing within a specified time (x).

The source of data can be fertility surveys, vital registration or censuses. These sources provide data on women by number of children ever born according to their birth order i.e. complete birth histories. The method and the sample sizes are also usually small due to high cost of collecting complete birth histories. In addition, the data normally suffers from the age-selection bias that results from the usual restriction of the sample to women under the age of 50 years.

This method has been used to assess the success of family planning programme in Kenya. From derived PPRs, the mean number of children ever born may be calculated from:

$$MCEB = P_0 + P_0P_1 + P_0P_1P_2 + \ldots$$

The PPRs were calculated for a period of 1962, 1969, and 1979. These PPRs were then plotted to provide time plots for easy observation. Similarly, time plots of children ever born data were also done. The results indicated that between 1969 and 1979, the PPR time plot revealed a rise in fertility for all the parity progression ratios. Progression from first to second birth rose from about 92 to 94 percent. MCEB also recorded a steady growth for the groups considered to have completed fertility. For age group 40-44 MCEB grew from 6.44 in 1969 to 7.02 in 1979.Similarly, the group 45-49 grew from 6.69 in 1967 to 7.17 in 1979.

Ochieng (1996) applied Yadav-Bhattacharya modification to Srinivasan parity progression model to estimate fertility in Kenya. The data used was obtained from 1993 KDHS. From the results of the analysis it was observed that pace of childbearing (parity progression ratios) at national level dropped steeply from parity two to parity four, the drop was then steady and slow. The drop as represented by parity progression ratios declined from 0.78228 in parity two to 0.69574 in parity eight. Thus, the values of PPR's were observed to decline, from parity two steadily to parity eight. Parity eight was considered as the highest value since there were fewer cases beyond parity eight. The value of Mean Children Ever Born of 3.515 was not very far from KDHS 1993 observed value of 3.17 level of fertility measured by MCEB was 3.51 per woman.

A study by Kimani (2005) on fertility change in Kenya, for the period 1998 to 2003 utilized parity progression approach to estimate fertility levels. The results obtained by Kimani were obtained through estimation of fertility using the parity progression ratios approach for Feeney (1989), an empirical based model. The approach starts by obtaining r(x, i), the probability of progressing to parity *i* at age x in the past year. The r(x, i), obtained are then used in the second step to generate a life table which gives parity distributions at each age. Data used were obtained from the 1998 and 2003 KDHS surveys. Fertility was estimated by using births in the past one year and then comparing these estimates with estimated fertility based on conventional approaches. Fertility estimates using the parity progression approach suggested continuation of fertility decline though at a reduced pace. Fertility declined from 5.04 births per woman in 1998 to 4.67 births in 2003. On the other hand, estimates from the conventional approach suggested no change in fertility. The slight reduction in fertility was a result of the reduction in fertility among women with six or more births and an increase in the proportions that were childless. The contribution of women parities 6 and above to fertility was reduced from 1.41 births per woman to 1.14. There was a rise in fertility for parities between 2 and 4 thus parity progression ratios among women in these parities were observed to have increased. The increase was confirmed by the birth interval analysis, which revealed that women who had attained parities 4 or 5 were more likely to have another birth.

2.3 Summary of the Literature

From the literature review, it was observed that there are two major approaches of calculating parity progression ratios: The life table method and the analytical models. The life table method provides period measures while the instantaneous parity progression ratios method provides both the instantaneous and period measures provided there is more than one data set. The life table method as introduced first by Henry (1953), failed to gain wide applications due to various problems associated with its measurement, data needs and also of conceptualization with regard to period and cohort measures. It requires vital registration statistics in order to generate accurate period parity progression ratios. This is a limitation to this study since the available data is the Kenya Demographic and Health Survey.

Feeney (1983), Feeney and Rose (1984) also proposed methods for estimating PPR utilizing birth interval data. Srinivasan (1967a, 1967b, 1968) introduced the idea of instantaneous parity progression ratio (IPPR). Later Yadav and Saxena (1989) obtained an interrelationship between IPPR and PPR. The procedure developed by Srinivasan (1967a, 1967b, 1968) as well as Yadava and Saxena (1989) have limited application as they need data on the interval between the date of birth of the last child and the terminal point of the reproductive period in addition to data on open and closed birth interval. Since in most of the surveys, data are collected only for those women who are within the reproductive period, such data are often not available. The information on the interval between the date of the last child and the terminal point of the reproductive period can be obtained if the data have been collected in the survey on age at last birth for the females who have crossed their reproductive life. These are also limitations for the available data set, the

(KDHS) since it lacks information on the interval between the date of birth of the last child and the terminal point of the reproductive period.

To overcome this problem a modified form of Srinivasan method was developed by Yadav and Bhattacharya and is referred to as Yadav-Bhattacharya modification to Srinivasan model. The method works well with both survey and vital registration data. It requires no knowledge on age of the woman at the termination of her birth process to age 45 years. This thesis aims at analyzing Kenya's fertility level and tempo using data from Kenya Demographic and Health Survey (KDHS) for the year 2003, through analysis of birth-interval dynamics and the parity progression ratios. The model to be used in obtaining fertility estimates is the parity progression model developed by Yadav-Bhattacharya, a modification of Srinivasan model.

2.4 Definition of Concepts

Parity Progression Ratios

This is the proportion of women who having given birth to their i-th child will proceed to the $[i + 1]^{th}$ child after some specified period of time.

Birth Interval

This is the duration of time between two consecutive live births of a woman or over a group of women in a community. There are two types of birth intervals; the open birth interval and closed birth interval.

Open birth interval

An interval is said to be open if the women, after having an i^{th} birth never move to the $(i + 1)^{th}$ birth. This is defined as the interval between the date of the last birth and the date of the survey.

Closed birth interval

An interval is said to be closed if the ith birth is followed by the (i +1) birth.

Mean Children Ever Born

This is the average parity per woman

Marriage

A state in which a woman is regularly exposed to the risk of childbearing, however governed by social and cultural circumstance

2.5 Variables and their Measurements

The study will examine Socio-economic variables namely; Education and type of place of residence and demographic factors that is, age of the mother and parity.

Socio-economic variables

Maternal Education

This refers to the level of formal education attained by the mother. This study classifies the levels of education into: no education, primary, secondary and higher.

Type of Place of Residence

This is the area where the respondent was living at the time of the survey. This is measured in terms of the following two categories; rural or urban.

Demographic Factors

Age of the Mother

This variable shows the current age of the mother. It will be categorized into 5-year groups, namely; 15-19, 20-24, 25-29, 30-34, 35-39, 40-44 and 45-49.

Parity

This refers to the total number of children ever born by a woman. Birth interval distribution for women will be categorized by the number of children ever born. The categories are: 1,2,3,4,5,6,7 and parity 8, which represent 94 percent of the total cases.

CHAPTER THREE

DATA AND METHODOLOGY

3.1 Introduction

This chapter presents the source of data, discusses the model of the study. It also outlines the theory behind the model and its derivation. Furthermore, it includes the assumptions of the model, data requirements and the procedure for calculating parity progression ratios.

3.2 Source of Data

The data used for this study was drawn from the Kenya Demographic and Health Survey (KDHS) 2003, which was a national representative survey. Unlike prior KDHS surveys, the 2003 KDHS was the first survey to cover the entire country, including North Eastern province and other northern districts that had been excluded from the prior surveys (Turkana and Samburu in Rift valley Province and Isiolo, Marsabit and Moyale in Eastern Province). Since the sample size is large, the results are generalized to give the picture of the country's fertility pattern. The survey selected a total of 8,195 households in which 2,751 were in urban and 5,444 were in rural area. A sample of 8,195 women of age 15-49 was interviewed.

The survey obtained detailed information on fertility levels, marriage, sexual activity, fertility preferences, awareness and use of family planning methods, breastfeeding practices, nutritional status of women and young children, childhood and maternal mortality, maternal and child health, awareness and behavior regarding HIV/AIDS, and other transmitted infections (STIs). New feature of the 2003 KDHS include the collection of information on malaria and use of mosquito nets, domestic violence and HIV testing of adults. Three questionnaires were used in the survey: household, men and women questionnaires.

As regards fertility the survey collected data on birth histories for women aged 15-49 years which is related to the study, of all children they had given birth to, those who were currently living with them, those who were living away, and those who had died. In addition, the following information was collected for each live birth: name, sex, date of birth, survival status, current age (if alive), and age at death (if dead). From maternal history, variables like last birth to interview, preceding birth interval and succeeding birth interval were obtained by different background characteristics i.e. age-groups, education level and type of place of residence.

3.3 Specific Data Required

1) The truncated open birth interval distribution of women with parity (i). This data provide the mean open birth interval denoted by E (U_i).
2) The closed birth interval distributed according to women of parity (i). This data provide the first raw moment denoted by E (T_i).
3) Truncation time in months denoted by C.

3.4 Yadav-Bhattacharya's Modification to Srinivasan Model

The model is built around birth intervals. These birth intervals both open and closed, distributions for women of parity (i), ($i \geq 0$) and parity progression ratios for women of parity (i) to (i + 1) provide a good basis for fertility estimate. When couples think of having children, they decide in terms of whether or not and when to have the i^{th} birth or $(i + 1)^{th}$ birth. The aggregate results of these decisions are directly represented in PPR's and birth interval distributions. The distribution of women by parity defined belongs to a population of women who have births of a given order during a given period. These groups of women are referred to as parity cohorts of order (i). Parity cohorts play the same role that the birth cohorts play in the conventional population dynamics because both represent entries into the population during a particular period of time. Women enter the population by having an $(i)^{th}$ birth and this is analogous to birth in an ordinary population.

The general idea, now familiar, is to ask what proportions of women proceed from one event in the childbearing sequence to the next? Of all women born, what proportion ever become mothers? Of those who have a first child, what proportion goes on to have a second? Of those who have a second child, what proportion progress to a third, and so on? The pattern of progression has a direct linkage to the birth intervals and hence the behaviour of fertility within a population. Parity progression from *i*-th birth to $(i + 1)$-th birth determines the level of fertility in a give population.

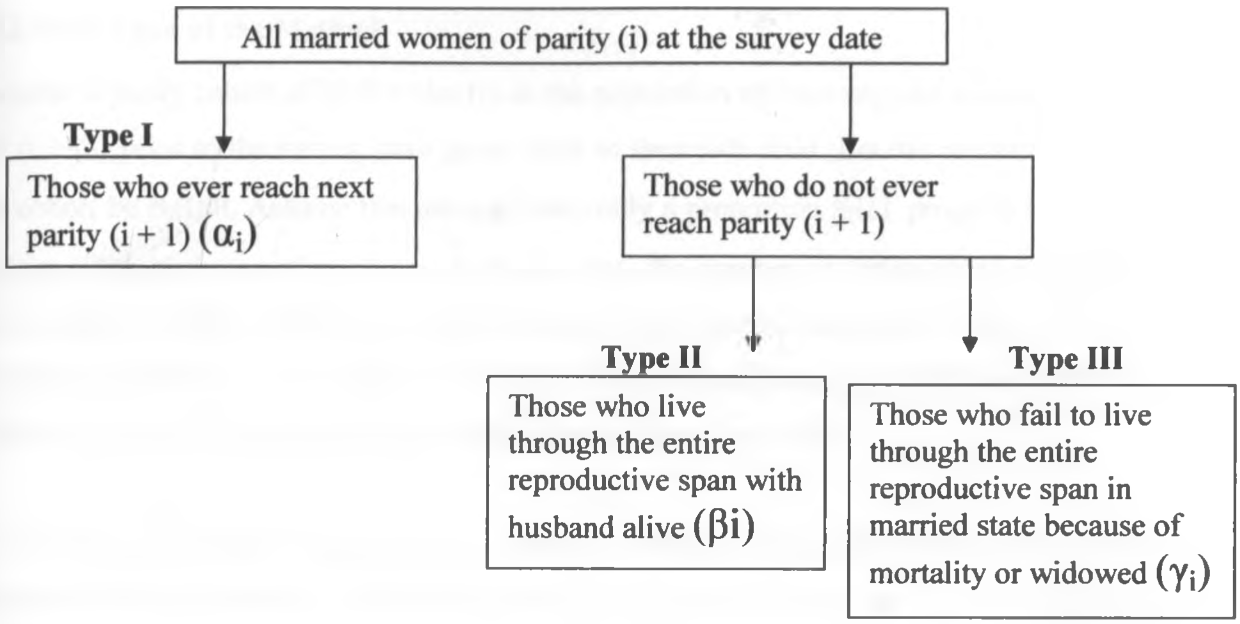
Open birth interval is a measure of the incidence of secondary sterility (Srinivasan, 1980). A woman is said to be sterile if her open birth interval remains open, otherwise if closed she is said to have experienced a parity progression. A woman's fertility behaviour in relation to open birth interval is thus defined with a probability parameter α_i such that α_i represent the probability that a woman of parity *i* will ever proceed to parity (*i* + 1) within a restricted time span "C" before the survey date. Therefore, the open birth interval must be less than or equal to a constant period "C". The interval "C" is chosen such that $P[T_i > C] = 0$, where T_i denotes the closed birth interval. These intervals relate to those women who proceed to the next parity within the time interval "C". Those who fail to proceed from parity *i* to parity (*i* + 1) within this time are defined by the probability $(1- \alpha_i)$. Thus any woman who give birth to *i*-th child has two mutually exclusive probabilities regarding to her fertility in future: She may either progress to give birth to the next child, parity (*i* + 1), with probability of α_i or she fails to do so with probability of $1- \alpha_i$.

