ESTIMATION OF FERTILITY IN KENYA USING PARITY PROGRESSION MODEL

BY

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN POPULATION STUDIES

POPULATION STUDIES AND RESEARCH INSTITUTE,
UNIVERSITY OF NAIROBI.

1996

D E C L A R A T I O N

s Thesis is my original work and has not been presented for a degree in any er University.

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DEDICATION

This Thesis is dedicated to My Parents, Maurice Mbai and Catherine Atieno, My Wife, Julita and Children, Belinda, Cynthia and Joan and My Brothers and Sisters.

ACKNOWLEDGEMENT

I am grateful to the UNFPA and the University of Nairobi for the financial assistance that has enabled me to undertake a full time study for the degree of Master of Science in Population Studies at the University of Nairobi.

I am greatly indebted to DR. Kimani. M. my principal supervisor, for his effort, guidance, encouragement and keen supervision throughout the study.

I am also very thankful to my second supervisor, Mr. T. A . Otieno, for his devotion and encouraging advice.

I appreciate the co-operation and assistance given to me by the entire staff and students at the Population Studies and Research Institute (PSRI). I would like to thank Prof. J. Oucho, the outgoing Director of the PSRI, for his outstanding leadership that enabled us to have access to the relevant facilities for our training. I extend also my warm appreciation to Prof J.A.M Otieno who spent his time to help me build the model of analysis, also I extend my thanks to Mrs Ruphine Chero and Mrs Agness Orudo for their tireless assistance in computer services.

Finally, my utmost appreciation is due to my parents my brother,

DR. C. O. Mbai, and my wife and children for their support and encouragement.

ABSTRACT

The study was intended to estimate Kenya's fertility from information derived from 1993 KDHS. The measurements used herein are parity progression ratios (pace of childbearing), the mean children ever-born (quantum of childbearing) and the mean length of birth intervals. It (study) was also meant to analyse the applicability of the model to the Kenya's data.

The model used in the analysis to obtain the estimates was parity progression model developed by Yadav - Bhattacharya a modification of Srinivasan model. This model require information on closed birth interval specifically the last birth interval and open birth interval distribution respectively. The last birth interval was considered because it is more recent and therefore fairly reliable.

The derivation of method is presented in chapter three while the application and discussion of the results is contained in chapter five. Chapter two outlines literature review of the previous studies while chapter four deals with the quality of data and chapter seven contains summary, conclusion and recommendations.

The quality of data was established to be fairly high. 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 moved from 0.78228 in parity two to 0.69574 in parity eight .

The level of fertility measured by MCEB was 3.51 per woman. According to the measures obtained by other background characteristics i.e age cohorts, educational levels and place of residence showed consistent results as the ones given by conventional methods.
It was also noted that despite the non - adjustment of the data the model gave reliable results and more so a better understanding of what goes on in the process of fertility change.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

Fertility decline has been the centre of demographic interest in the past half of the century. Many scholars have devoted their studies towards this phenomena to find reasons which can explain the decline. Many of them have taken their time to find out factors (education, place of residence, age, income, occupation, religion etc) that can be considered to be the major causes of the decline. To determine these factors many studies have been done in the fields of economics, sociology, anthropology, psychology and demography. However, studies based on socio-economic, socio-cultural and socio-demographic have tended to dominate most of studies on fertility.

On the other hand demographers have taken the responsibility of developing the accurate measures of fertility based on all possible demographic data available. There has been contention that some measures are abstract and do not relate to the actual childbearing experiences, because of this, some technical demographers have proceeded to develop statistical relations which they believe give accurate relations between demographic variables and fertility levels.

This thesis aims at estimating fertility level in Kenya through analysis of birth-interval dynamics and the parity progression ratios.

The data used was KDHS (1993) that covered approximately 8,000 women excluding areas that are inhabited by a population of less than 4 percent of the country's total population. These areas included North Eastern province and other Northern districts (Samburu and Turkana in Rift Valley province and Isiolo and Marsabit in Eastern province). The results of the study will therefore give a picture of a pace of childbearing.

1.2 PROBLEM STATEMENT

Kenya has sustained a high fertility level, the available data shows the trend and levels since 1969. In 1969 the total Fertility Rate (TFR) was 7.6 (1969 census), in 1979 TFR was 7.9 (1979 census). This figure dropped to 6.7 in 1989 (1989 KDHS) and by 1993 it was 5.4 (KDHS 1993).

The drop from 7.9 live births per woman in 1979 through 6.7 in 1989 to 5.4 in 1993 shows a clear picture of fertility decline and indeed a steep one. This fall raises the question as to what demographic factors are responsible and among which group have these factors played a crucial role?

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 has therefore provided major estimation approach. While the methods in fertility estimation have been considered realistic, the approach of the procedures fails 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 behaviour (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 might not therefore give a measure of tempo of fertility.

In studying the fertility transition it is important to look at the family - building process which can be desegregated 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.

From above the following two problems are outlined :-

1. While fertility transition is known to take a reasonably long time, in Kenya the phenomena has been so sudden i.e the rate at which it happened has been short. This is a problem worth studying.

2. The methodologies used to study fertility levels tends to give conflicting conclusion hence there is a problem of measurement, this problem need to be studied.

1.3 OBJECTIVES OF THE STUDY

The main objective is to study/analyse the Kenya's tempo of fertility using parity progression schedule and birth-interval analysis.

The specific objectives are;

1. To estimate parity progression ratios for each parity (i) since it provides an insight into some of possible changes in both tempo and quantum of fertility during this period of fertility transition in Kenya.

2. To examine the differentials in parity progression ratios according to education level, place of residence and age.

3. To estimate the birth-intervals by parities and to use it to determine the process of pace of childbearing in Kenya.

4. To examine the differentials in birth-interval distribution according to educational level, place of residence and age.

1.4 STUDY RATIONALE

This study desegregate 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 begins with marriage and 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 measure marital fertility while birth intervals measure the speed of occurrence of births.

The desegregation of fertility by parity is useful for comparing the observed with the expected pattern of fertility behaviour, particularly where data quality is suspect. This study focuses on the parity distribution among the ever-married aged 15-49 years and examines 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. Parity progression ratios therefore reflect explicit decisions on the part of women and their families to have or not to have another child.

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 fertility 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. Age reporting remains very poor in many countries of the world (Feeney, 1983)

The PPRs provide 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.

While the conventional TFR is sensitive to inter-cohort changes in age at first birth, which are most likely to result from inter-cohort changes in age at first marriage, it only signifies changes in nuptiality behaviour rather than in fertility behaviour. The TFR calculated from period parity progression ratios (PPRRs) or instantaneous PPRs is far less than sensitive to change in marriage patterns hence reflect a natural fertility situation better than the conventional fertility measures.

Finally, parity progression ratios can provide a better evaluation technique for the family programme efforts.

1.5 SCOPE AND LIMITATION OF THE STUDY

This study focuses a group of ever-married with emphasis on age-group 40-49. In the study of fertility transition it is important to focus on what is happening in the higher order parities, which has the tendency to fall steeply. The study covers a wide part of the country that is occupied by 96% of the country's population, leaving out the entire North Eastern province and other four districts i.e Samburu, Turkana, Isiolo and Marsabit. The survey interviewed 7,540 women between the ages 15 years to 49 years. Owing to the size of the data, the result is generalized to give the picture of the country's fertility pattern.

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

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

1. <u>Age misreporting</u> - the data indicate age heaping in the ages which end with the digits 0 or 5. The digit preferential is likely to push some respondent into or out of the group under focus (KDHS 1993).

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. Some of these women fail to remember some of their dead children who were born alive, while some forget about their living children who do not live with them in the same households.

4. Poor-knowledge about the exact date of births:- The data on date of birth gives evidence on birth spacing which are not exact. Data on date remains poorly reported in developing countries (Feeney, 1988). When data is not accurate, then it is likely to provide a wrong pattern of the PPRs which is a measure of fertility.

1.6. DEFINITION OF CONCEPTS

Parity Progression Ratios: refers to the proportion of women who, having had an ith birth continue or proceed to have an (i+1)th birth after some specific period of time.

Birth Interval -refers to the time between successive live births. They are of two types of birth-intervals, open birth-interval and closed birth-interval.

Open Birth Interval - birth interval is said to be open if the women after having birth (i) never move to (i+1)-th birth.

Closed Birth Interval - birth interval is said to be closed if the i-th birth is followed by (i+1)-th birth.

Mean Children Ever Born - This refers to average parity per woman.

Urban Area - Is a place which has a population of more than 2000 people.

Education - The levels of education are classified into 3 - categories, those who never attended are classified as none, Primary, (1-8) years, Secondary, (9 and above years).

CHAPTER TWO

LITERATURE REVIEW .

2.1 INTRODUCTION

This review focuses on the topic of fertility dynamics with specific emphasis on the measurement techniques. Since the statement of the problem outlined the issue of measurement, the review of this literature is focusing on the parity progression models as tools of analysis in this study. These models are categorized in three forms referred to as life-table, Instantaneous parity progression ratios (IPPRs) and Own-children method. The literature review is therefore divided into three parts. It focuses on the objectives of the reviewed studies, the sources of data that were used in these models and the results obtained.

2.2 LIFE-TABLE

Henry (1953) developed a life-table technique for the analysis of fertility distribution. According to Henry, the 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+1st) birth to women with a given time elapsed since (i)-th birth as their numerators and numbers of parity(i) women by the time elapsed since (i)-th birth as their denominator. According to this a approach a period (t) 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 $q_{i,x,t}$ of the period life table are then defined as

$$q_{i,x,t} = \frac{B_{i,x,t}}{\sum_{Y} N_{i-1,Y,t-x} - \sum_{Y=0} N_{i,y,t-x+y}}$$

where $N_{i,j,k}$ = number of women having an (i)-th birth at duration (j) in period (k). the $q_{i,x,t}$ may by extension be readily obtained for period longer than one month. For a period lasting from month (t_1) to month (t_2), they are then

$$q_{i,x,t1,t2} = \frac{B_{i,x,t1,t2}}{\sum_{t=t_1}^{t_2} [\Sigma_{Ni-1,y,t'x} - \sum_{y=0}^{x-1} N_{i,y,t'-x+Y}]}$$

where $B_{i,x,t1,t2}$, = births of order(i) occurring during the period t_1 to t_2 at duration x months since last birth and $N_{i-1,y,t-x}$ = number of women having a birth of order i-1 at duration Y in month t-x. The period t_1 to t_2 may be a calender year or a series of calender years. This method could also be specified in a bridged form.

Since the conditional $q_{i,x,t1}$, comprise, for a set of progression ratios and a series of calender years, a large body of data, the values are summarized by command of the period parity progression ratio P(i), estimated by the life table proportion having had an additional birth by duration of 10 years.

This method was used by Bhrolchain (1987) to analyse the period parity progression ratios and birth intervals both in England and Wales. The study covered the period between 1941 and 1971. The parity progression can also be used to obtain estimate of a period total fertility rates using the formula

$P_0 + P_0P_1 + P_0P_1P_2 + \ldots\ldots + P_0P_1P_2P_3$ that may be considered an alternative to the conventional age-specific computation. Finally, the contribution of changes in each of the progression ratio to the period variation in this alternative total fertility rate is examined.

The result of the study indicated that the proportion marrying progressed from 0.84 in 1945 to 0.92 in 1969 according to PPPRs figure then dropped to 0.86 in 1970 /71. Progression to first birth for 1951-1970/71 was also high in general. That is, it rose from 0.83 in 1951 to a maximum of 0.92 in 1966 and then fell to 0.88 in 1970/71. Progression from first birth to second moved up from 0.73 in 1945 by 10 percent in 1946 and stayed high in 1947 and then fell to low level of 0.68 in 1952, rising steadily thereafter to fluctuate around 0.85 on 1964-68 before declining to 0.82 in 1970/71. The same behaviour was also noticed by progression to parity three and four respectively. In summary, there were three types of movements observed; A fairly slow drift upwards in the progression to marriage to first birth from the early 1950's to the later 1960's. The change in the ratios from 1951 to the peak year being 5 percent and 10 percent respectively (0.005 and 0.08) absolute; A very steep increase in the propensity to proceed to a second birth, the relative increase in the peak year 1968 over 1951 being 26 percent (0.18 absolute change); lesser increase in the fairly low values of theirs and fourth progression to 1964 of 14 percent and 11 percent (0.08 and 0.05 absolute changes).

Conditional probabilities of first birth show more substantial rises at duration 0-8 months than at later durations up to the mid 1960's and then fell more rapidly at cohort durations, between 9 and 17 months. Conditional probabilities of second birth also show differentials rates of rise and fall, shifting up especially rapidly at duration 12-48 months and falling off somewhat at duration 1-2 years. Third birth probabilities specific to duration show less pronounces movement with respect to rate of rise and fall.

In reference to birth intervals, 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 shows the most substantial change in speed over the period examined, the interval declined by 5 months and then rose slightly, however it levelled off in the later 1960's. Third and fourth intervals showed a smaller decline then does the second interval and each also showed a contraction and later small expansion in dispersion.

The source 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, the last vital event to the mother must occur below age 45 years. From these 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 easily obtained. However, one of the limitations of the method is the unavailability of a complete vital registration system in developing countries and this makes the period analysis unreal indication of the true extent of temporal change.

Henry (1980) modified his original work. This approach provides interval distributions as well as progression ratios. The calculation of period progression ratios is carried as follows. Given a set of age duration or interval - specific probabilities r_E, r_0, r_1, ...for any given year, the expression $1-(1-r_E)(1-r_0).........(1-r_x)$ represents the proportion of women in a hypothetical cohort experiencing event "C" during any given year (y) who will have experienced event "D" by the end of 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 time of occurrence of event "C". Similarly the calculation 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.

This method has been applied to the data from China in 1993 by Feeney and Wang Feng. The main objective was to analyse parity progression and birth interval statistics in relation to the Chinese government birth planning policies. The result of the study indicated that the period progression from marriage to first birth between 1972 and 1981 was very high approximately 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 because of the population policy. The period progression from the first birth to second birth dropped drastically and this perhaps reflected the effectiveness of the one-child policy. The period mean interval also was seen to rise. From the second child to the third child the drop was sharp and this helped to explain the fertility transition in China. The drop was more marked in cities and towns. To understand the levels hence trend over time, the period parities were translated in TFR and the result indicated that the level of six children per women before 1970 dropped to near replacement level in 1990.

The data required can be obtained from fertility surveys which includes date of birth, age at first marriage, pregnancy and contraceptive history. From these histories the birth intervals can be worked out. However the method faces the problem of truncation bias due to age selection. This age selection bias, biases the measured level of progression from first birth to second birth upward. The other limitation is due to reporting adopted children as natural children, this influences the parity progression ratios. In societies where there is strict limitation of family size like China first female births may be reported as adopted children to enable the parents hope to secure a natural son as their official only child.

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. This method allows the computation of completed parity distribution and parity progression ratios on a period basis.

The method was used in the United States of America to analyse fertility trends as evidenced by the distribution of childbearing on a period basis. He (Whelpton) produced a time series for the USA. Comparable statistics have been produced only for Japan. Retherford and Cho (1978) extended the own-children estimation procedure to provide the Whelpton probabilities for China.

The main source of data are vital registration and population registers. These sources provide the details of women birth histories. From these histories the numbers of births by age of mothers and birth orders can be directly obtained. Similarly the numbers of women by age and parity can also be derived from the data. Like other methods it has the following short comings:- The procedure of calculating Whelpton age-parity specific birth probabilities is awkward in practice because of the volume of numbers involved in magnitude 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.

Srinivasan (1980) combined the data on open birth interval from women of parity(i) with the data on the closed interval to prepare a life table. The closed birth interval can be obtained by using the following methods; in the first method it is observed from women of parity (i+1) only as the last closed birth interval (LBI) and in the second method, from women of parity (i+1) and above as all closed birth intervals (i) to (i+1), (ACBI). If the number of completed months of a birth interval is (x), then the ordinal month is taken as (x+1). If C_x denotes the number of closed interval with ordinal month (x) and (0_x), the number of open intervals with the same ordinal month (x) and if

$N_x = C_x + O_x$ then q_x, the probability of an interval getting closed between (x) and (x+1) or during the month (x) is given by

$$q_x = \frac{C_x}{\sum_{y=x}^{w} N_y - \frac{O_x}{2}}$$

Where "w" is the upper limit of the intervals for which data have been observed. The probability that a woman continues in the same parity (i) without progressing to the next parity (i+1) for a period of (x) months after the (i)-th child is given by $l_x = P_0 P_1 \ldots\ldots\ldots P_{x-1} P_x$

since $P_x = 1 - q_x$

This method was applied to Fijian fertility data. From the life table the mean birth interval was calculated using the following relation.

$$T_i = 3(l_{i,0} + l_{i,120}) + 6(l_{i,6} + l_{i,12} + \ldots\ldots + l_{i,114}) \ldots\ldots$$

The life table was worked for each parity separately and for two different closed births. It was also worked out at interval of 6 months up to 120 months.

The results indicated that at the end of 120 months about 20 to 30 percent of the women continued to remain in the same parity. It was observed that for the sake of completeness, the period could have been extended up to 240 months (20 years). The study conducted through the mean values of the birth intervals suggested a systematic increase in the mean values with birth order. The mean interval increased from 49.29 months for parity one to 66.10 months for parity six plus. The reciprocal of the mean values for each parity corresponds closely to the parity specific fertility rates in the population. This was observed to decline as the parities increased and this could be due to the age factor.

The sources of data required for the application of the method are fertility survey or complete vital registration. The source must provide data on the time of occurrence of each of the vital events together with the background characteristics of the woman and her contraceptive and marriage history. This life table technique suffer the problem of selection and truncation. Thus whether we analyse the all closed birth intervals or only the last birth interval the selection and truncation bias continue to operate in them in different manner. Further in the life table approach, the PPRs are relatively difficult to derive from commonly available data, that is, retrospective sample data. Even developed countries with a long history of complete registration, the data usually lack the necessary information on time of last birth (Feeney, 1988).