The general case of the distribution of the open interval for any woman not necessarily "fertile" is studied by dividing all married women of parity *i* in the reproductive age group at the time of the survey into three mutually exclusive types:

1) Those women who ever reach next parity (i +1).
2) Those women who do not ever reach next parity (i +1), but who live through the entire reproductive span with husband alive.
3) Those who do not ever reach parity (i +1), but who fail to live through the entire reproductive span in the married state because of mortality or of widowhood.

Let α_i , be the probability that a married woman of parity *i* at the time of the survey ever proceeds to parity (i + 1) and β_i be the probability that she will live through the rest of her reproductive state in the married state without giving birth to any more children. Obviously, the proportion γ_i which is $1- \alpha_i - \beta_i$ indicates the probability that a married woman of parity *i* at the time of the survey will die or be widowed before her reproductive period of life without giving birth to any more children. Diagrammatically, the division of the three mutually exclusive classes (Types I, II and III) are shown as in figure 2.1.

Figure 3.1 Diagrammatic Division of P_{i0} into Three Mutually Exclusive Classes



Source: Demography Vol.5, pg 34, 1968.

If the mean open birth interval and first two raw moments of the corresponding closed interval within the defined period, denoted by "C" are known, then (α_i),the probability of a woman progressing to parity (i + 1) from parity *i* can be estimated. This probability, (α_i), is the parity progression ratio.

3.4.1 Assumption of the Model

Yadav-Bhattacharya's modification to Srinivasan model is built under the following assumptions:-

1) The level of mortality is low among the women of reproductive age (15-49) during their reproductive cycle.
2) The population is closed to migration specifically for the women under the study (Women of parity i in the reproductive age group at the time of the survey)
3) The time interval beyond which there is no progression from parity (i) to parity (i +1) is restricted to a value "C". There is a threshold time interval from which the chance of giving birth is almost nil.

4) There is one to one correspondence between i-th births during any time period and the women with their i-th births during this period.

3.4.2 Derivation of the Method

Consider a parity cohort of birth order (i) as the population of women, who between the time (t) and (t + dt) prior to the survey have given birth to their *i*-th child. Let the number of women in this cohort be $B_i(t)dt$. Assume that among these, only a proportion $a_i(t)$, progress to have (i+ 1)-th from (i)-th birth sometimes later, implying that, the number of fertile women at time (t) in such a cohort would be $B_i(t)a_i(t)dt$. Among these fertile women, those who will contribute to the open birth interval, U_i , at that time of survey are the women who have failed to have their (i + 1)-th child within a time interval (t) from the date of their (i)-th child.

Let $F_i(t)$ be the distribution function of T_i, where T_i is the inter-live birth between the *i*-th and (*i* + 1)-th birth. The proportion of women of parity (i) not progressing to the (i+ 1)-th child between the time't' is thus given by $1- F_i(t)$.

From the definition above, the total number of women with i-th order open interval is given by:-

$$\int_0^w B_i(t)a_i(t)[1-F(t)]dt$$

Where 'w' denotes the maximum reproductive span of women

The probability density function of *i*-th order open birth interval U_i, say $g_i(t)$ is defined as

$$g_i(t) = \frac{B_i(t)a_i(t)\ [1-F_i(t)]}{\int_0^w B_i(t)a_i(t)[1-F(t]\ dt} \qquad (3.4.2.1)$$

The mean and the second raw moment of the open interval for the fertile women of parity (i), denoted by $E(U_i)$ and $E(U_i^2)$ respectively are given by the following expression:-

$$E(U_i) = \int_0^w tg(t)dt$$

$$= \int_0^w \frac{tBi(t)ai(t)[1-F(t)]dt}{\int_0^w Bi(t)ai(t)[1-F(t)]dt}$$

$$\therefore E(U_i) = \frac{\int_0^w tB_i(t)a_i(t)[1-F(t)dt}{\int_0^w B_i(t)a_i(t)[1-F(t)]dt} \qquad (3.4.2.2)$$

And

$$E(U_i^2) = \int_0^w t^2 g(t)dt$$

$$= \int_0^w \frac{\{t^2 B_i(t)a_i(t)[1-F(t)]dt\}}{\int_0^w B_i(t)a_i(t)[1-F(t)]dt}$$

$$\therefore E(U_i^2) = \frac{\int_0^w t^2 B_i(t)a_i(t)[1-F(t]\, dt}{\int_0^w B_i(t)a_i(t)[1-F(t)]dt} \qquad (3.4.2.3)$$

Under stability assumption $B_i(t)dt$ is independent of (t) but only depend on the time interval dt during the last 25-30 years that the rate of occurrence of i-th order births has been constant over time. Thus, the number of i-th order births would only depend on the time interval and not on its location in the time range.

Equally let $a_i(t)$ also constant with time under the same assumption. Subsequently

$$E(U_i^2) = \frac{\int_0^w t B_i(t) a_i(t)[1-F(t)]dt}{\int_0^w B_i(t) a_i(t)[1-F(t)]dt}$$

$$E(U_i^2) = \frac{\int_0^w t\,[1-F_i(t)]\,dt}{\int_0^w [1-F_i(t)]\,dt}$$

$$\therefore \; E(U_i) = \frac{E[T_i^2]}{2E[T_i]} \qquad (3.4.2.4)$$

And also $E[U_i^2] = \dfrac{E[T_i^2]}{3E[T_i]}$

These relations have been derived for the fertile group of women, however for any married population of women; there exists two types of women i.e those who progress to the next parity (i+ 1) from parity i and those who do not proceed to a higher parity after the i-th birth. This process of progression occurs with probabilities of α and 1- α respectively.

Assuming that the effect of mortality among women in those groups is negligible, the observed distribution of U_i is a mixture of two distributions i.e. $U_i^{(F)}$, the open interval for fertile women and $U_i^{(S)}$, the open interval for the non-fertile women (those who remain within the parity). The distribution of U_i is thus identical with the distribution of $U_i^{(S)}$ with the probability of $(1- \alpha_i)$.

Let us denote the random variables $U_i^{(F)}$ and $U_i^{(S)}$ by the symbols F_i and S_i for convenience. It follows from above that F_i is the random segment of $T_{i,}$ and S_i is the random segment of V_i, which denotes the interval between the date of the birth of the last child and the date of attaining 45 years of age or the end of the reproduction span. Recall from earlier equations that:-

$$E(F_i) = \frac{E(T_i^2)}{2E[T_i]} \qquad (3.4.2.5)$$

$$E(S_i) = \frac{E(V_i^2)}{2E[V_i]} \qquad (3.4.2.6)$$

$$E(S_i^2) = \frac{E(V_i^3)}{2E(V_i)} \qquad (3.4.2.7)$$

Expressing U_i and U_i^2 in terms of F_i and S_i we obtain

$$E(U_i) = \alpha_i E(F_i) + (1-\alpha_i) E(S_i)$$

$$= \alpha i \frac{E(T_i^2)}{2E[T_i]} + (1-\alpha_i) \frac{E(V_i^3)}{2E(V_i)} \qquad (3.4.2.8)$$

And

$$E(U_i^2) = \alpha i \frac{E(T_i^3)}{2E[T_i]} + (1-\alpha_i) \frac{E(V_i^3)}{2E(V_i)} \qquad (3.4.2.9)$$

From 3.4.10 making α_i the subject of the formulae, we have

$$\dot{\alpha} = \frac{\dfrac{E(U_i)\, E(V_i^2)}{2E(V_i)}}{\dfrac{E(T_i^2) - E(V_i^2)}{2E(T_i)\, 2E(V_i)}} \qquad (3.4.2.10)$$

Where α_i is the estimate of the instantaneous parity progression. In order to apply this model the data is required on age of women at the termination of their last birth. In the modified model, only women who give birth to the *i*-th child within a restricted time span C before this survey are considered. Thus the open birth interval must be less than or equal to a constant period C. The interval C is chosen such that $P[T_i > C] = 0$

Let the proportion of women who proceed to the next parity (i +1) and those who do not proceed to higher parity after *i*-th birth be α_i^* and $1-\alpha_i^*$ respectively.

Using the original model's argument, the number of women who proceed to next parity (i+ 1) is given by:

$$\int_0^c \alpha_i B_i(t)\,[1-F_i(t)]\,dt = \alpha_i B_i E(T_i)$$

Equally, the number of women who do not proceed to the next parity is given by

$$\int_0^c (1-\alpha_i) B_i\,dt = (1-\alpha_i) B_i C$$

The total number of women in parity (i) then becomes

$$\alpha_i B_i E(T_i) + (1-\alpha_i) B_i C$$

The proportion $\alpha_i^* = \dfrac{\alpha_i B_i E(T_i)}{\alpha_i B_i E(T_i) + (1-\alpha_i) B_i C}$

$$\therefore \alpha_i^* = \frac{\alpha_i E(T_i)}{\alpha_i (T_i) + (1-\alpha_i) C} \qquad (3.4.2.11)$$

The new mean open birth interval, E (U*), for such women would be

$$E(U^*) = \alpha^* \frac{\int_0^c t B_i [1-F_i(t)]dt}{\int_0^c 0B_i\,[1-F_i(t)]\,dt} + \frac{\int_0^c t B_i dt}{\int_0^c B_i dt}(1-\alpha_i^*)$$

or

$$= \alpha_i^* E(U_i) + (1-\alpha_i^*)\,C/2 \qquad (3.4.2.12)$$

Substituting for E (Ui) from 3.4.2.4

$$E(U_i^*) = \alpha_i^* \frac{E(T_i^2)}{2E(T_i)} + (1-\alpha_i^*)\,C/2$$

Replacing α_i^* by 3.4.2.1 we have

$$E(U_i^*) = \frac{\alpha_i^* E(T_i) E(T_i^2)}{\alpha_i E(T_i) + (1-\alpha_i)C \; 2E(T_i)} + \frac{(1-\alpha i E(Ti)C/2}{\alpha_i E(T_i) + (1-\alpha_i)C}$$

$$= \frac{\alpha_i E(T_i^2)}{2[\alpha_i E(Ti) + (1-\alpha_i)C]} + \frac{\{\alpha i E(T_i) + (1-\alpha_i) C - \alpha_i E(Ti)\}C/2}{\alpha_i E(T_i) + (1-\alpha_i)C}$$

Making α_i the subject of the formula, we have

$$\acute{\alpha}_i = \frac{C^2 - 2CE(U_i^*)}{C^2 + 2E(U_i^*)[E(Ti) - C] - E(T_i^2)} \qquad (3.4.2.13)$$

Where:-

$\acute{\alpha}_i$ – is the parity progression ratio

U_i – is the open birth interval

T_i – is the last closed birth interval

C – is the truncated time in months

i – is the i-th parity for every woman

3.5 Steps in Calculating PPRs

There are six steps involved in calculating the values of PPRs as discussed below:-

Step 1

Calculation of values represented by the formula $C^2 - 2CE(U_i)$ for every parity i.

Step 2

Calculation of the values represented by the relationship $2E(U_i)[E(T_i) - C]$ categorized by the variable (i).

Step 3

Calculation of the second raw moment of the last closed birth interval for every woman of parity (i). This moment is denoted as $E(T_i^2)$.

Step 4

Calculating the values of $C^2 - E(T_i^2)$.

Step 5

Calculation of the sum of values obtained in step 2 and step 4. This provide the denominator of the Parity Progression Ratios.

Step 6

Calculation of the parity progression ratios (PPRs) for every value i. The Parity Progression Ratios values are obtained by dividing the value obtained in step 1 by the value obtained in step 5.

3.6 Practical Considerations in Using the Method

The method requires the choice of a value "C" in the formulae 3.4.2.13. The value "C" represent the number of years for which the progression from *i*-th birth to (*i*+ 1)-th birth by every woman is very negligible. Different values of "C" provide different results (PPRs).

A computational inspection of the sizes of mean children ever born (MCEB) by Ochieng (1996) indicated that MCEB depended directly on the value of "C". He observed that there was a steep rise in the values of MCEB as the value of "C" changed from 11 years to 12 years, indicating the extent of truncation error included in the calculation. When the value of "C" equal to 12 years was considered graphical evidence showed that many births or many women who were in progression to higher births were cut out of the analysis. Conversely, if the value of "C" was made equal to 14 and 15 years, it depicted also a steep rise in the mean children ever born: The value of "C" equal to 15 years produced results which indicated a clear reflection of memory lapse on the side of the respondence. The memory lapse can be explained on the background of the long duration of time frame covered in the birth histories, thus this study covers the period from 1990 to 2003.

These irregularities in values of MCEB for values of "C" equal to 11 years on one end and "C" equal to 15 on the other hand justifies the choice of "C" equal 13 years, as the working value of "C" from which Parity Progression Ratios (PPRs) and MCEB will be calculated for this study. The value of "C" equal to 13 years is the mean value of the extremes, that is, 11 years and 15 years beyond which a negligible number of women progress from parity (i) to parity (i+1).

The method of the study focuses on birth interval analysis and parity progression ratios. The study will focus on the entire population of ever-married women between ages 15-49 years. The study will compare the pace of childbearing in the lower order births with an aim of explaining the effects of family planning programmes for age groups 25- 49.