Chiang Vanden Berg (1982) developed a fertility table which was designed for period analysis to estimate the completed parity distribution implied by observed period parity specific fertility rates and mean ages at birth. A relationship between the maximum likelihood estimators of the parity progression ratio and the parity specific fertility was derived under the assumption that fertility is independent of a woman's age. It was noted that human fertility is governed by a set of fertility intensity functions { $\Lambda_0(x)$, $\Lambda_1(x)$,... } prevailing in a study population. Each $\Lambda_i(x)$ is a function of parity(i) and age(x) within the reproductive period of women. The fertility rate specific for parity(i) for a woman of age (x_i) denoted by r_i was defined as the ratio of the expected number of births of order(i+1) to the expected length of exposure to the risk of having an (i+1)th child. Thus a woman will have a child with a probability P_i and will not have a child with a probability 1-P_i. Therefore, the expected number of children of birth order(i+1) that she will have is P_i. Algebraically P_i is expressed as:

$$P_i = \frac{(X_w - X_i)r_i}{1 + (X_w - X_{i+1})r_i}$$

where X_i is the mean ages for women of parity(i) and X_w is the mean age of women at the end of the reproductive period.

This method was applied to Bihar and Rajasthan fertility survey data. The main objective was to examine the applicability of the method. The results showed that the parity progression ratios in both the states were above one. These values then fell progressively as the order of the parities increased except for higher orders. This inconsistency in the trend of parity progression ratios was attributed to the misreporting of the ages of the mothers at birth.

The main sources of data are vital registration, fertility surveys and censuses while the input data required are numbers of births distributed by birth orders and mean ages at birth of different orders. The mean age at zero parity is considered as the entry of women in the reproductive life. The method has the following limitations:- It faces the problem of truncation bias. This rises with the age considered at the end of childbearing processes. It is also highly affected by the reporting of the age of the mothers at birth. In countries where vital registration is of quite poor quality, the parity specific rates would be under-estimated. If they are derived from surveys, they would again suffer from the time reference error.

Feichtinger and Lutz (1983) modified the original works of Chiang Van den Berg (1982). This table is built up in analogy to an ordinary (mortality) life table where parity replaces age as the indexing variable. The parity progression ratios then correspond to the survival probabilities; their complements - the probabilities of death in the ordinary life table at a certain parity. Starting with a radix, l(0) of 1,000 women entering the reproductive age, l(i) column then gives the number of women who survived to parity (i). Hence, as in a regular life table, l(i) is defined by;

$$l(i) = l(i-1)\, P(i-1)$$

where P(i) is the parity progression ratio at parity (i). The column of life table deaths, d(i), gives the number of women who drop out of the process of child bearing at that parity and hence remain at parity (i). Thus d(i) is defined as

$$d(i) = l(_i)(1-P(i)) \text{ or}$$

$$d(i) = l(i) - l(i+1)$$

Empirically this descriptive form of the fertility table pertaining to a cohort through the d(i) column, which corresponds directly to the observed completed parity distribution. Once the d(i) column is given, the l(i) and P(i) column can be derived by simple algebraic transformation according to the definitions given above. Using the functions P(i), l(i) and d(i) it is also possible to calculate the mean number of children born beyond parity (i), F(i), directly from the given data by

$$F(i) = \sum_{x=i+1}^{m} f(x),$$

$$\text{where } f(i) = \frac{l(i)}{l(0)}$$

m - being the highest parity considered. The quantity f(i) gives the number of births of order (i) per women. This F(i) is also referred to as mean parity or mean family size of a cohort under study. Ryder (1982) calls it the total fertility rate for births of order (i).

The method was used in 1983 for comparative analysis of completed parity distributions for all the countries which participated in WFS. It has also been applied to Austrian data and the main objective was to demonstrate its potential for assessing distributional consequences of currently observed fertility behaviour (Feeney and Lutz, 1991).

The result of the study undertaken in Austria indicated that the calculated value of F(i) for each of the country that took part in WFS, F(i)'s were compared and it was noted that the parity distribution did not reflect the fertility pattern by then because the group of women (40-49) to which the analysis was limited, had passed their childbearing ages. The mode of the completed parity distribution for high fertility countries ranges mostly between six and nine children, whereas in all European countries it was at parity two. Analysis of the parity progression ratios for developing countries indicated a monotonically declining PPRs from a maximum at parity zero to a minimum at the highest parity. However, for industrialized countries the pattern of parity progression ratios are characterized by steep decline until parity two after which the curve levels off or even increases. This increase at higher parities could be attributed to selectivity of a few high fertility women. Result for the study done in Austria indicated that the total fertility rate was 1.62 children per woman while the level of childlessness was extremely high at 28 percent. However, differentials existed both by regional and for educational levels. The overall trend indicated that high proportion progressed to second birth than in the first and third births respectively. Very few women progressed to fourth and fifth births. The major sources of data are fertility surveys and birth registration.

The specific data required included birth histories which provide the distribution of the number of children ever born with their birth orders. If parity specific rates are derived from surveys, then the method would suffer from time reference error. Thus it works well with data obtained from vital registration. This requirement limits most developing countries since they have incomplete birth registration. The method also yields biased estimates, especially for progression to first births.

2.3 IPPRS MODEL

Srinivasan (1967) developed an IPPR model. This method uses both the closed and open birth interval. Closed birth interval provides the estimation of women moving form parity (i) to parity (i+1), similarly open birth intervals can be used for estimating the incidence of secondary sterility. If U_i represents the open interval after parity (i) for women within the reproductive group (15 to 45) and the parameters α_i, β_i and γ_i are defined such that α_i represents the probability that a woman of parity (i) will ever proceed to parity (i+1) and β_i represent the probability that the women will not reach parity (i+1) but continue to live throughout her reproductive life in the married state, and γ_i denotes the probability that a woman will get widowed or divorced before reaching parity (i+1) and before reaching 45 years of age. Thus all these probabilities are mutually exclusive and $\alpha_i + \beta_i + \gamma_i = 1$

the probability of α_i = $\dfrac{EU_i - EV^2_i/2EV_i}{ET^2_i/2ET_i - EV^2_i/2EV_i}$

where α_i is the PPRs.

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 Fiji result and India result showed that they almost had the same PPRs except for parities 0 and 5 and over, indicating a higher fertility among Indian women. The source of data are fertility survey and complete vital registration. The data must provide an information on the time of occurrence of each of the vital events together with the background characteristics of the woman and her contraceptive and marriage history. The data must be clear 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 and most especially in the developing countries.

Yadav-Bhattacharia (1985) developed a modification to Srinivasan (1967) model.This method was originally developed by Srinivasan (1967) and simplified by himself in 1980. The original method required a knowledge of order specific closed and open birth interval data and the data on the age of mothers at the time of termination of their last births. From the original model it was noted that for illiterate women whose ages at last birth could not be accurately measured, the model (Srinivasan) appeared difficult to apply. A modification to this model was therefore designed which 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. This time span relates to two types of women, those who proceed to the next parity within a time interval "C" and those who do not proceed to the next parity within the time span "C". These proportions are different from α_i and $(1-\alpha_i)$ derived in Srinivasan (1967) and can be denoted by α^*_i and $(1-\alpha^*_i)$. α^*_i can be expressed in terms of α_i, its derivation is explained in the previous method.

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 different data sets compiled from three large scale sample surveys conducted in the states of Bihar, Rajasthan and among the Parsi community of Bombay (Srinivasan et al, 1985).

The result indicated that some of the estimates exceeded unity, particularly at the 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 gives higher estimates of parity progression ratios than those of other methods.

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.

Feeney and Ross (1984) studied the relationship between open and closed birth intervals distribution on the basis of analysing 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 dx 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 therefore 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:

$$k_i(x_i t) \quad = \quad l_{xi}B_i(t\text{-}x),\ \nabla\ x > 0$$

The question that arises at this point is how do we obtain the variable $l_{x,i}$ since it is not obtainable from the data set? The answer to this question rely on the progression and mortality factors of those women who joined parity (i).

Progression from parity (i) to parity (i+1) and death are considered as the causes of decrement of the population of women of parity (i). From this argument, if $n_i(x)$ denote the force of progression to (i+1)-th birth within (x) years after the (i)-th birth and $m_i(x)$ denote the force of mortality at the same time, then the sum of these two forces is the total force of attrition of women of parity (i). Thus $l_{x,i}$ is the parity progression ratio and is algebraically as follows:

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

This study was undertaken using Indonesian data on open birth-interval distribution with an aim of estimating parity progression ratio, it provided 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.

Feeney, G (1988) computed the parity progression ratio (PPRs) from a distribution of women by children ever borne. By accumulating the parity distribution up from the bottom, the numbers N(i) of the 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 empirically based on observed proportion not progressing within a specified time (x).

This method has been used to assess the success of family programme in Kenya (Feeney, 1988). 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 result 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.

The source of data can be fertility surveys or 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 reflect the following limitations; birth history data are always small in number 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 result from the usual restriction of the sample to women under age 50 years.

2.4 OWN-CHILDREN METHOD

The own-children technique was discussed by Luther et al (1987). This is a matching procedure in which each woman of reproductive age in each sample household is matched with the children in this household who are own children. The resulting "own-children" history differs from the woman's birth history by the exclusion of deceased and "non-own" children that is, children not living in the same household as their mother. This provides the information about children ever born and surviving, how many deceased and "non-own" children are missing. The idea of the reconstruction procedure is to add these missing children to the "own-children" history using information on when the "own-children" were born, age at marriage of the woman, and empirical pattern of fertility and mortality. The method was applied to China's survey by Luther et al (1987). The objectives of the study were to compare results from a reconstructed birth histories with results from an actual birth histories and to study the parity structure of fertility change in China between 1955 and 1987. From these birth histories period parity progression ratios (PPPRs) were computed for the years 1972 to 1987. To examine the trends and levels of fertility, the calculated PPRs were transformed into TFR which is normally a measure of the level of fertility.

The corresponding period parity progression ratios computed from reconstructed birth histories from the 1987 surveys and those calculated from the 1982 one-per thousand survey, in which information on birth histories was collected revealed that the statistics calculated from the reconstructed birth histories are very good. The result for trend revealed that the PPRs for every parity indicated a decline in value between 1972 to 1980 before a slight increase and this helped to explain the decline in fertility. The values of TFR dropped from 4.72 in 1973 to 2.41 in 1981 they went up to 1982 before falling again. This increase was due to the increase in proportions of women progressing from first to second birth.

The data sources are censuses and fertility survey while the data are birth histories i.e the number of women by number of children ever born distributed by birth orders. These birth histories are reconstructed to give "own-children" history. The limitation of the method indicates that; The progression of higher order tends to show larger relative errors because these higher order progression involve very small numbers of births. Secondly, the birth history data are always available in small number and they always have age-selection bias that result from the usual restriction of the sample to women under age 50 years. The small sample size is due to relatively high costs of collecting a complete birth history.

In summary, the literature review showed the objectives, sources of data, methodologies and the analysis (result) of every study that was considered relevant for this work. The objectives of the studies were noted to be different, however, they were all linked to fertility measures and trends over time. The sources of data were ranging from Fertility Surveys, Censuses, Birth Registration and Demographic and Health Surveys. The methods used in the studies were all based on the parity progression ratios. However, they were different forms depending on the nature of the data that were available. These forms included: (a) life table techniques used by Henry (1953) , Whelpton (1954),Henry (1980) Srinivasan (1980), Chiang Vanden Berg (1982), Lutz (1989), Ni Bhrolchain (1987), Feeney and Wang Feng (1993), Feeney and Lutz (1991), (b) Own children method used by Luther et al (1987), (c) Instantaneous parity progression model used by Srinivasan (1980), Feeney (1988) and Yadav et al (1985). The methods provided the results of fertility measures either in terms of period parity progression ratios or instantaneous parity progression ratios and whichever measure that was used the result indicated a very good measure of fertility levels and trends and also with good details of fertility behaviours at parity levels.

From the forgone literature review it was observed that there are three major approaches of calculating parity progression ratios. These are life table (fertility table) method, own-children method and instantaneous parity progression ratios (IPPRs) approach. The first two methods provide the period measures while the third approach can provide both the instantaneous and period measures provided there are more than one set of data. In this work the instantaneous measure is used because of the following reasons summarized below:

1. The life-table (fertility table) requires vital registration statistics in order to generate accurate period parity progression ratios (PPPRs). This is a limitation to this study since the data available is demographic and health survey (KDHS).

2. The own-children method has a tendency of generating relative errors in the progression of higher order. This error is likely to be magnified in high fertility countries. Moreover this method requires a reconstructed birth histories, an exercise which requires much time.

3. Feeney and Ross (1984) method of calculating IPPRs works well with data obtained from the birth register. This source of data is incomplete in many countries, including Kenya, because of the high cost of its adminstration.

4. Srinivasan method requires data that include the age of the mother at the termination of the last birth to age 45 years. Most of the survey data do not provide the information on the age of the woman at the termination of last birth (Feeney, 1983). More so data on age remains to be poorly reported in many countries of the world.

Because of these reasons a modified form of Srinivasan method was developed by Yadav and Batacharya and is called Yadav-Bhatacharya modification to Srinivasan model. This 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. It is built under the same principle as the Srinivasan model. This study adopts the use of Yadav and Bhattacharya's model.

CHAPTER THREE

YADAV - BHATTACHARYA'S MODIFICATION TO SRINIVASAN MODEL

3.1 INTRODUCTION

This chapter discusses the model of the study and its theoretical framework. Thus it outlines the theory behind the model and its derivation. It includes the assumptions of the model, data requirements and the procedure for calculating parity progression ratios. Also included in the chapter is the method of the study.

3.2. THEORETICAL FRAMEWORK

The model is built around birth intervals. These birth intervals both open and closed, distributions for women of parity (i), ($i \geq 0$) and the parity progression ratios for women of parity (i) to (i+1) provide a good basis for fertility measurement. 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 result of these decisions are directly represented in PPR's and birth-interval distributions. The distributions defined here belong to a population of women who have births of a given order during a given period. This group of women are referred to as a 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. Thus the two cohorts are analogous. Women enter the population by having an (i)-th birth and this is analogous to birth in an ordinary population.

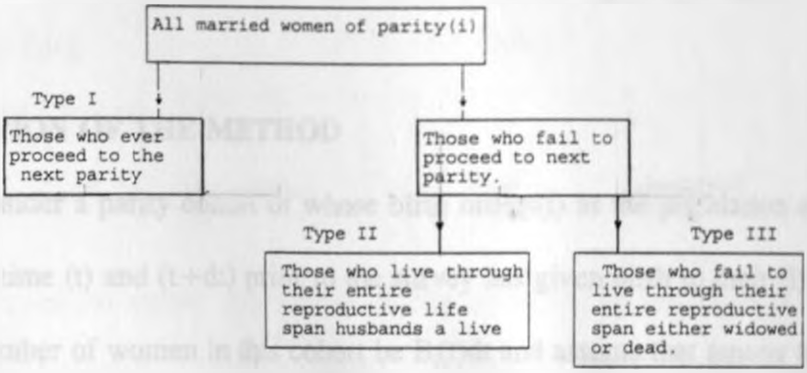
The major question is, what proportion of women of parity(i) ever move to the next parity (i+1)? The pattern of progression has a direct linkage to the birth intervals and hence the behaviour of fertility within a population. Just as the birth cohorts' progression from one age-group to the next determines the level of mortality in that population so is the parity progression from (i)-th birth to (i+1)-th birth in case of fertility. The two demographic characteristics (fertility and mortality) are therefore analogous and their study approach are also similar.

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 therefore 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. Thus the open birth interval must be less than or equal to a constant period "C". The interval "C" is chosen such that $P[T_i > C] = 0$, 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", and those who do not proceed to the next birth within the same time. Those who fail to proceed from parity(i) to parity(i+1) within this time are defined by the probability of $(1 - \alpha_i)$. Thus any woman who give birth to (i)-th child has two mutually exclusive probabilities open to her in her future with regard to fertility. She may either progress to give birth to the next child (i+1), with probability of α_i or she fails to do so with probability of $1-\alpha_i$. Those who fail to progress to the next parity either live through their entire reproductive life span with their husband a live or as widowes or they die before reaching the end of their reproductive age. Thus there are three mutually exclusive and collectively exhaustive of all women of parity(i) in the reproductive age group at the time of the survey.

This theory can be diagrammatically expressed into three classes

(types I, II and III) as shown in the figure 2.1. below.

FIG.2.1 DIAGRAMMATIC DIVISION OF A SUBPOPULATION INTO THREE MUTUALLY EXCLUSIVE CLASSES



Source: (Srinivasan, 1968)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 is the parity progression ratio.

The model of this theoretical framework is derived in section 3.4.

3.3 ASSUMPTIONS OF THE MODEL.

The model is built under the assumptions that:

1. There is no migration for the women under the study

2. That the level of mortality is low among the reproductive women (15-49) during their reproductive cycle.

3. The time interval beyond which there is no progression from parity(i) to parity(i+1) is restricted to a value "C".

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 DERIVATION OF THE METHOD

Let us consider a parity cohort of whose birth order (i) as the population of women who between the time (t) and (t+dt) prior to the survey has given birth to their (i)-th child.

Let the number of women in this cohort be $B_i(t)dt$ and assume that among these only $a_i(t)$ proportion progress to have (i+1)-th birth from (i)-th birth sometimes later.

This implies 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)-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 then given by $1-F_i(t)$.

From the above definitions, the total number of women with (i)-th order open interval is given by

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

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

$$g_i(t) = \frac{B_i(t)a_i(t)[1-F_i(t)]}{\int_0^w B_i(t)a_i(t)[1-F_i(t)]dt.} \qquad (3.4.1)$$

The mean and the second row 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.

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

$$= \int_0^w \frac{t\, B_i(t)a_i(t)[1-F_i(t)]dt.}{\int_0^w B_i(t)a_i(t)[1-F_i(t)]dt}$$

$$\therefore \quad E(U_i) = \frac{\int_0^w t\, B_i(t)a_i(t)[1-F_i(t)]dt}{\int_0^w B_i(t)a_i(t)[1-F_i(t)]dt} \qquad (3.4.2)$$

and

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

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

$$\therefore \quad E(U^2_i) = \frac{\int_0^w t^2 B_i(t)a_i(t)[1-F_i(t)]dt}{\int_0^w B_i(t)a_i(t)[1-F_i(t)]dt} \qquad (3.4.3)$$

Under the 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 births has been constant over time. Therefore, the number of (i)-th order births would only depend on the time interval and not on its location in the time continuum.