The reasons why we consider PPRs and Birth Intervals Distribution (BID) for the analysis of fertility behaviour is that: The PPR's provide the proportion of women moving to the next birth (parity) after obtaining the previous one, thus, one can evaluate the changes or levels in terms of the proportion dropping out after obtaining a particular birth. The PPRs may also be used to track back fertility measures year by year so that fertility decline may be observed after a long period. In terms of fertility measurement, PPRs aggregates to provide the value of mean children ever born (MCEB) which is a measure of maternal total fertility rate (MTFR). With availability of data collected at some intervals of time, the values of MCEB can be used to assess the fertility behavior over that period of time. Similarly, Birth Interval Distribution is useful for the interpretation of fertility since it aggregates into family size. Therefore, BID is used to: (1) Calculate PPRs (2) Assess its contribution to fertility levels through birth spacing, which measures fertility tempo.

PPR is related to Mean Number of Children Ever Born by the highlighted formulae below:

$$MCEB = P_1 + P_1P_2 + \ldots + \frac{P_1P_2P_3 + \ldots P_n}{1 - P_n} \qquad (3.6.1)$$

The methodology of analysis will consider the percentage of women progressing from Pi to P_{i+1} and the level of stopping. Under this approach, there are two ways of looking at fertility levels, that is: Period Parity Progression Ratios (PPPR's) and the Instantaneous Parity Progression Ratios (IPPR's). The study is based on Instantaneous Parity Progression Ratios (IPPR's) for the following reasons: the approach provides instantaneous measures which works well with both survey and vital registration data and requires no knowledge on age of the woman at the termination of her birth process to age 45 years. The method focuses on the fertility behavior across the parities which is synthetic as it combines a mixture of several age-cohorts of women. According to the parity progression approach, the values of PPR's are expected to drop as the order of parities move from *i* to *i* +1. More interest will be focused in the values of PPR's at higher order parities and the pace of childbearing in the lower birth orders. These values will be calculated by various background factors of the population in order to estimate differentials .The background factors include; age, education level and type of place of residence. The measures will be obtained either by displaying the PPRs graphically or in terms of summary measure (MCEB).

3.6.1 Graphical Method

This method provides the pictorial presentation of fertility. Graphs will indicate relationship between the calculated ratios i.e. Parity Progression Ratios and parities. Theoretically, PPRs should fall steeply at higher parities showing clearly the levels of cessation. Selected socio-economic variables will be plotted on the same axis for comparative analysis.

3.6.2 Mean Children Ever Born (MCEB) Method

MCEB is a measure of maternal total fertility rate (MTFR) and is calculated from parity progression ratios as expressed in equation 3.6.1. In the analysis, MCEB is used for comparing the level of MTFR for women covered by different socio-economic background factors i.e. education level, type of place of residence, region of residence and the age group of a woman which theoretically, influence the level of fertility significantly.

CHAPTER 4

QUALITY OF DATA

4.1 Assessment of the Quality of Data

As Bumpass et al. (1982) has pointed, analysis of birth intervals on child spacing demands high quality data. Thus the data utilized for analysis in this study were examined in detail through several approaches to determine their quality. At first level, the overall quality in terms of reporting was examined. The second level focused on the quality of reporting of births. The final level of the assessment focused on the quality of the data on the birth intervals.

The following approaches were used to assess the quality of data.

1. Analysis of standard errors of the variables included in the study.
2. A study of the histograms and line graphs of the variables included in the study.
3. Extent of imputation of occurrence of events.
4. Digit preference on the intervals.

4.2 Standard Errors of Variables of the Study

Table 4.1 shows the distribution of standard errors on last birth interval, all closed birth interval and open birth interval. Also included is the total children ever born.

Table 4.1 Standard Errors of Vital Variables

Item	Standard errors
All closed birth intervals	0.0181
Last closed birth intervals	0.0348
Open birth intervals	0.0475
Children ever born	0.0365

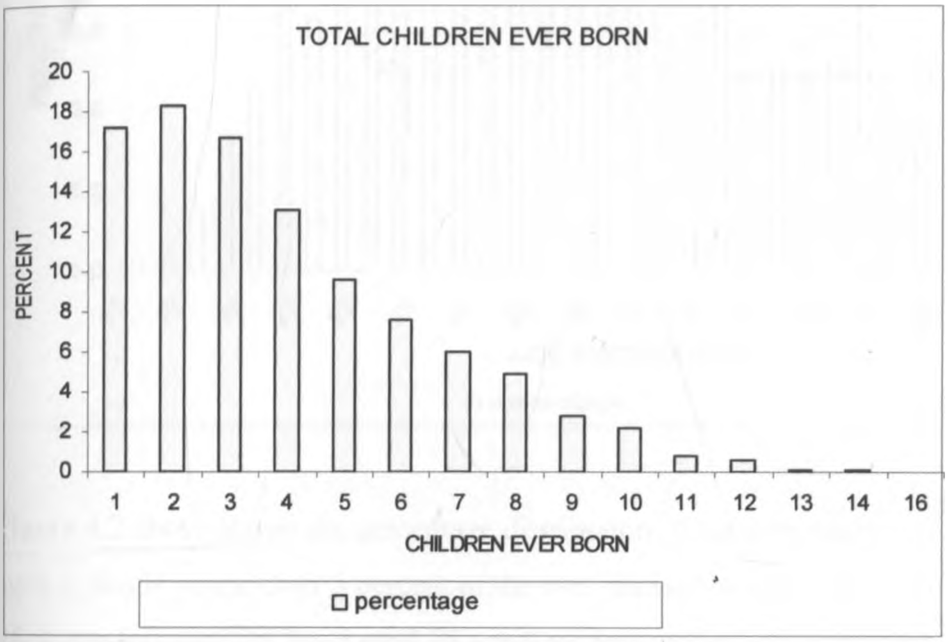
Table 4.1 indicates that the degree of the sampling done for these variables was high and suggests that the quality of the data was reasonably a good one. The picture provided by table 4.1 suggest that two questionnaires out of a hundred for the category of all closed birth intervals gave unacceptable information while for last closed birth intervals, three questionnaires out of a hundred gave unacceptable information. Moreover, about five questionnaires out of one hundred for the category of open birth intervals gave unacceptable information. For the category of children ever born, 4 questionnaires out of one hundred gave unacceptable information. Thus,

these standard errors indicate good sampling design and so points out on the quality of the data as very reliable.

4.3 Histogram Analysis of the Data

A study of various histograms for different variables and other distributions of socio-economic factors reveal different behaviour in distributions as measured by the extent of skewness.

Figure 4.1 A Histogram of Total Children Ever Born



The histogram above shows the distribution of the respondents according to total children ever born. The histogram shows that majority of the ever married women reported that they had given birth to a total of two children. This group comprised of 18.3 percent of the entire population of ever married women. This was followed by the women who reported to have given birth to one child at 17.2 percent, three children at 16.7 percent and four children who accounted for 13.1 percent of the entire population of ever married women respectively. The least of the group was the women who had reported to have given birth to thirteen and fourteen children, which accounted for 0.1 percent of the entire population, followed by those who reported to have given birth to twelve children at 0.6 percent, eleven children at 0.8 percent and ten children at 2.2 percent respectively. These shows almost even distribution of CEB thus a sign of good quality of data.

Figure 4.2 A Histogram of Age Distribution in Single Years

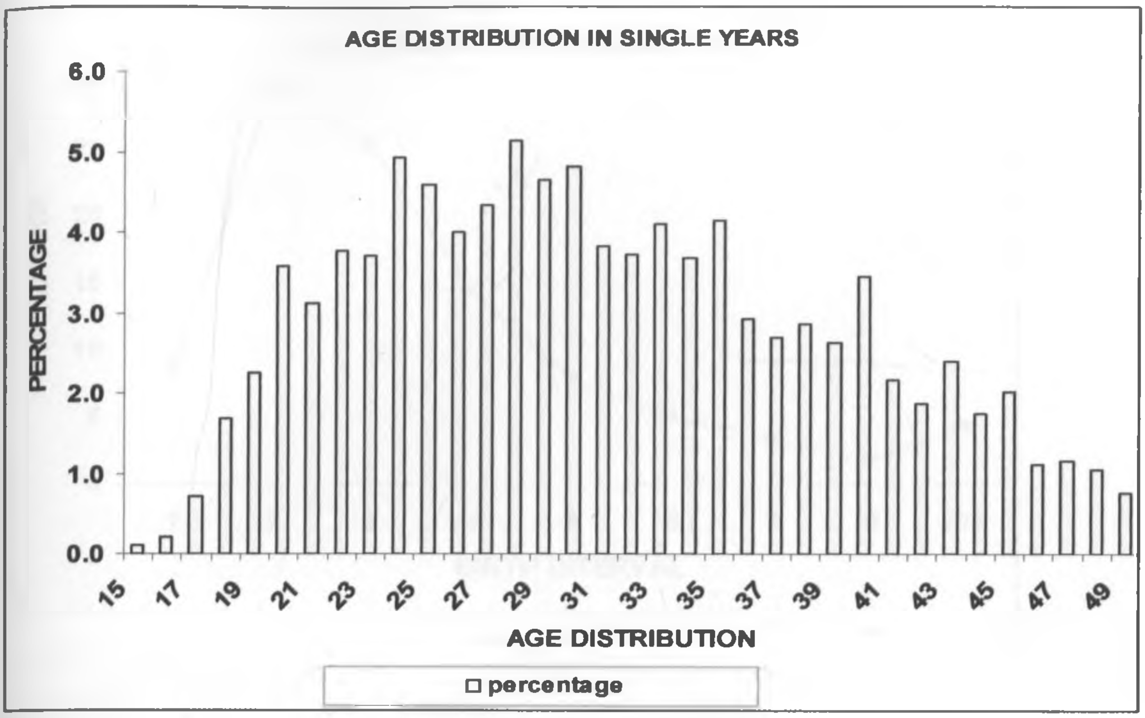


Figure 4.2 above shows the percentage distribution of the ever married women according to their ages in single years. Over 5 percent of the ever married women who were the majority were aged 28 years, followed by those aged 24 years who comprised of 4.9 percent of the entire population of the ever married women, 30 years of age who were 4.8 percent and those aged 25 and 29 years who were 4.6 percent respectively. The least group was the women who were aged 15 years who comprised of 0.1 percent of the entire population of women, followed by those aged between 16 years who accounted for 0.2 percent, 17 years who accounted for 0.7 percent of the population and those aged 49 years who accounted for 0.8 percent of the entire population of the ever married women respectively. Clearly, age reporting indicates concentration at points: 25, 26, 27, 28, 29, 30, 33 and 35. Age reporting is fairly distributed across all ages thus indicating data as being of good quality for use in the analysis.

Figure 4.3 A Line Graph of Last Closed Birth Interval Categorized in Years

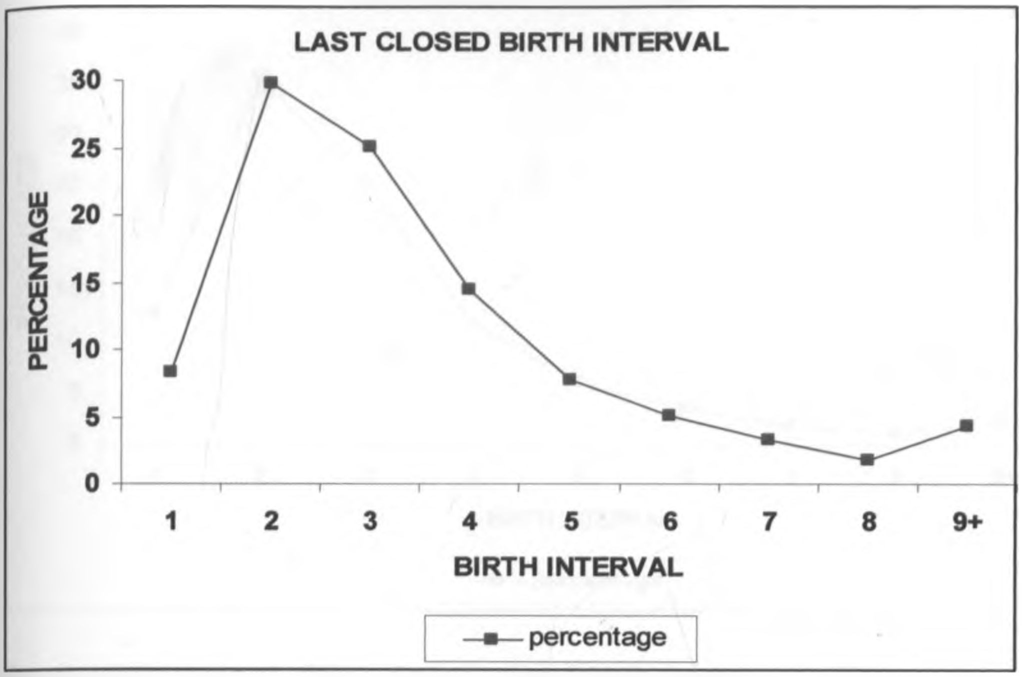
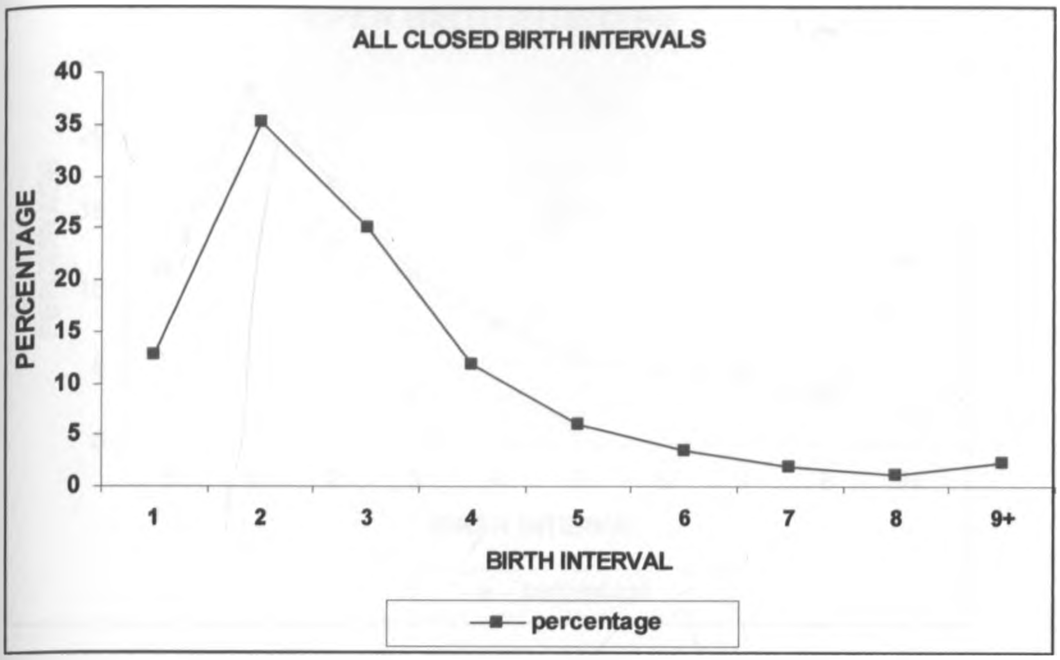