Similarly let $a_i(t)$ also remain constant with time under the same assumption. Then

$$E(U^2_i) = \frac{\int_0^w tB_ia_i[1-F_i(t)]dt}{\int_0^w B_ia_i[1-F_i(t)]dt}$$

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

$$\therefore \quad E(U_i) = \frac{E[T^2_i)}{2E[T_i]} \qquad (3.4.4)$$

Similarly

$$E[U^2_i] = \frac{E[T^2_i)}{E[T_i]} \qquad (3.4.5)$$

Proofs of equations 3.4.4 and 3.4.5

Let X be a random variable with density function

f(x), therefore the distribution function $P(X \leq x) = F(x)$.

Now, for $x \geq 0$

$$E[X] = \int_0^w xf(x)dx = \lim_{T \to \infty} \int_0^T xf(x)dx$$

Using integration by parts,

$$\int_0^T xf(x)dx \equiv \int udv$$

Let

$u = x \Rightarrow du = dx$

$dv = f(x)dx \Rightarrow v = \int f(x)dx = F(x)$

$$\therefore \int_0^T xf(x)dx = uv - \int_0^T vdu$$

$$= xF(x)\Big|_0^T - \int_0^T F(x)dx$$

$$= TF(T) - \int_0^T F(x)dx$$

$$= T[1-1+F(T)] - \int_0^T [1-1+F(x)]dx$$

$$= T-T[1-F(T)] - \int_0^T [1-\{1-F(x)\}]dx$$

$$= T-T[1-F(T)] - \int_0^T 1.dx) + \int_0^T [1-F(x)]dx$$

$$= T-T[1-F(T)] - T + \int_0^T [1-F(x)]dx$$

$$= -T[1-F(T)] + \int_0^T [1-F(x)]dx$$

But

$$F(T) = \text{Prob}(X \le T) = \int_0^T f(x)dx$$

$$\therefore \quad 1 - F[T] = \int_T^\infty f(x)dx$$

Multiplying both sides by T

$$\therefore \quad T[1 - F[T]] = T < \infty \int_T^\infty f(x)dx \le \int_T^\infty x\, f(x)dx \text{ . Since } T \le x$$

$$\le \int_T^\infty f(x)dx$$

$$\therefore \quad \lim_{T \to \infty} T[1-F(T)] \le \lim_{T \to \infty} \int_0^T xf(x)dx \to 0$$

but $$E[X] = \lim_{T \to \infty} \int_0^T xf(x)dx$$

$$= -T[1-F(T)] + \lim_{T \to \infty} \int_0^T (1-F(x)]dx$$

$$= 0 + \lim_{T \to \infty} \int_0^T [1-F(x)]dx$$

$$\therefore \quad E[X] = \int_0^\infty [1-F(x)]dx$$

At least, consider for $X \geq 0$

$$E[X^2] = \int_0^\infty x^2 f(x)dx = \lim_{T \to \infty} \int_0^T x^2 f(x)dx$$

Let $u = x^2 \Rightarrow du = 2xdx$

$du = f(x)dx \Rightarrow v = \int f(x)dx = F(x)$

$$\therefore \quad \int_0^T x^2 f(x)dx \equiv \int udv$$

$$= uv - \int vdu$$

$$= \left. X^2F(x) \right|_0^T - \int_0^T 2xF(x)dx$$

$$= T^2F(T) - \int_0^T 2\,xF(x)dx$$

$$= T^2[1-1+F(T)] -2 \int_0^T x[1-1+F(x)]dx$$

$$= T^2 - T^2[1-F(T)] -2 \int_0^T xdx + 2 \int_0^T x[1-F(x)]dx$$

$$= - T^2[1-F(T)] + \int_0^T x[1-F(x)]dx$$

But

$$T^2[1-F(T)] = T^2 \int_T^\infty f(x)]dx = \int_T^\infty T^2f(x)dx$$

$$\leq \int_T^\infty x^2 f(x)dx$$

$$\Rightarrow \lim_{T\to\infty} T^2[1-F(T)] \leq \lim_{T\to\infty} \int_T^T x^2f(x)dx \to 0$$

$$\therefore \quad E[x^2] = \lim_{T\to\infty} - T^2[1-F(T) + \lim_{T\to\infty} 2 \int_0^T x[1-F(x)]dx$$

$$= \lim_{T\to\infty} T^2[1-F(T) + 2 \lim_{T\to\infty} \int_0^T x[1-F(x)]dx$$

$$= -0 + 2 \lim_{T\to\infty} \int_0^T x[1-F(x)]dx$$

$$= 2 \lim_{T\to\infty} \int_0^T x[1-F(x)]dx$$

$$\therefore \quad E[x^2] = 2 \int_0^\infty x[1-F(x)]dx$$

$$\int_0^\infty [1-F(x)]dx = \frac{E(x^2)}{2E[x]}$$

Similarly,

$$E[X^3] = \int_0^\infty x^3 f(x)dx = \lim_{T\to\infty} \int_0^T x^3 f(x)dx$$

Let $u = x^3 \Rightarrow du = 3x^2dx$

and

$$dv = f(x)dx \Rightarrow v = F(x)$$

$\therefore$

$$\int_0^T x^3 f(x)dx \equiv uv\Big|_0^T - \int_0^T vdu$$

$$= x^3F(x)\Big|_0^T - 3\int_0^T x^2F(x)dx$$

$$= T^3F(T) - 3\int_0^T x^2F(x)dx$$

$$= T^3[1-1+F(T) - 3\int_0^T x^2[1-1+F(x)]dx$$

$$= T^3 - T^3[1-F(T)] - 3\int_0^T x^2\,dx + 3\int_0^T x^2[1-F(x)]dx$$

$$= T^3 - T^3[1-F(T)] - T^3 + 3\int_0^T x^2[1-F(x)]dx$$

$$= -T^3[1-F(T)] + 3\int_0^T x^2[1-F(x)]dx$$

$$E[X^3] = \lim_{T\to\infty} T^3 [1-F(T)] + \lim_{T\to\infty} \int_0^T x^2 [1-F(x)]dx$$

$$= \quad 0 + 3 \int_0^\infty x^2[1-F(x)]dx$$

$$\therefore \quad \int_0^\infty x^2[1-F(x)dx = \frac{E[x^3]}{3E[X^2)}$$

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 occur with probabilities of α and $1-\alpha$ 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 distribution i.e $U^{(f)}_i$ - the open interval for fertile women, $U_i^{(s)}$ - the open interval for the non-fertile women (those who remain within the parity). The distribution of U_i is therefore 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 the purposes of 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 reproductive span. From earlier discussion we have the following equations.

$$E(F_i) \quad = \quad \frac{E(T_i^2)}{E(T_i)} \qquad (3.4.6)$$

and

$$E(S_i) = \frac{E(V_i^2)}{2E(V_i)} \quad (3.4.7)$$

$$E(S_i^2) = \frac{E(Vi^3)}{2E(V')} \quad (3.4.8)$$

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

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

$$= \alpha_i \frac{E(T_i^2)}{2E(T_i)} + (1-\alpha_i) \frac{E(V_i^2)}{2E(V_i)}. \quad (3.4.9)$$

and

$$\underline{E(U_i^2)} = \alpha_i \frac{E(T_i^3)}{3E(T_i)} + (1-\alpha_i) \frac{E(V_i^3}{3E(V_i)} \quad (3.4.10)$$

From (3.4.9) making α_i the subject of the formulae, we have

$$\hat{}\alpha = \frac{\frac{E(U_i) \ E(V_i^2)}{2E(V_i)}}{\frac{E(T_i^2)}{2E(T_i)} - \frac{E(V_i^2)}{2E(V_i)}} \quad (3.4.11)$$

where α_i is the estimate of the instantaneous parity progression.