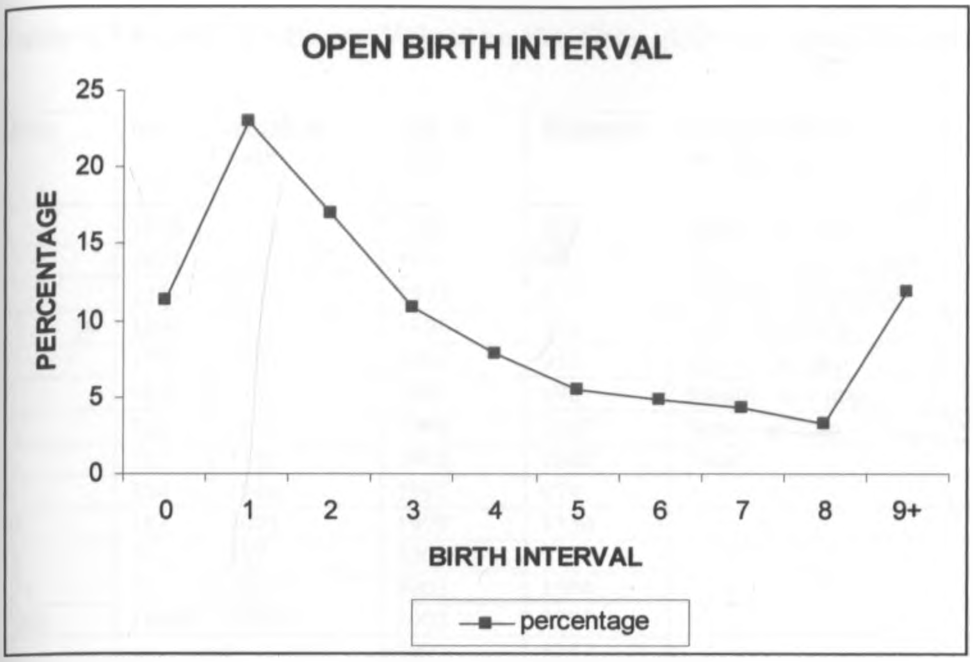
Figure 4.3 shows the distribution of the last closed birth interval (LCBI). The graph shows a trend which is concentrated around an interval of 2 years with 30% of the cases, which is followed by an interval of 3 years with 25% of all the cases and an interval of 4 years with 14% of the cases. The least closed birth interval of 8 years had 2% of the total cases, followed by 9 years and above with 4% of the total cases and 6 years with 5% of the total cases respectively. Moreover, the distribution is positively skewed with a magnitude of 2.12. This shows that the mean (3.5) is higher than the mode (2.0) and the median (2.8). The figure gives a consistent pattern with all the other two types of birth intervals. In either setting this is an indication of relatively good data on birth interval.

Figure 4.4 A Line Graph of All Closed Birth Intervals Categorized in Years



The line graph above shows that all closed birth intervals (ACBI) also give almost a similar distribution with the concentration of interval around 2 years. The distribution is positively skewed with a magnitude of 2.36. This shows that the mean (3.016) is higher than the mode (2.0) and the median (2.5). The closeness of the two types of intervals gives an indication of a good quality of data. Comparing their mean, median, mode, variance and skewness they are very close and this is one of the basis upon which the conclusion on the quality of the data is based. The figure gives a consistent pattern with all the other two types of birth intervals. This is an indication of relatively good data on birth interval.

Figure 4.5 A Line Graph of Open Birth interval Categorized in Years



The line graph above of open birth interval (OBI) shows a high concentration of intervals around zero, one, two and three years. The distribution is positively skewed with a magnitude of 1.16. This shows that the mean (3.6) is higher than the mode (0.4) and the median (2.3). The figure gives a consistent pattern with all the other two types of birth intervals. This is an indication of relatively good data on birth interval.

Table 4.2: Types of Birth Intervals and their Measures of Central Tendency and Dispersion

Birth interval	Mean	Median	Mode	Variance	Skewness
OBI	3.5991	2.333	0.4167	11.2610	1.1611
LCBI	3.5111	2.8333	2.0000	5.0097	2.1214
ACBI	3.0164	2.5000	2.0000	3.491	2.3584

A good data provides a symmetrical distribution which is noticed when the three measures of central tendency i.e. mean, median and mode coincide. As the distribution departs from symmetry these three values are pulled apart, the difference between the mean and mode being the greatest. If the mean is greater than the median and the mode then the distribution is said to be negative. Table 4.2 above shows the measures of dispersion and central tendency of the three variables. The table gives almost a consistent pattern in all the three variables. This is an indication of relatively good data.

4.4 Extent of Imputation of Occurrence of Events

Table 4.3 Extent of Missing Values on the Time of Occurrence of Vital Events.

births	total	month of birth	year of birth	frequency	completeness of information	frequency	% of missing information
1	3028	1240	1990	926	Month and year	12886	5.9
2	2671	1151	1991	801	Year and age - m imp	328	97.6
3	2189	1229	1992	973	Y & age - y ignored	273	98.0
4	1690	1356	1993	854	Year - a, m imp	180	98.7
5	1275	1197	1994	950	Age - y, m imp	11	99.9
6	985	1141	1995	998	Month - a, y imp	2	100.0
7	720	1058	1996	1067	None - all imp	13	99.9
8	512	1162	1997	1040	Total	13693	
9	304	1046	1998	979			
10	182	1073	1999	1130			
11	75	987	2000	1144			
12+	62	1053	2001	1104			
Total	13693	13693	2002	1201			
			2003	526			
			Total	13693			

Literature shows that fertility survey data in developing countries indicated that in many cases women are not able or not willing to report the month and / or year of occurrence of various vital events in their lives (Srinivasan, 1980). In most cases the investigators impute the best estimates in most such situations. The proportion of these estimates is an index of quality of data.

Table 4.3 shows the extent of missing values on the time of occurrence of different vital events. The percentage for which month and year of occurrence is not known was found to be 5.9 percent. Thus, the events for which the information on the month of occurrence was missing, the imputation was made by assuming that events occurred in the middle of the year .The level of imputation for this data suggest that the quality of data is good.

4.5 Digit Preferences on the Intervals.

In order to quantify the extent of preference at half and one year durations, the approach of Srinivasan (1980) was used. This approach is based on the fact that, in fairly large samples, the distributions of the frequencies for the residuals should be uniform.

Literature shows that the data on birth intervals compiled from developing countries are subject to serious digit preferences (Srinivasan,1980), with women reporting the intervals in multiples of one year or half a year. In such cases, if the reported intervals are divided by 12 or 6 and classified by their residues, 1, 2, 3, 4,..., 11, 12 in the first case and 1, 2,..., 5, 6 in the second case, there will be undue clustering of frequencies at 12 and 6 in the first case and at 6 in the second case. If there are no digit preferences, we expect, in fairly large samples, the frequencies to be uniformly distributed with 1/12 in each cell in the first case and 1/6 in the second case. Even in slightly skewed distributions, such as in the birth interval distributions, it can be shown that the distribution of residues will be more or less uniform. It can be shown that the distribution of residues is more or less uniform using the measure of departure from uniformity defined (See appendix A).

In the first case if the observed frequencies or the number of intervals with the residue number 1, 2, ... 12 are denoted by $f_1, f_2 \ldots f_{12}$ and the total is denoted by f, then under the null hypothesis that there is no digit preference, the quotient:-

$$q_1 = \sum_{i=1}^{12} \frac{|12f_i - f|}{f}.$$

should be approximately zero. If all of them get concentrated in one residual digit, one of the f_i will equal f and the remaining f_i's will be zero making the q_1 value equal to 22. Thus the minimum value of q_1 will be zero and the maximum will be 22. If we take $Q1 = q_1/22$, then Q1 can be considered to be digit preference quotient taking values 0 to 1, the value 0 being taken when there is absolutely no digit preference and the value 1 taken when all the birth intervals are in multiples of 12 months.

Similarly, for the second case, we can compute another digit preference quotient on the basis of six-monthly preferences instead of twelve monthly preferences based on

$Q_2 = q_2/10$

Where

$$q_2 = \frac{\sum_{i=1}^{6} |12f_i - f|.}{f}$$

Where f_i is the frequency of intervals which leave a residue of *i* when divided by 6, and f is the total number of intervals.Q2 takes value 0 to 1.

Table 4.4 Digit preference Quotients (DPQ), Q_1 (12 monthly) and Q_2 (6 monthly) for Different Birth intervals.

Types of intervals	DPQ1(12 monthly)	DPQ2 (6 monthly)	DPQ2 (6 monthly)
LCBI	0.039 (4994)	0.042(2623)	0.026(2371)
ABI	0.039 (13693)	0.028 (7314)	0.020(6379)
OBI	0.025 (1193)	0.033 (598)	0.021 (595)

Note: Figures in brackets indicate the number of intervals in which the Digit Preference Quotients have been computed.

Table 4.4 shows that the extent of digit preference, in the Q1 value is least in open birth intervals and highest in both last closed birth intervals and all birth intervals. DPQ1 values were found to be highest in both last closed birth interval and all birth intervals with a value 3.9 per cent. For open birth interval the value was 2.5 which depicted the least value. DPQ2 values for the three types of intervals are found to be 4.2 per cent and 2.6 percent for last closed birth interval, 2.8 per cent and 2 per cent for all birth intervals and 3.3 percent and 2.1 per cent for open birth interval. The low values for these quotients are really striking. These are indicative of high quality data for a developing country, and is indeed a compliment to the care and efficiency with which the survey was conducted.

Considering the values of q1 and q2 (refer to appendix A), (Tables A1 to A9) under the null hypothesis stated above. The value q1 for last closed birth interval is 0.856 and is the same for all birth intervals but higher than the open birth interval which gives a value of 0.545. This shows that there is slightly higher digit preference in last closed birth interval and all birth intervals than open birth interval. Similarly, for q_2 and under the category for 1 to 6 months, q_2 values for last closed birth interval is higher than the values of both open birth interval and all birth intervals. The value for all closed birth interval was 0.423, for the open birth interval being 0.328 and for all birth interval being 0.276 which was the least value. Again it shows a slightly higher digit preference in last closed birth interval compared to both open birth interval and all birth intervals, though the values are low which indicate a reasonable quality of data. Under the category of 7 to 12 months, the values of q2 are higher for the open birth interval, followed by all birth intervals and least in all closed birth interval. The values are 0.212, 0.204 and 0.026 respectively. Thus comparing the q_2's for the two categories, the results shows that there is a higher digit preference in the first category i.e. first 6 months compared to the second category of 7 to 12 months.

From table 4.4 we point out that the level of digit preference is not as low though the values of DPQ1 and DPQ2 are all lower than 50 percent. This should be taken into consideration when interpreting the results.

In conclusion, the data was observed to be positively skewed when histogram analysis was used, thus, none of the variables was symmetrically distributed. Considering the extent of imputation of vital events the data suggest that a low percentage of vital events were missing hence good quality of data. On the state of digit preference the values of DPQ1 and DPQ2 were found to be lower than 50 percent in all the intervals. Thus the quality of data was fair.

CHAPTER FIVE

ESTIMATES OF PARITY PROGRESSION RATIOS.

5.1 Introduction

This chapter focuses on the application of the model. The study aims at linking the calculated PPR's (which is a measure of the pace of childbearing) and the birth-intervals in order to give an understanding of tempo fertility in Kenya. This chapter discusses the pace of childbearing as measured by the parity progression ratios and birth interval analysis.

5.2 Estimation of PPR

Table 5.1 below provides the data set used in the application of the model. E (Ui) is the mean truncated open birth interval distribution of women with parity (i), which provides the mean open birth interval. The variable V222 in the KDHS defined as the interval between the last birth and the date of the interview in months the base being respondents who have had one or more births is used to compute the mean open birth interval in years. E(Ti) is the mean closed birth interval distributed according to women of parity (i). The variable B11 in the KDHS defined as the preceding birth interval calculated as the difference in months between the current birth and the previous birth, counting twins as one birth the base being all births except the first birth and its twins is used to compute this first raw moment for each parity (i) in years. VAR (Ti) is the variance of the closed birth interval for each parity (i) which is obtained by running descriptive statistics.

Table 5.1: Mean Open and Closed Birth Intervals by Parity

Parity (i)	E(Ui) years	E(Ti) Years	VAR(Ti)
1	2.7702	0.0000	0.0000
2	3.3271	3.4425	4.5051
3	3.4470	3.7260	6.0052
4	3.7282	3.5690	5.6323
5	3.7829	3.7383	5.6407
6	4.2423	3.5693	5.3687
7	4.0698	3.4214	4.1714
8	4.4058	3.1978	3.8676
9	4.9934	3.1316	2.8653

Source: KDHS 2003

The value of C=13 years and this represents the number of years for which the progression from *i*-th birth to (*i*+1)-th birth by every woman is very negligible. The sample of birth intervals used here is drawn for ever-married women.

5.2.1 Computation Procedure

Step 1

Calculation of the values represented by the formula $C^2 - 2CE(U_i)$ for every parity i. The value of C is 13 years while the values of E (Ui) are contained in column 2 of table 5.1. Thus:-

$$C^2 - 2CE(U_i) = 13^2 - 2 \cdot 13 \cdot 3.3271$$

$$= 82.4945, \quad \text{for parity } i = 2$$

The calculations of the other values in table 5.2 are similarly calculated.

Table 5.2: Table of Results of Step 1

Parity (i)	C^2 -2CE(U_i)
1	96.9754
2	82.4945
3	79.3786
4	72.0674
5	70.6451
6	58.6996
7	63.1860
8	54.4485
9	39.1727

Note: C = 13 years

Source: Computed from the model.

Step 2

Calculation of the values represented by the relationship 2E(U_i) [E(T_i)-C] categorized by the parity i. An illustration of the example is done below.

$$2E(U_i)[E(T_i)-C] = 2*3.3271*[3.4425-13]$$
$$= -63.5981, \text{ for parity } i = 2$$

The values for the expression for all the parities are tabulated in table 5.3

Table 5.3: Table of Values of Step 2

Parity (i)	2E(U_i)[E(T_i)-C]
1	-72.0246
2	-63.5981
3	-63.9346
4	-70.3206
5	-70.0715
6	-80.0162
7	-77.9656
8	-86.3733
9	-98.5525

Source: Computed from the model.

Step 3.

Calculation of the second raw moment of the last closed birth interval for every woman of parity (i). The figures are derived from table 5.1 where we have values for E (T_i) and Var (T_i). This moment is denoted as E (T_i^2) and is obtained by the following relationship.

$$E(T_i^2) = [E(T_i)]^2 + Var(T_i)$$

An illustration is given below.

$E[T_2^2] \quad = \quad (3.4425)^2 + (4.5051)^2$

$\therefore E(T_2^2) \quad = \quad 16.3560$, for parity i = 2

These values are entered in table 5.4

Table 5.4: Table of Second Raw Moment of Closed Birth Interval for Women of Parity (i)

Parity (i)	$E(T_i^2)$
1	0.0000
2	16.3560
3	19.8882
4	18.3703
5	19.6160
6	18.1086
7	15.8772
8	14.0937
9	12.6725

Source: Computed from the model.

Step 4

Calculating the values of C^2 - E (T_i^2). The values of E (T_i^2) are contained in table 5.4. The following example illustrate the computation of these values.

$C^2 - E(T_2^2) \quad = \quad (13)^2 - 16.3560$

$\quad = \quad 152.6440$, for parity i = 2

Table 5.5 shows the values obtained in step 4

Table 5.5: Table of Values in Step 4

Parity (i)	$C^2 - E(T_i^2)$
1	169.0000
2	152.6440
3	149.1118
4	150.6297
5	149.3840
6	150.8914
7	153.1228
8	154.9063
9	156.3275

Source: Computed from the model.

Step 5

Calculation of the sum of values obtained in steps 2 and 4. This provide the denominator of the PPRs (Parity Progression Ratios). An illustration is given by the following example

For parity i = 2

$Den_2 = -63.5981 + 152.6440$

$= 89.0459$, for parity i = 2

Table 5.6 gives the results of this step

Table 5.6: Table of Values in Step 5

Parity (i)	$(2E(U_i)[E(T_i)-C]) + (C^2 - E(T_i^2))$
1	96.9754
2	89.0459
3	85.1772
4	80.3091
5	79.3126
6	70.8752
7	75.1572
8	68.5329
9	57.7750

Source: Computed from the model.

Step 6

Calculation of parity progression ratios (PPRs) for every parity i. These values (PPRs) are computed by dividing the entries in table 5.2 by those in table 5.6. The values of PPR (2), for example is computed as:

$$PPR_{(2)} = \frac{82.4945}{89.0459}$$

$$= 0.9264, \text{ for parity } i = 2$$

Table 5.7 shows the values of table 5.2 and 5.6 and entries of PPR values for every parity (i).

Table 5.7: Table of $PPR_{(i)}$ (National level)

Parity (i)	C^2 -2CE(U_i)	(2E(U_i)[E(T_i)-C]) + (C^2 - E(T_i^2))	$PPR_{(i)} = \alpha_i$
1	96.9754	96.9754	
2	82.4945	89.0459	0.9264
3	79.3786	85.1772	0.9319
4	72.0674	80.3091	0.8974
5	70.6451	79.3126	0.8907
6	58.6996	70.8752	0.8282
7	63.1860	75.1572	0.8407
8	54.4485	68.5329	0.7945
9	39.1727	57.7750	0.6780
MCEB			**5.6884**

Source: Computed from the model.

The tables indicated above i.e. tables 5.2 to 5.7 are summarized in one table as shown in table 5.8

Table 5.8: A Summary of Step One to Step Six

Parity (i)	Table 5.2	Table 5.3	Table 5.4	Table 5.5	Table 5.6	Table 5.7
1	96.9754	-72.0246	0.0000	169.0000	96.9754	
2	82.4945	-63.5981	16.3560	152.6440	89.0459	0.9264
3	79.3786	-63.9346	19.8882	149.1118	85.1772	0.9319
4	72.0674	-70.3206	18.3703	150.6297	80.3091	0.8974
5	70.6451	-70.0715	19.6160	149.3840	79.3126	0.8907
6	58.6996	-80.0162	18.1086	150.8914	70.8752	0.8282
7	63.1860	-77.9656	15.8772	153.1228	75.1572	0.8407
8	54.4485	-86.3733	14.0937	154.9063	68.5329	0.7945
9	39.1727	-98.5525	12.6725	156.3275	57.7750	0.6780

Source: Computed from the model.

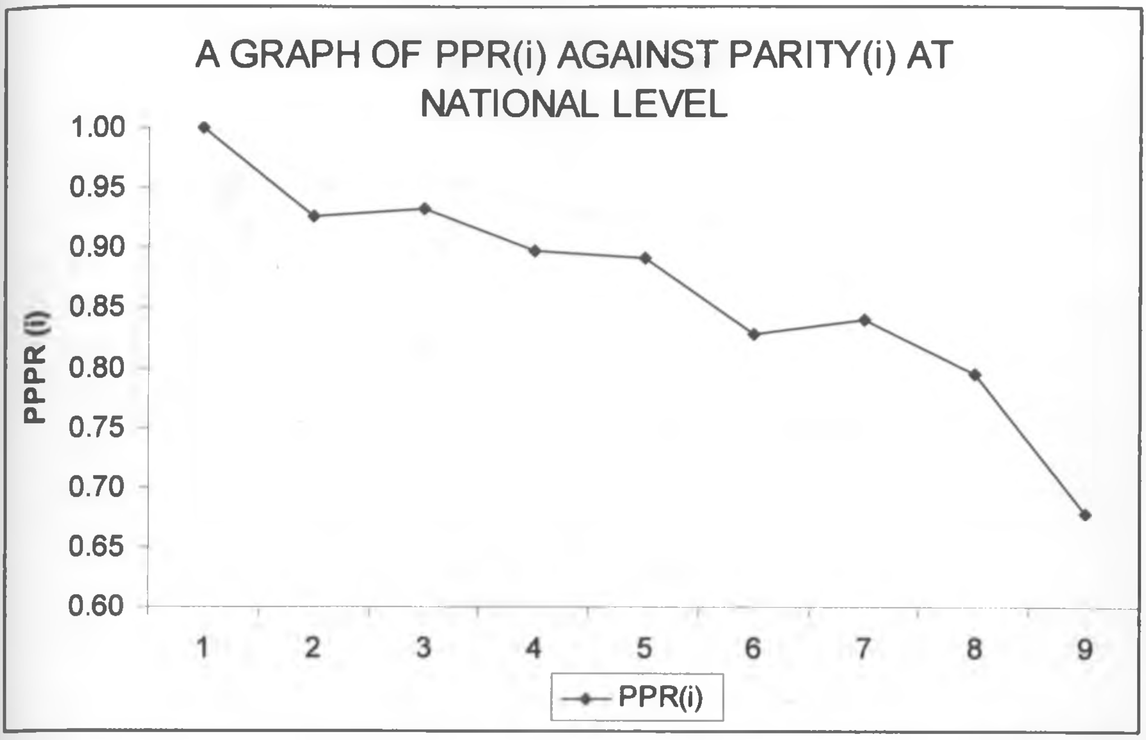
N.B: These values show the IPPRs for women of parity (i) during the period spanned by "C" i.e. 13 years prior to survey date, (1990-2003). Since at parity one there is no information on the last closed birth interval, it is not possible to ascertain the proportion of women who progress to parity one. Moreover, the model considers parities truncated at a specific parity beyond which number of women progressing from the truncated parity (i) to parity (i + 1) is very negligible.

5.3 Discussion of the Results

The results in Table 5.8 provide the picture of Kenya's fertility behaviour. The values show the proportion of women who progress from lower parities to higher parities. The figures suggest that about 79 % of women who had an eighth child progressed to have a ninth child. The results further showed that the national fertility level was 5.688 children per woman.

An examination of PPRs in Table 5.8 indicated the following; approximately 92.6% of those women who had the first child went for the second child. In parity three, the proportion increased to 93%. The proportion of women progressing to parity five, who had a fourth child dropped to 89.7 % and the decline pattern, was observed to continue through parities 5 and 6. This was followed by a slight increase in the proportion of women of parity seven who progressed to parity eight which was 84 % percent. At higher parities, the proportion of women who progressed to the ninth and the tenth child declined i.e. 79% and 67% respectively. The above results are also given in figure 5.1. The high use of contraceptive in marriage is most probably the reason that may have influenced the declines in proportion of women moving in parities 4 to 6 (Yang, 1994). The upsurge at parity seven could be due to age misreporting which possibly pushed many women up across the age group limit or more cases in the higher categories which arose as a result of selection bias in the survey (Lutz, 1989).

Figure 5.1 PPRs at National Level



Source: Drawn from estimates of PPRs computed from KDHS, 2003.

As shown in figure 5.1 above there was an increase in proportion of women proceeding to parity three from parity two, this was followed by a decline in parities four, five and six with an abnormality increase in parity seven and then resumption of the decline in parity eight and nine which indicate rapid decline at higher parities. The graph thus provides a clear picture of fertility behaviour for 2003 period.