In order to apply this model the data is required on age of the 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

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

Similarly 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 $\alpha^*_i = \dfrac{\alpha_i B_i E(T_i)}{\alpha_i B_i E(T_i) + (1-\alpha_i)B_i C}$

$$\therefore \quad \alpha^*_i = \frac{\alpha_i E(T_i)}{\alpha_i E(T_i) + (1-\alpha_i)C} \qquad (3.4.12)$$

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

$$E(U^*_i) = \frac{\alpha^* \int_0^C tB_i[1-F_i(t)]dt}{\int_0^C B_i[1-F_i(t)]dt} + \frac{\int_0^C tB_i dt}{\int_0^C B_i dt}(1-\alpha^*_i)$$

or

$$= \alpha^*_i E(U_i) + (1-\alpha^*_i)C/2 \qquad (3.4.13)$$

Substituting for $E(U_i)$ from 3.4.4

$$E(U^*_i) = \alpha^* \frac{E(T_i^2)}{2E(T_i)} + (1-\alpha^*_i)C/2$$

Replacing α^*_i by 3.4.12 we have

$$E(U^*_i) = \frac{\alpha_i E(T_i)E(T_i^2)}{[\alpha_i E(T_i)+(1-\alpha_i)C]\ 2E(T_i)} + \frac{(1-\alpha_i E(T_i)C/2}{\alpha_i E(T_i)+(1-\alpha_i)C}$$

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

making α_i the subject of the formula, we have

$$\hat{}\alpha_i = \frac{C^2 - 2E((U^*_i)C}{C^2 + 2E(U^*_i)[E(T_i) - C] - E(T_i^2)}$$

or

$$\hat{\alpha}_i = \frac{C^2 - 2CE((U^*_i)}{C^2 + 2E(U^*_i)[E(T_i) - C] - E(T_i^2)} \qquad (3.4.14).$$

where U_i - is the open birth interval

T_i - is the last closed birth interval

C - Truncated time in months

i - is the (i)-th parity for every women

3.5 DATA REQUIREMENTS

The principal sources of data are fertility surveys and vital registration.The data provide information on the time of occurrence of each vital events. The data must be clear on open and closed birth intervals distributed by total number of children.

3.5.1 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. The second raw moment of the closed birth interval of women with parity(i).

4. Truncation time in months denoted by C.

3.6 STEPS OF CALCULATING PPRS

The details of the steps for calculating the values of PPRs are fully discussed in chapter five. The choice of the value "C" is discussed in section 3.7.

Step 1

Calculation of values represented by the formula $C^2 - 2CE(U_i)$ for every parity i. The values of C is 13 years (refer to section 3.7) while the values of $E(U_i)$ are contained in column 2 of table 5.1. The results are in table 5.2.

Step 2

Calculation of the values represented by the relationship $2E(U_i)[E(T_i) - C]$ categorized by the variable (i). The results are displayed in table 5.3.

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 $E(T_i^2)$ and the values are contained in table 5.4.

Step 4

Calculating the values of $C^2 - E(T_1^2)$. The values of $E(T_i^2)$ are contained in table 5.4

Step 5.

Calculation of the sum of values obtained in step 2 and step 4. this provide the denominator (Den) of the PPRs (Parity progression Ratios). The computed values are in table 5.5.

Step 6.

Calculation of parity progression ratios (PPRs) for every value i. These values (PPRs) are computed by dividing the entries in table 5.2 by those in table 5.6.

3.7 METHOD OF THE STUDY

This method requires the choice of a value denoted by "C" in the formulae 3.4.14. This value "C" represents the number of years for which the progression from (i)-th birth to (i+1)-th by every women, is very negligible. It is therefore, very important to note that different values of "C" provide different results (PPRs). Refer to appendix C, figures **C1** to **C4**.

A computational inspection of the sizes of mean children ever born (MCEB) indicate that MCEB depend directly on the value of "C". Figure **C1** in the appendix C show an increase in MCEB values for different choices of "C". From the graph **C1** it is observed that there is a steep rise in the values of MCEB as the values of "C" changes from 11 years to 12 years. The steepness in this graph indicates the extent of truncation error included in the calculation. Thus if the value of "C" equal to 12 years is considered then the graphical evidence shows that many births or many women who are in progression to higher births are cut out of the analysis.

On the other hand, if the value of "C" is made equal to 14 years and 15 years there is also a rise (steep) in MCEB equal to 4.172 to 5.072. The value of "C" equal to 15 years produce a result which indicate a clear reflection of memory lapse on the side of the respondence, a conspicuous variation between the computed MCEB (5.072) and the observed MCEB (3.17) provide the evidence of the memory lapse. This memory lapse can be explained on the background of the long duration of time frame covered in the birth histories, this study covers the period from 1980 to 1993.

These two anomalies in values of MCEB for values of "C" equal to 11 years on one end and "C" equal to 15 years on the other hand justifies the choice of "C" equal to 13 years, as the working value of "C" from which MCEB (the fertility measurement) and Parity Progression Ratios (PPRs) are calculated for this work.The value of "C"equal to 13 years is the mean value of the extremes i.e 11 years and 15 years beyond which very negligible number of women progress from parity(i) to parity(i+1). Appendix **C** fig. **C1** shows the relationship between MCEB and the values of "C" from which the value of "C" equal to 13 was considered.

The method of study focuses on two dimensions, these are birth-interval analysis and parity progression ratios. The analysis of these two measures gives a clear picture of the fertility process.

The group under focus is the ever-married women between age group 40-49 because they are about to reach the end of their childbearing span. However, because the size of data for 40-49 group was too small, this study included the entire population of ever-married women between ages 15-49 and the analysis focused on higher order births, where the values of PPRs are expected to fall conspicuously in relation to lower order births. The study will compare the pace of childbearing in the lower order births with a view to explaining the effects of family planing programmes for age - groups 25 - 29 to 45 - 49.

Questions that might arise in this study are, why consider PPRs and Birth-Interval distribution (BID) in the analysis of fertility behaviour? How do they measure fertility? The PPR's provide the proportion of women moving to the next birth (parity) after obtaining the previous one, thus one can evaluate the change or levels in terms of the proportion dropping out after obtaining a particular birth. The ratio (PPRs) may also be applied to track back fertility measures year by year so that fertility decline may be observed after a long period. This period measurement called period parity progression ratio (PPPRs), is not used in this study. 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 behaviour over that period of time. Similarly BID is useful for the interpretation of fertility because it aggregates into family size. Thus it is used to (1) calculate PPRs, (2) assess its contribution to fertility levels through birth spacing which measures the tempo of fertility.

PPR is related to the mean number of children ever born by the underlined formulae.

$$MCEB = 1 + P_1 + P_1P_2 + \ldots + \frac{P_1P_2P_3 \ldots P_n}{1 - P_n} \qquad (3.7.1)$$

The methodology of analysis will consider the percentage of women progressing from P_i to P_{i+1} and level of stopping. Under this approach there are two ways of looking at fertility levels, these are period parity progression ratios (PPPR's) and the instantaneous parity progression ratios (IPPR's). This work adopts IPPRs for reasons already explained in the summary of the literature review. This method focuses on the fertility behaviour across the parities and hence synthetic since it combines a mixture of several age-cohorts of women. This study was therefore based on fertility estimation from a single set of data. According to this approach the values of PPR's are expected to drop as the order of parities move from (i) to (i+1). PPRs essentially measures the pace of childbearing and it also translates into summary measures of fertility level. As outlined in the early paragraphs of this chapter more interest is focused in the values of PPR's at higher parities and the pace of childbearing in the lower birth orders. These values (PPR's) will be calculated by various background factors of the population in order to estimate differentials these background factors include age, education and place of residence. We can obtain measures through either displaying the PPRs graphically or in terms of summary measure (MCEB).

3.7.1. GRAPHICAL METHOD

This method is very necessary because it provides the pictorial behaviour of the fertility on a two dimensional scale.

The graphs presented (chap.5: fig's 4.1 to 4.5) in this study show the relationship between the calculated ratios (PPR's) and parities. Theoretically PPRs should fall steeply at the higher parities showing clearly the levels of stopping. All the categories of socio-economic factors will be plotted on the same axis for comparative analysis.

3.7.2. MCEB METHOD

MCEB is the mean children ever born, it is a measure of maternal total fertility rate (MTFR). It is calculated from parity progression ratios as has been outlined in equation (3.7.1). In this analysis MCEB is used for comparing the level of MTFR for women covered by different socio-economic background factors like level of education, place of residence etc. Thus the study will outline the socio-economic factors which significantly influence the level of fertility.

The methodology also uses the age which is found necessary because as already stated it is important to focus on women who have completed their childbearing with a view to examine how they compare with the younger ones.

CHAPTER FOUR

SOURCES AND THE QUALITY OF DATA

4.1 SOURCES OF DATA

The source of data was KDHS 1993. This survey targeted 15 districts; Bungoma, Kakamega, Kericho, Kilifi, Kisii, Machakos, Meru, Muranga, Nakuru, Nandi, Nyeri, Siaya, South Nyanza, Taita-Taveta, Uasin Gishu, Nairobi and Mombasa, these districts were selected because they were larger in their provinces and they had District Population Officers.

A total of 8,805 households was selected for the survey, of which 7,950 were properly covered. The shortfall was primarily due to absenteeism from the households or cases of shifting to other places of the covered households, 7,540 or 95% were interviewed. 2,762 eligible men were identified out of which 2,336 or 85% were interviewed.

The woman's Questionnaire was used to collect information from women aged 15-49. Information from a sub-sample of men aged 20-54 was collected using the man's Questionnaire.

The data collected provided the information on fertility and mortality. As regards fertility, information on maternal histories, fertility regulation based on family programmes, other proximate determinants (marital status, polygamy, age at first sexual intercourse, recent sexual activity, postpartum amenorrhoea and insusceptibility and termination of exposure to pregnancy) and fertility preferences were collected. For this particular study the type of data required was the reproductive histories of women aged 15-49 years. This data providedinformation on the total number of children (boys and girls) living with their mothers and living elsewhere and the number who had died. Contained in this data was also the history of all live births, including such information as, name, month and year of birth, sex and survival status, For children who had died, information on age at death was solicited. These data were collected for different background characteristics. From maternal history, variables like last birth to interview, preceding birth interval, succeeding birth interval were obtained by different backgrounds i.e age-groups, education and place of residence.