Figure 5.2 Comparison of PPR's using 1993 KDHS and 2003 KDHS

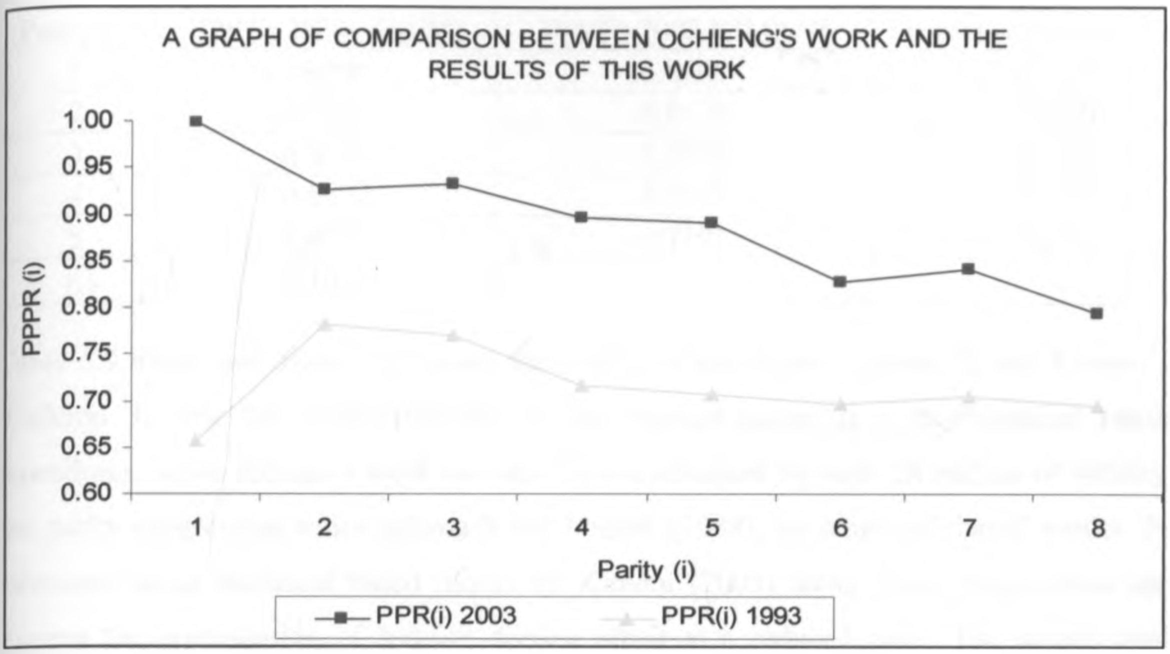


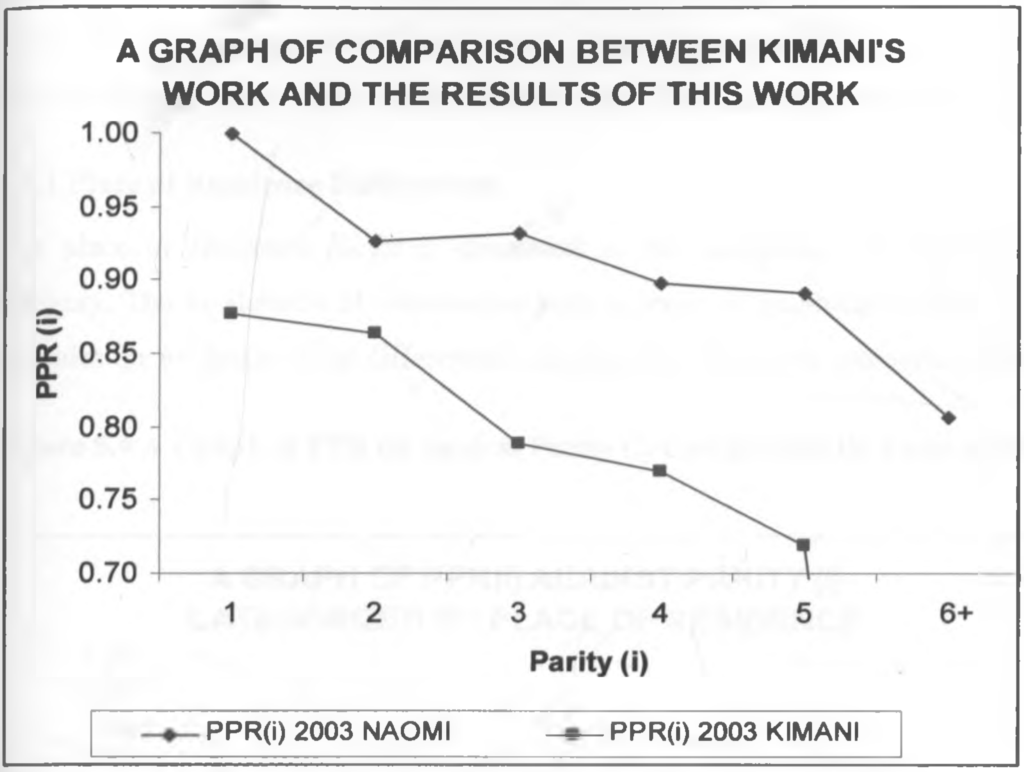
Figure 5.2 shows the comparison of the results obtained in this thesis and the work done by Ochieng (1996) using KDHS 1993 data set. From the results of his analysis it was observed that pace of childbearing (parity progression ratios) at national level dropped steeply from parity two to parity four, the drop was then steady and slow. The values of PPR's were observed to decline, from parity two steadily to parity eight. Similarly, the results of this study depict a steady decline in PPRs apart from the attenuation at parity three and seven which could be attributed by age misreporting or digit preference. According to KDHS 1993, the TFR dropped from a high of 6.7 in 1989 (1989 KDHS) and by 1993 it was 5.4 (KDHS 1993). The drop in the TFR was the fertility decline and indeed a steep one was the focus of the study. This study addresses the gap of the stall in fertility in mid-transition as depicted by the 2003 KDHS survey data. The results show that 2003 had higher values of PPRs across all parities compared to 1993 thus a higher pace of childbearing.

Table 5.9: Comparison of Pattern of PPR's

Parity (i)	PPR(i) 2003 NAOMI	PPR(i) 2003 KIMANI	absolute difference (2)-(3)
1	1.0000	0.8769	0.1231
2	0.9264	0.8638	0.0626
3	0.9319	0.7886	0.1433
4	0.8974	0.7697	0.1277
5	0.8907	0.7191	0.1716
6+	0.8059	-	-

Table 5.9 above and figure 5.2 shows the results of this study (column 2) and Kimani's work (Column 3). For this study (column 2), the applied model is a mathematical (analytical) procedures, while Kimani's work (column 3) was obtained through estimation of fertility using the parity progression ratios approach for Feeney (1989), an empirical based model. Fertility estimates using empirical based model by Kimani (2005) using parity progression approach suggest the continuation of fertility decline albeit at a reduced pace. The results confirmed relatively high fertility in Kenya in comparison with countries which have completed transition. For instance, progression to higher parities still remains high; the progression from 5^{th} to 6^{th} birth is about 78 percent. This implies that among the women who attain parity nearly 80 percent of them continue to parity 6. Moreover, the results of this study confirms high fertility in Kenya and progression to higher parities remains high i.e. the results of this study reflects that approximately 81 percent of the ever married women progress to have six children and more. Moreover, the results show a decline from parity one through parity two with an abnormal increase in parity three and then a resumption of the decline in parity four through parity six and above albeit at a reduced pace. It is important to note that while the differences in the approaches exist but the results show the same patterns in terms of trends across the parities.

Figure 5.3 Comparison of Pattern of PPRs



Source: Drawn from estimates of PPRs computed from KDHS, 2003.

Figure 5.2 above shows a decline from parity one through parity two with an abnormal increase in parity three which is depicted by the results of this work, while Kimani's work depicts an abnormal great decline in parity three. This is followed by a resumption of the decline in parity four through parity six and above. The graphs shows that the results are plausible since the same patterns in terms of trends across the parities is shown, however, apart from parity three where the results of this work shows an abnormal increase in the proportion of women who move to parity three while Kimani's work depict an abnormal decrease in the proportion of women who move to parity three.

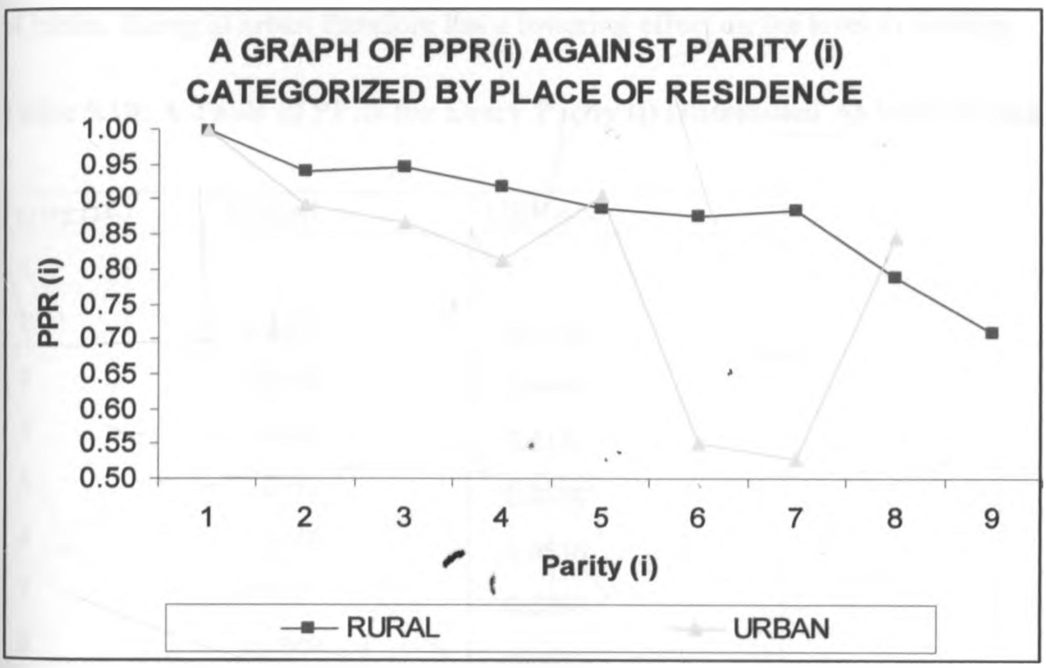
5.4 Differentials in PPR's.

The aim of this analysis is to obtain a clear picture of the fertility situation when various groups in the population under study are focused. It provides detailed information about the pace of childbearing in every cohort categorized by age and selected socio-economic factors.

5.4.1 Place of Residence Differentials

The place of residence factor is discussed in two categories i.e. rural category and urban category. The availability of information both in terms of graphical evidence and tabular values provides the evidence of the differentials displayed by these two categories in the fertility study.

Figure 5.4 A Graph of PPR (i) Against Parity (i) Categorized By Place of Residence



The evidence provided by figure 5.3 shows that rural category had higher value of PPR generally compared to urban category. The rural category depicts a decline in PPR from parity one to two which is followed by an abnormal increase of 0.6 percent of the women who proceed to parity three and a resumption of the decline in the PPR from parity four through six and an abnormal slight increase from parity six to seven, after which a steep decline in PPR is resumed from parity eight through nine and higher order parities. For the urban category, PPR is shown to fall steadily from parity one through four and an abnormal upsurge at parity five which accounts for nine percent increase in proportion of women who progress to parity five. This is followed by a sudden rapid decline in parities six and seven and an abnormal upsurge in parity eight. These results therefore show that the rural women have a high pace of childbearing compared to their urban counterparts. While there was no women progressing to parity nine for those who reside in urban area, a large proportion of approximately 71 percent of the ever married women residing in rural area progressed to have a ninth child. At parity five the PPR for both the rural and urban category were almost at par with 89 percent of the rural ever married women proceeding to parity five and 90 percent of the urban women proceeding to parity five. This indicates a high pace of childbearing of the urban women in parity five. Thus the sudden stoppage at urban areas could be attributed to limiting of family sizes while the high pace of childbearing at rural areas could be associated with short birth intervals and low pace of childbearing in urban could be due to long birth intervals as urban women tend to be more receptive to family planning for limiting of births. Being in urban therefore has a lowering effect on the level of fertility.

Table 5.10: A Table of PPRs for Every Parity (i) Distributed As Place of Residence

Parity (i)	RURAL	URBAN
1		
2	0.9400	0.8928
3	0.9462	0.8682
4	0.9193	0.8141
5	0.8872	0.9030
6	0.8748	0.5516
7	0.8837	0.5290
8	0.7869	0.8450
9	0.7088	*
MCEB	**6.0091**	**4.4897**

Source: Computed from the model.

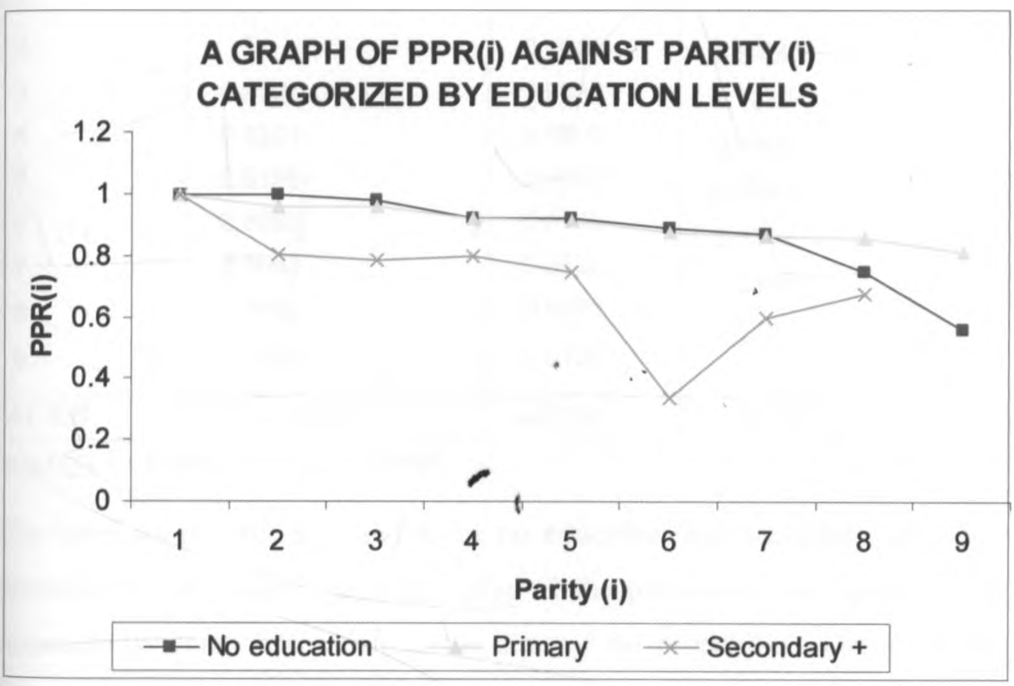
Table 5.10 above shows that rural category had higher value of PPR generally compared to urban category. Since at parity one there is no information on the last closed birth interval, it was not possible to ascertain the proportion of women who progress to parity one. While 71 percent of the rural women progressed to get a ninth child, only 53 percent progressed to have a seventh child and there was no ninth child for the urban category. Moreover, the mean Children Ever Born value was higher in the rural area with a value of 6.0 unlike in the urban which was 4.5.