4.2 QUALITY OF DATA

The study of the quality data in this work is carried out on various methods of analysis. The following were the approaches taken.

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

4.3 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	0.010
Last closed birth intervals	0.010
Open birth intervals	0.038
Children ever born	0.036

Table 4.1 indicates that the degree of the sampling done for these variables was high and suggest that the quality of the data was reasonably a good one. The picture provided by table 4.1 suggest that one questionnaire out of a hundred for both the categories of all closed birth intervals and last closed birth interval gave unacceptable information. Similarly about four questionnaires out of one hundred for both the categories of open birth interval and children ever born gave unacceptable information.

These standard errors (s.e) therefore indicate good sampling design and so point out on the quality of the data as very reliable.

4.4 HISTOGRAM ANALYSIS OF THE DATA

A study of various histograms for different variables reveal different behaviours in distributions as measured by the extent of skewness. Refer to figures in the appendix **(D)**.

Consider the last closed interval (LBI), the histogram shows a trend which is concentrated around 36 months, however, the distribution is negatively skewed with a magnitude of 1.72. This shows that the mean is lower than the mode and the median.

All closed birth intervals (ACBI) also give almost a similar distribution with the concentration of interval around 36 months and negative skewness of 1.719. 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 histogram of open birth interval (OBI) shows a high concentration of interval around one, two and three years. The distribution gives a positive skewness of 0.714 in magnitude.

It is important to point out that good data provide 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 defined as positively skewed and if the mean is less than the median and the mode then the distribution is said to be negatively skewed. Table 4.2 shows the measure of dispersion of the three variables.

Table 4.2: Types of birth intervals and their measures of dispersion

Birth interval	Mean	Median	Mode	Variance	Skewness
OBI	3.875	3.000	1.000	7.944	0.714
LBI	2.998	3.000	3.000	1.795	1.720
ACBI	2.996	3.000	3.000	1.790	1.719

The table (4.2) gives almost a consistent pattern especially in the last two variables i.e LCB and ACBI and this is relatively good data.

4.5. 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 known	Year of birth not known	% of missing informa-tion
1	5415	165	53	4.0
2	4481	267	66	7.4
3	3649	293	64	9.8
4	2943	256	71	11.1
5	2306	233	63	12.8
6	1725	211	50	17.8
7	1258	167	50	17.2
8+	2122	336	83	19.7

Source: 1993 KDHS.

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 enter 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 on different vital events. The percentage for which the month of occurrence is not known was found to range between three percent in the first birth to sixteen percent for the eighth and above births. The trend of the month of the values missing for the month not known increases with birth orders, a probable indication of age influence. On the other hand the percentage of missing information was found to fall between four percent for the first birth and nineteen point seven percent for eighth and above births. 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 (Trevor, C. 1991). The level of imputation for this data suggest that the quality of data is good.

4.6. DIGIT PREFERENCES

Literature shows that the data on birth intervals compiled from developing countries are subject to serious digit preferences, (Srinivasan, K. 1980), with women reporting the intervals in multiples of one year or half a year. Thus if the reported intervals are divided by 12 or 6 and classified by their residues, 1, 2, 3, ...11, 12 in the first case and 1, 2, ...5,6 in the second case, there will be clustering of frequencies at 12 and 6 in the first case and at 6 in the second case respectively. If there are no digit preferences, then 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. It can be shown that the distribution of residues is more or less uniform using the measure of departure from uniformity defined below (See appendix (**B**)).

Consider the first case of residual distribution of 1, 2, 3,........12. If these number are denoted by f_1, f_2,........,f_{12} while the total is denoted by f, then under the null hypothesis that there are no digit preference, the quotient.

$$q_1 = \sum_{1=1}^{12} \frac{(|12f_i - f|)}{f}. \qquad (4.1)$$

should approximately be zero. If all of them get concentrated in one residual digit, one of the f_1 will equal f and the remaining f_i's will be zero making the q_1 value to 22. Thus the minimum value of q_1 will be zero and the maximum will be 22. Suppose we take Q_1 = $q_1/22$, then Q_1 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 birth intervals are multiples of 12 months. Similarly for the second case worked on the basis of six-monthly preferences provides the measure based on

$$Q_2 = q_2/10$$

Where

$$q_2 = \sum_{1=1}^{6} \frac{(|6f_i - f|)}{f} \qquad (4.2)$$

Table 4.4: Digit Preference Quotients (OPQ), Q_1 (12 monthly) and Q_2 (6 monthly) for different Birth Intervals.

ALL INTERVALS

Types of intervals	DPQ_1	DPQ_2 (Parity 1 to 6)	DPQ_2 (Parity 7 to 12)
ACBI			
LCBI	0.297 (4483)	0.106 (3461)	0.305 (1022)
OBI	0.261 (2145)	0.050 (1586)	0.327 (559)

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

Table 4.4 shows that the extent of digit preference, in both the Q_1 and Q_2 situations is generally lower for OBI. However, for parity 7 to 12, OBI shows a higher value for Q_2 than its counterpart (LBI). Nevertheless the two values Q_2 for Parity 7 to 12 are higher than the values of lower parities i.e 1 to 6 and this gives an indication of the existence of errors and most likely the errors due to digit preference and memory lapse.

In DPQ_1, the OBI values is lest compared to LBI value which are 26 and 30 percent respectively, while DPQ_2 values for OBI is lower than the value for LBI which falls in the category of parity 1 to 6. These values are 5 and 11 percent respectively and for the second category of DPQ_2 i.e for parity 7 to 12, the value of LBI is lower than the value of OBI and they are 31 and 32 percent.

Considering the values of q_1 and q_2 (refer to appendix (**B**), tables 2.5 to 2.8) under the null hypothesis stated above. The value q_1 for LBI is 6.5287 and is higher than the value for OBI which is 5.7483. This shows that there is slightly higher digit preference in LBI than OBI. Similarly for q_2 and under the category for parity 1 to 6, q_2 value for LBI is higher than the value for OBI. They are 1.0623 and 0.5044 respectively. Again it shows a slight digit preference in LBI though the values are low which indicate a reasonable quality of data. Under the category of parity 7 to 12 the values of q_2 are higher for both LBI and OBI. On the 0 to 10 digit scale they measure 3.0528 and 3.2737 respectively. Thus comparing the q_2's for the two categories, the result shows that there is a high digit preference in the second category.

From table 4.4, we learn that the data is not of very low in quality as the values of DPQ_1 and DPQ_2 are all lower than 50 percent, however the slight existence of digit preference is likely to influence the overall result to some extent.

Tables of digit preference quotients by categories with education levels, place of residence for all the three birth intervals are shown in the appendix (**B**) tables **B1** to **B4**. Both the values of DPQ_1 and DPQ_2 give measurement on a zero to one scale and their values show the extent of digit preference on a particular birth interval.

In conclusion the data were observed to be both negatively and positively skewed when histogram analysis was used, thus none of the variable 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 background of digit preference the values of DPQ_1 and DPQ_2 were found to be lower than 50 percent in all the variables. Thus the quality of data was slightly fair.

CHAPTER FIVE

APPLICATION OF THE MODEL IN ESTIMATING OF FERTILITY LEVEL.

5.1 INTRODUCTION

This chapter focuses on the application of theoretical model discussed in chapter one and derived in chapter two and the analysis of birth-interval and their relationship with fertility level as set out in the objective of the study. The study at this point 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 of fertility in Kenya.

The background of this model is explained in chapter three and the derivation of the method is also given therein. Table 5.1 provides the data set used in the application of the model.

Table 5.1: Mean open and closed birth intervals by parity in years.

Parity (i)	Mean open interval	Mean closed interval
		3.3351
1	5.0431	3.3210
2	4.4029	3.4315
3	4.4377	3.3608
4	4.7748	3.3306
5	4.8387	3.2469
6	4.8522	3.4072
7	4.8547	3.4609
8	4.8980	

Source: KDHS 1993

The value of C=13 years and this is explained in chapter two. The sample of birth intervals used here are drawn for women ever - married.

5.2 COMPUTATIONAL PROCEDURE

Step 1

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

$$C^2 - 2CE(U_i) = 13^2 - 2x13x5.0431$$

$$= 37.8794, \text{ for } i=1$$

Table 5.2: A table of $C^2 - 2CE(U_i)$

Parity i	$C^2 - 2CE(U_i)$
1	37.8794
2	54.5246
3	53.6198
4	44.8552
5	43.1938
6	42.8428
7	42.7778
8	41.6520

Note:C=13 years.

Step 2

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

$$2E(U^2)[E(T^2) - C] = 2x4.4029[3.3210 - 13]$$

$$= -85.231338$$

the values for the expression for all the variable are tabulated in table 5.3.

Table 5.3: **Table of $2E(U_i)[E(T_i) - c]$**

Parity i	$2E(U_i)[E(T_i) - C]$
1	- 97.482114
2	- 85.231338
3	- 84.924265
4	- 92.050504
5	- 93.574652
6	- 94.647984
7	- 93.140332
8	- 93.445024

Source: Computed from 1993 KDHS.