Considering the place of residence factor, the value of MCEB (4.4897) for the ever married women in the urban is lower than the value MCEB (6.0091) for the ever married rural women and this further confirms that the urban women had an early stopping of childbearing.

5.4.2 Educational Differentials

Respondents education level was categorized in (no education, primary and Secondary and above). The results of PPR's are shown in Figure 5.4 and Table 5.11.

Figure 5.5 A Graph of PPR (i) Against Parity (i) Categorized By Education Level



Source: Drawn from estimates of PPRs computed from the model.

The evidence provided by Figure 5.4 above shows that the secondary and above category of education had a low propensity of childbearing in all the parities than the other two categories. Although the graphs displayed attenuation in parity seven from a drop in parity six, the overall trend showed a steep and sudden decline from high values in the lower parities. The attenuation in parity seven could be attributed to errors such as age misreporting or digit preference. While the steep drop in parity six could be associated with stopping in childbearing. One may argue that the steep drop may have been caused by age selection effect that reduced the size of data for women in that parity. For the primary category of education, apart from the small upsurge in the proportion of women who progress from parity two to three, the category depicts a steady decline in the proportion of women who move to higher parities. Moreover, the ever married women who had no education depicted a steep decline in the proportion of women who progressed to parity eight and nine. Thus, the pace of childbearing remained high for those with no education and primary education categories and many still progressed to nine plus parities.

Table 5.11: A Table of PPRs for Every Parity (i) Distributed by Education Levels

Parity (i)	No education	Primary	Secondary +
1			
2	*	0.9600	0.8059
3	0.9783	0.9632	0.7831
4	0.9221	0.9209	0.7963
5	0.9198	0.9153	0.7443
6	0.8890	0.8745	0.3348
7	0.8663	0.8625	0.5990
8	0.7452	0.8592	0.6755
9	0.5594	0.8133	*
MCEB	**6.7319**	**6.2903**	**3.5643**

Source: Computed from the model

The asterisks at parities 2 and 9 for no education and secondary and above level shows the limitation of the model since the value of the probability was greater than one and negative respectively which is contrary to the laws of the probability. This could not offer meaningful interpretation of the fertility level at those parities.

Table 5.11 provides the value of PPRs distributed with parities for every educational categories. Generally, secondary category and above had a low propensity of childbearing in all the parities than the other two categories. Proportion of women who had two children were 81 percent and the proportion of women who progressed to parity three declined to 78 percent this is followed by a slight increase in proportion of women who progress to parity four and the decline in PPR is resumed at parity five and at parity six there is a steep decline in the PPR which is followed by an upsurge in parity seven and eight. Although the graphs displayed attenuation in parity seven from a drop in parity six, the overall trend showed a steep and sudden decline from high values in the lower parities. The attenuation in parity seven could be attributed to errors such as age misreporting or digit preference. While the steep drop in parity six could be associated with stopping in childbearing. One may argue that the steep drop may have been caused by age selection effect that reduced the size of data for women in that parity. For the primary category of education, apart from the small upsurge in the proportion of women who progress from parity two to three, the category depicts a steady decline in the proportion of women who move to higher parities. This is also the case with ever married women who had no education with a steep decline being depicted in the proportion of women who progress to parity eight and nine. Thus, the pace of childbearing remained high for those with no education and primary education categories and many still progressed to nine plus parities. The low value of Mean Children Ever Born (3.5643) of the secondary category supports the findings that women with secondary education stop childbearing earlier. The findings also suggest that women falling in the No education category had the highest value MCEB (6.7319) followed by those with primary education with the value of MCEB being (6.2903).These results agree with the results obtained by the conventional methods.

5.4.3 Region of Residence Differentials,

The PPRs are estimated for eight regions i.e. Nairobi, Central, Coast, Eastern, Nyanza, R. Valley, Western and N. Eastern. Generally fertility patterns by region of residence indicates continuation of fertility decline though at a reduced pace apart from attenuations at specific parities which could be attributed to errors such as age reporting or digit preference.

Table 5.12: PPRs by Regions

Parity (i)	Nairobi	Central	Coast	Eastern	Nyanza	R. Valley	Western	N. Eastern
1								
2	0.837	0.817	*	0.908	0.943	0.975	0.942	0.929
3	0.933	0.720	0.909	0.958	0.928	0.971	0.979	0.966
4	0.847	0.745	0.889	0.943	0.902	0.913	0.939	0.958
5	0.957	0.646	0.835	0.929	0.851	0.960	0.876	0.954
6	0.522	0.688	0.724	0.868	0.763	0.919	0.668	0.953
7	*	0.626	0.921	0.823	0.770	0.893	0.877	0.889
8	0.808	0.297	0.765	0.660	0.853	0.806	0.793	0.874
9	*	*	0.756	0.809	0.552	0.712	0.506	0.755
MCEB	**4.189**	**3.480**	**5.741**	**5.928**	**5.526**	**6.607**	**5.797**	**6.591**

Source: Computed from the model

The asterisks at parities 2, 7 and 9 for Nairobi, Central and Coast provinces shows the limitation of the model since the values of the probabilities were greater than one and negative in some cases which is contrary to the laws of probability. This could not offer meaningful interpretation of the fertility level at those parities.

Table 5.12 above provides the values of PPRs distributed by parities for every region of residence of the respondents. Generally, parity progression ratios in all the regions depict high fertility in Kenya. We observe at low order parities for example, that the progression from 2nd to 3rd birth is about 93 percent for respondents in Nairobi province, 72 percent for Central, 91 percent for Coast, 96 percent for Eastern, 93 percent for Nyanza, 97 percent for Rift Valley and North Eastern. This is a clear indication of high fertility levels at low order parities. Fertility patterns by region of residence also indicates continuation of fertility decline though at a reduced pace apart from attenuations at specific parities which could be attributed to errors such as age reporting or digit preference. Progression to higher parities still remains high in most regions. We observe, for instance, that the progression from 7th to 8th birth was least in Central province with only 30 percent of the women progressing to have an eighth child, this was followed by women in Eastern province with a value of 66 percent and Western at 79 percent. The remaining regions depicted a value of 80 percent and above. This confirms the fact that, progression to higher parities still remains high in all regions apart from Central province.

Analysis of region of residence shows that ever married women in Central province depicted the lowest value of MCEB (3.4803), which is followed by Nairobi province with the value of MCEB being (4.1891).The highest value of MCEB is depicted in Rift valley province with a value of MCEB (6.6074), which is closely followed by North Eastern province with MCEB being (6.5908).

5.5 Analysis by Differentials Using MCEB

Examining the relations between the mean children ever born (MCEB) and the factors (educational level, type of place of residence and region of residence) included in the study, the results supports the findings that has been discussed already and thus consistent with those of PPRs.

5.6 Birth- Interval and Its Relation to Pace of Childbearing.

Table 5.1 provided the national mean birth intervals which were used to determine the process of childbearing and hence fertility level as measured by the quantum of family size. The intervals given are both the last closed birth interval (LCBI) and open birth intervals (OBI) which are distributed with respect to parities. The lengths of the intervals were observed to be about five years and below up to about three years for OBI and for LCBI the interval ranged between three to four years. The lengths of open birth interval was slightly higher at higher order parities, while the length of the last closed birth interval was slightly higher at lower parities as compared to high order parities. The longer duration of open birth interval is an indication of stoppage in childbearing while the shorter birth interval is an indication of the tempo of childbearing among the ever married women. A study of birth interval differentials therefore stands to provide an insight on the relationship.

5.7 Birth – Interval Differentials

The analysis of the birth intervals and their influence on the level of fertility with references to educational levels, type of place of residence, region of residence and age group of the respondent were considered important for the purpose of policy design and implementation.

5.7.1 Educational Differentials

According to the levels of education levels considered (no education, primary and secondary +) the table below provides the distributions of LCBI, OBI and ACBI with respect to parities. The LCBI distributions showed a constant rate of 3 years (36 months) for those with no education and primary level of education while those with secondary and above level of education depicted an interval of approximately 4 years. For the open birth interval, those with secondary and above level of education and those with no education showed a longer birth interval of approximately 4 years while those with primary education depicted an interval of approximately three years. ACBI showed almost constant lengths of three years for all the ever married women regardless of the education level. Table 5.14 below displays the distributions of the mean intervals against education levels.

Table 5.13 A Table of Mean Birth Intervals against Educational Levels

Educational Level	LCBI (YEARS)	OBI (YEARS)	ACBI(YEARS)
No education	3.1742	3.5354	2.6765
Primary	3.4561	3.2606	3.0299
Secondary +	3.9344	4.3469	3.4938

Source: Computed from 2003 KDHS

Table 5.14 above shows that all the birth intervals for the Secondary and above were the longest, followed by the ever married women with primary level of education and the shortest birth intervals were depicted among the ever married women with no education. Clearly, the higher the education level, the longer the birth interval and the lower the fertility level. Thus those with no education level showed a higher speed of childbearing compared to those with secondary and above level of education.

5.7.2 Place of Residence Differentials

When the place of residence (urban and rural) were considered, it was observed that for all parities the length of all birth intervals (LCBI, OBI and ACBI) were longer for the ever married women who reside in the urban, compared to those residing in rural areas, with the values of the last closed birth interval and open birth interval being approximately four years and all closed birth intervals being approximately three years. For the ever married women residing in the rural, all the three types of birth intervals considered depicted a value of approximately three years. Thus the rural women displayed a higher speed of child bearing.

Table 5.14 A Table of Mean Birth Intervals against Place of Residence

Place of Residence	LCBI (YEARS)	OBI (YEARS)	ACBI(YEARS)
Urban	3.8125	4.0424	3.2656
Rural	3.4017	3.4140	2.9454

Source: Computed from 2003 KDHS

According to table 5.15 above, the mean length of all the three types of birth intervals for ever married urban women was found to be longer than their counterparts. Thus rural women displayed a higher speed of childbearing.

5.7.3 Region of Residence Differentials

When the region of residence was considered, it was observed that for all parities the mean lengths of all the three types of birth intervals were shorter for all the ever married women in the North Eastern province and longer for the women in Central and Nairobi provinces. This is shown in the table below.

Table 5.15 A Table of Mean Birth Intervals against Region of Residence

Region of residence	LCBI (YEARS)	OBI (YEARS)	ACBI(YEARS)
Nairobi	4.0436	4.0297	3.5230
Central	4.1436	4.4171	3.6653
Coast	3.5689	3.5315	3.0546
Eastern	3.8506	3.6384	3.2418
Nyanza	3.3326	3.6105	2.9027
R. Valley	3.2422	3.0354	2.9439
Western	3.0907	3.3878	2.8267
N. Eastern	2.6610	3.0013	2.2407

Table 5.16 above shows that Nairobi, Central, Coast and Eastern provinces had the longest mean birth interval for the last closed birth interval of approximately four years while Nyanza, R. Valley, Western and N. Eastern provinces depicted a shorter last closed birth interval of approximately three years. Moreover for the open birth interval the first five provinces showed a

longer birth interval of approximately four years and the last three depicted a shorter interval of three years. For the mean of all closed birth interval Nairobi and Central provinces showed the longest mean birth intervals of approximately four years and the shortest was depicted by women in the North Eastern province with a value of approximately two years, while the rest provinces showed an interval of three years each. Generally, North Eastern province depicts shorter birth interval in all the three types of birth intervals considered implying a higher speed of childbearing among the ever married women in that province unlike their counterparts in Nairobi and Central who show a long mean birth interval for all the categories considered.

In conclusion, a general examination at the speed or proportion of women progressing to the next birth or parities by education level, type of place of residence and region of residence, various trends were observed. Rural category had higher value of PPR generally compared to urban category. Thus, rural women had a high pace of childbearing compared to their urban counterparts. While there was a sudden drop in the pace of childbearing for urban women, the rural women progressed to parity nine plus at a higher pace of child bearing. The sudden drop could be attributed to limiting of family sizes through the contraceptive use or infecundability due to natural causes, while the high pace of childbearing could be associated with short birth intervals. Thus, being in urban has a lowering effect on the level of fertility. The secondary and above category of education had a low propensity of childbearing in all the parities than any other group. The attenuation in parity seven could be attributed to errors such as age misreporting or digit preference. While the steep drop in parity six could be associated with stopping in childbearing. The age factor provided no clear pattern of process as measured by PPRs.

The low value of Mean Children Ever Born (3.5643) for the educational category of the secondary and above supports the findings that women with secondary education stop childbearing earlier. Moreover, the value of MCEB (4.4897) for the ever married women in the urban was lower than the value MCEB (6.0091) for the ever married rural women and this further confirms that the urban women had an early stopping of childbearing. Analysis of region of residence showed that ever married women in Central province depicted the lowest value of MCEB (3.4803), which is followed by Nairobi province with the value of MCEB being

(4.1891).The highest value of MCEB is depicted in Rift valley province with a value of MCEB (6.6074), which is closely followed by North Eastern province with MCEB being (6.5908).

All the birth intervals for the Secondary and above were the longest, followed by the ever married women with primary level of education and the shortest birth intervals were depicted among the ever married women with no education. The mean length of ACBI was noted as 3.49 years for those with secondary and above category of education while the mean for those with no education and primary level of education was 2.6765 and 3.0299 respectively which were found to be slightly shorter. Clearly, the higher the education level, the longer the birth interval and the lower the fertility level. Thus those with no education level showed a higher speed of childbearing compared to those with secondary and above level of education. The mean lengths of ACBI birth intervals for ever married urban women was found to be 3.27 years which was longer than their counterparts that depicted a value of 2.95 years. Thus rural women displayed a higher speed of childbearing. Generally, North Eastern province depicted shorter birth intervals in all the three types of birth intervals considered i.e. LCBI (2.66), OBI (3.00) and ACBI (2.24). Implying a higher speed of childbearing among the ever married women in that province unlike their counterparts in Nairobi and Central who showed a long mean birth interval for all the categories considered i.e. LCBI (4.0436), OBI (4.03) and ACBI (3.52), LCBI (4.1436), OBI (4.42) and ACBI (3.67) respectively. Further analysis of age differentials by the three types of birth intervals showed that women aged between 15-34 years had shorter birth intervals unlike their counterparts who were aged 35-49 years.

In summary, this chapter analyzed the pace of childbearing (PPR's), quantum of family size (MCEB) and the tempo of childbearing (birth spacing). All these analyses helps to determine the level of fertility. The study also focused on background factors such as educational level, place of residence and region of residence to determine the group differences.

From the three categories discussed above, one can conclusively say that the fertility level in Kenya depended largely on limitation of family size rather than birth spacing.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter discusses the summary of the research findings, conclusion and recommendations for both policy makers and further research. These recommendations are made on the basis of the findings.

6.2 Summary of the Findings

The aim of this study was to examine the Kenya's tempo of fertility through birth interval dynamics and the parity progression schedule using data from the 2003 Kenya Demographic and Health Survey (KDHS). Specifically, the study sought to estimate parity progression ratios for each parity using birth intervals and to examine the differentials in parity progression ratios and birth interval distribution according to educational level, place of residence and region of residence.

To achieve the above objectives, Yadav and Bhattacharya's modification to Srinivasan model was applied in estimating the proportion of women progressing from parity (i) to parity (i+1). The procedure was based on the information of birth interval distribution for women categorized by the number of children ever born which was defined throughout the study as parity (i). The birth interval distribution used here were open birth interval and the last closed birth interval. Analysis of differentials using PPRs and birth intervals of the selected socio-economic variables was undertaken to obtain a clear picture of the fertility situation. Extensive assessment of the data prior to its utilization revealed that it was of fairly high quality.

At national level, the values of PPR's ranged between 0.9319 at parity (3) and 0.6780 at parity (9). Since at parity one there was no information on the last closed birth interval, it was not possible to ascertain the proportion of women who progressed to parity one. Approximately 92.6 % of those women who had the first child progressed to have a second child. Moreover, the proportion of women who progressed to parity three increased to 93.2 % .On the contrary, the proportion of women progressing to parity four, dropped to 89.7 % and the decline pattern was observed to continue through parities 5 and 6. This was followed by a slight increase in the proportion of women who progressed to parity seven which was 84.1 % percent. The proportion of women who progressed to the eighth and the ninth child declined further to 79.5 % and 67.8 % respectively.

The results due to type of place of residence were analyzed in two categories identified as rural and urban. It was noted that generally, rural women had a high pace of childbearing compared to their urban counterparts. Under the rural category, the results were very unstable. While 71 percent of the rural women progressed to get a ninth child, only 53 percent progressed to have a seventh child and there was no ninth child for the urban category.

The results by educational levels show that the secondary and above category had a low propensity of childbearing in all the parities than the other two categories. Although the graphs displayed attenuation in parity seven from a drop in parity six, the overall trend showed a steep and sudden decline from high values in the lower parities. Primary category provided the values of PPR's falling between 0.9600 for parity (2) and 0.8133 for parity (9). While those no education category the PPR's values fell between 0.9783 for parity (3) and 0.5594 for parity (9). For the primary category of education, apart from the small upsurge in the proportion of women who progress from parity two to three in the primary category, the categories depicted steady decline in the proportion of women who moved to higher parities (parities eight and nine). Moreover, the ever married women who had no education also depicted a steep decline in the proportion of women who progress to parity eight and nine with values of 75% and 56% respectively. Thus both no education and primary categories reflect almost a similar pattern on the pace of childbearing. The pace remained high for those two categories and many still progressed to nine plus parities.

Analysis by region of residence showed a continuation of fertility decline though at a reduced pace apart from attenuations at specific parities which could be attributed to errors such as age reporting or digit preference. High fertility levels still persist at low order parities. For example, the least percentage of progressing from 2nd to 3rd birth was depicted in Coast province at 72 percent and all the other regions depicted progression of greater than 90 percent. Progression to higher parities still remains high in most regions. We observe, for instance, that the progression from 7th to 8th birth was least in Central province with only 30 percent of the women progressing to have an eighth child, this was followed by women in Eastern province with a value of 66 percent and Western at 79 percent. The remaining regions depicted values of 80 percent and above. This confirms the fact that, progression to higher parities still remains high in all regions apart from Central province.

MCEB was used as a summary measure for the level of fertility by different socio-economic background factors. Those with secondary education had the lowest value of MCEB (3.56), followed by primary category with a value of MCEB (6.29) and no education category of MCEB (6.73). On the other hand, the urban category had a low value of MCEB (4.49) and the rural category had a value of MCEB (6.01). Moreover, analysis of region of residence showed that ever married women in Central province depicted the lowest value of MCEB (3.4803), which is followed by Nairobi province with the value of MCEB being (4.1891).The highest value of MCEB was depicted in Rift valley province with a value of MCEB (6.6074), which is closely followed by North Eastern province with MCEB being (6.5908). These values were used to estimate differences in quantum of childbearing.

Analysis of the speed of childbearing as measured by birth spacing showed that among the educational levels, no education category depicted the highest speed (tempo) of childbearing with the shortest mean birth interval values of LCBI (3.2 years), followed by those with primary education at 3.5 years and the longest being for those with secondary at 3.9 years. The duration was also short for the open birth interval for those with no education at OBI (3.5 years), primary 3.3 years and secondary 4.3 years. Similarly, the same observation was made among the rural women. They also showed a higher speed of childbearing with a birth spacing of LCBI (3.40 years) and OBI of (3.41).While women in the urban depicted a longer mean birth interval of LCBI (3.81 years) and OBI (4.04 years). Nairobi and Central provinces showed the longest mean birth intervals of approximately four years and the shortest was depicted by women in the North Eastern province with a value of approximately two years, while the rest provinces showed an interval of three years each. Generally, North Eastern province depicts shorter birth interval in all the three types of birth intervals considered implying a higher speed of childbearing.

6.3 Conclusion

One of the objectives of this study was to estimate parity progression ratios for each parity using birth intervals. The key conclusions from the findings of the estimates of the parity progression ratios and their behavior across the parities reveal fertility decline though the pace and quantum of childbearing remained high. This is an indication of high fertility in Kenya and higher proportion of women progressing to higher order births.

The second objective was to examine the differentials in parity progression ratios according to educational level, place of residence and region of residence. According to this study's finding the key conclusions are: rural women have high pace of childbearing compared to their urban counterparts. Moreover, secondary and above category of education have low propensity of childbearing in all the parities than the other two categories (no education and primary education). Clearly, education has a negative effect on fertility. Furthermore, region of residence show continuation of fertility decline though at a reduced pace.

The third objective was to examine differentials in birth interval distribution according to educational level, place of residence and region of residence. The key conclusions from the findings discussed above are: Those with no education and primary level of education have the highest speed (tempo) of childbearing and shortest mean birth intervals while women with secondary and above level of education have the longest birth intervals thus low pace of childbearing. Moreover, women who reside in the rural area have a higher speed of childbearing with shorter durations of birth intervals while women in the urban have longer mean birth intervals. Lastly being in a certain region has an influence on the tempo of childbearing for instance, Nairobi and Central provinces showed the longest mean birth intervals and the shortest was depicted by women in the North Eastern province.

6.4 Recommendations

The relationship between ACBI and level of fertility suggest that the long length of LCBI and low value of MCEB among the secondary women may be due to limiting practices encouraged by family planning programmes or shorter time spent during child bearing. Thus the longer inter-birth spacing implies that the family size for those with secondary and above level of education will necessarily be low. Education of women then still remains one of the principal ways at which low fertility can be achieved but this is only possible when it is up to secondary level and above thus policies should be formulated to increase educational opportunities for girls to secondary level and above.

The results depicted a continuous decline in proportion of women progressing from parity 4 through 6 and an upsurge in parities 3 and 7. Further research in those particular parities need to be conducted to establish the reasons for the upsurge in specific parities.

Trends in parity progression ratios could not be established as one data set was used. Further research is recommended to establish the patterns and trends of parity progression ratios using all the data sets that is, (KFS, KDHS 1993, KDHS 1998 and KDHS 2003).

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Appendix A: Digit Preference Quotients Tabulation

This appendix contains Digit preference Quotients (Q1 and Q2) for different types of birth intervals.

Table A1: Digit preference Quotient (DPQ), Q_1 (12 monthly) for Last closed birth interval

Last closed birth interval	fi	12fi-f	/12fi-f/	/12fi-f//f	Q1
1	428	142	142	0.028	0.039
2	400	-194	194	0.039	
3	474	694	694	0.139	
4	483	802	802	0.161	
5	447	370	370	0.074	
6	391	-302	302	0.060	
7	387	-350	350	0.070	
8	415	-14	14	0.003	
9	373	-518	518	0.104	
10	380	-434	434	0.087	
11	389	-326	326	0.065	
12	427	130	130	0.026	
f	**4994**		**q1**	0.856	

Table A2: Digit preference Quotient (DPQ), Q_2 (6 monthly) for Last closed birth interval

Last closed birth interval	fi	6fi-f	/6fi-f/	q_2	Q2
1	428	-55.00	55	0.423	0.042
2	400	-223.00	223		
3	474	221.00	221		
4	483	275.00	275		
5	447	59.00	59		
6	391	-277.00	277		
f	**2623**	**Σ/6fi-f/**	**1110**		

Table A3: Digit preference Quotient (DPQ), Q_2 (6 monthly) for Last closed birth interval

Last closed birth interval	fi	6fi-f	/6fi-f/	q_2	Q2
7	387	-49	49	0.261	0.026
8	415	119	119		
9	373	-133	133		
10	380	-91	91		
11	389	-37	37		
12	427	191	191		
f	**2371**	**Σ/6fi-f/**	**620**		

Table A4: Digit preference Quotient (DPQ), Q_1 (12 monthly) for All birth intervals

All birth intervals	fi	12fi-f	/12fi-f/	/12fi-f//f	Q1
1	1240	1187	1187	0.087	0.039
2	1151	119	119	0.009	
3	1229	1055	1055	0.077	
4	1356	2579	2579	0.188	
5	1197	671	671	0.049	
6	1141	-1	1	0.000	
7	1058	-997	997	0.073	
8	1162	251	251	0.018	
9	1046	-1141	1141	0.083	
10	1073	-817	817	0.060	
11	987	-1849	1849	0.135	
12	1053	-1057	1057	0.077	
f	**13693**		**q_1**	0.856	

Table A5: Digit preference Quotient (DPQ), Q_2 (6 monthly) for Last closed birth interval

All birth intervals	fi	6fi-f	/6fi-f/	q_2	Q2
1	1240	126.00	126	0.276	0.028
2	1151	-408.00	408		
3	1229	60.00	60		
4	1356	822.00	822		
5	1197	-132.00	132		
6	1141	-468.00	468		
f	**7314**	**Σ/6fi-f/**	2016		

Table A6: Digit preference Quotient (DPQ), Q_2 (6 monthly) for Last closed birth interval

All birth intervals	fi	6fi-f	/6fi-f/	q_2	Q2
7	1058	-31	31	0.204	0.020
8	1162	593	593		
9	1046	-103	103		
10	1073	59	59		
11	987	-457	457		
12	1053	-61	61		
f	**6379**	**Σ/6fi-f/**	1304		

Table A7: Digit preference Quotient (DPQ), Q_1 (12 monthly) for Last closed birth interval

open birth interval	fi	12fi-f	/12fi-f/	/12fi-f//f	Q1
1	103	43	43	0.036	0.025
2	104	55	55	0.046	
3	100	7	7	0.006	
4	88	-137	137	0.115	
5	108	103	103	0.086	
6	95	-53	53	0.044	
7	103	43	43	0.036	
8	95	-53	53	0.044	
9	100	7	7	0.006	
10	98	-17	17	0.014	
11	94	-65	65	0.054	
12	105	67	67	0.056	
f	**1193**		**q1**	**0.545**	

Table A8: Digit preference Quotient (DPQ), Q_2 (6 monthly) for Last closed birth interval

open birth interval	fi	6fi-f	/6fi-f/	q_2	Q2
1	103	20.00	20	0.328	0.033
2	104	26.00	26		
3	100	2.00	2		
4	88	-70.00	70		
5	108	50.00	50		
6	95	-28.00	28		
f	**598**		**196**		

Table A9: Digit preference Quotient (DPQ), Q_2 (6 monthly) for Last closed birth interval

open birth interval	fi	6fi-f	/6fi-f/	q_2	Q2
7	103	23	23	0.212	0.021
8	95	-25	25		
9	100	5	5		
10	98	-7	7		
11	94	-31	31		
12	105	35	35		
f	**595**		**126**		