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 $E(T_i^2)$ and is obtained by the following relationship

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

An illustration is given below.

$$E[T_6^2] = (3.2469)^2 + (1.5257)^2$$

$$\therefore \quad E(T^2_6) = 12.87012$$

these values are entered in table 5.4

Table 5.4: A table of second raw moment of closed birth interval for women of parity (i)

Parity i	$E(T_i^2)$
1	13.91097
2	14.068833
3	14.41062
4	14.296533
5	14.343705
6	12.870124
7	15.125762
8	15.686149

Source: Computed from 1993 KDHS.

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.

$$C^2 - E(T_i^2) = (13)^2 - 14.296533$$

$$= 154.70347$$

Table 5.5 shows the values obtained in step 4.

Table 5.5: A table of $C^2 - E(T_i^2)$

Parity i	$C^2 - E(T_i^2)$
1	155.08903
2	154.93117
3	154.58938
4	154.70347
5	154.6563
6	156.12988
7	153.87424
8	153.31385

Source: Computed from 1993 KDHS.

Step 5.

Calculation of the sum of values obtained in step 2 and step 4. this provide the denominator (Den) of the PPRs (Parity progression Ratios). An illustration is given by the following example

For i = 3

$$Den_3 = 154.58938 - 84.924265$$

$$= 69.665115$$

Table 5.6 gives the results of this step

Table 5.6: A table of the denominator of PPRs.

Parity i	Den. i
1	57.606916
2	69.699832
3	69.665115
4	62.652966
5	61.081648
6	61.481896
7	60.733908
8	59.868827

Source: Computed from 1993 KDHS.

Step 6.

Calculation of parity progression ratios (PPRs) for every value i. These values (PPRs) are computed by dividing the entries in table 5.2 by those in table 5.6. The value of PPR(4), for example is computed as

$$PPR_{(4)} = \frac{44.8552}{62.652966}$$

$$= 0.7159309$$

Table 5.7 shows the entries of these values for every parity (i).

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

Parity i	$PPR^{(i)} = \alpha_i$
1	0.65755
2	0.78228
3	0.76968
4	0.71593
5	0.70715
6	0.69684
7	0.70435
8	0.69574
MCEB	3.51475

source: Computed from 1993 KDHS.

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 table of computed results.

Parity (i)	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
1	37.8794	-97.482	13.9110	155.089	57.6069	0.65755
2	54.5246	-85.231	14.0688	154.931	69.6998	0.78228
3	53.6198	-84.924	14.4106	154.589	69.6651	0.76968
4	44.8552	-92.051	14.2965	154.703	62.6530	0.71593
5	43.1938	-93.575	14.3437	154.656	61.0816	0.70715
6	42.8428	-94.648	12.8701	156.130	61.4819	0.69684
7	42.7778	-93.140	15.1258	153.874	60.7339	0.70435
8	41.6520	-93.445	15.6861	153.314	59.8688	0.69574

Source: computed from 1993 KDHS.

Note: these values show the IPPRs for women of parity(i) during the period spanned by "C" i.e 13 years prior to survey date, (1980-1993).

Key:	
Column 1	Table 5.2
Column 2	Table 5.3
Column 3	Table 5.4
Column 4	Table 5.5
Column 5	Table 5.6
Column 6	Table 5.7

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 70% of women who had a seventh child progressed to have an eighth child. The result showed that the national fertility level was 3.515 children per woman considered in the survey.

Observation show that the fertility trend revealed by this finding is plausible to that obtained by Njogu (1991) which is presented in the columns one and three in table 5.9.

A general look at the PPRs over parities indicated the following, although it is not very clear what happened at parity one, since the value is very low, a good resumption was seen in parity two where 78% of those women who had the first child went for the second birth. In parity three the proportion dropped to 77%, the pattern is observed to continue through parities 4,5 and 6. It is not very clear what happened at the higher parities, where the values of PPRs are observed to level off as opposed to a steep declining values which are expected. This flat behaviour of PPRs could be due to age misreporting which possibly pushed many women up across the age - group limit or few cases in the higher categories which arose as a result of selection bias in the survey or may be real effect due to heterogeneity in the population; there is one small group of women with extremely high fertility which, beyond a certain parity, dominate the picture (Lutz, 1989) and the quality of data which was dealt with in chapter three. It was underlined that the quality of data was likely to affect the result to some extent. As has been noted above only Njogu's (1991) work is available to compare with this result. The main purpose of comparing is to derive any plausibility between the two.

Table 5.9: A table of comparison of PPR's for the data of 1977/78 (KFS), 1989 and 1993 KDHs.

Parity (i)	1977/78 (KFS)	1989 (KDHS)	1993 (KDHS)	absolute difference (2)-(3)
1	0.89	0.86	0.66	0.20
2	0.91	0.85	0.78	0.07
3	0.93	0.84	0.77	0.07
4	0.91	0.85	0.72	0.13
5	0.86	0.84	0.71	0.13
6	0.84	0.77	0.70	0.07
7	0.84	0.80	0.70	0.10
8+	0.78	0.67	0.70	- 0.03

Source: KDHS preceding 3, 1883-1901.

The table show that the results of this study (column 3) are plausible when compared to the results obtained by Njogu (1991). These are presented in columns one and two. The results obtained by Njogu were obtained through the empirically based models. This model was based on observed proportions not progressing within 60 months (5 years) from previous birth and developed further through hazard models. For this study the applied model is a mathematical (analytical) procedure and this makes the difference between the two approaches. Column 3 was obtained by this analytical method. It is important to note that while the differences in the approaches are outlined the obtained results were plausible and showed the same patterns in terms of trends across the parities, refer to figure 4.2 in page 68. A low value of PPR in parity one for columns 3 could be attributed to many young women not marrying, subfecundity and unstable marriages.

The graphical evidence available in figure 4.1 shows a decline from parity two through parity six with an abnormality in parity seven and then a resumption in parity eight. The graph thus provide a very clear picture of fertility behaviour between a period of 1978 and 1993. It is therefore very important to introduce differentials in our discussion in order to see if patterns exhibited by different groups are similar or not.

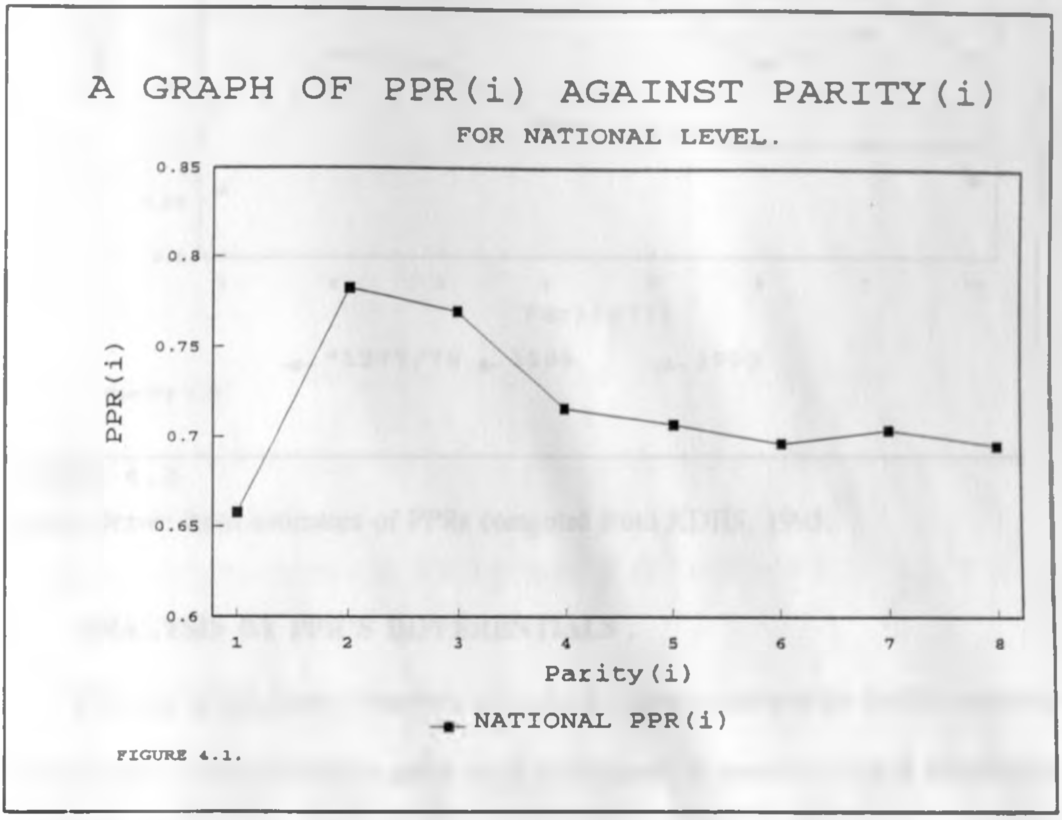


FIGURE 4.1

Source: Drawn from estimates of PPRs computed from KDHS, 1993.

Figure 4.2 shows the comparison of the results obtained in this thesis and the work done by Njogu (1991) using KFS (1978)and KDHS (1989) data sets. The graph shows that the results are plausible.

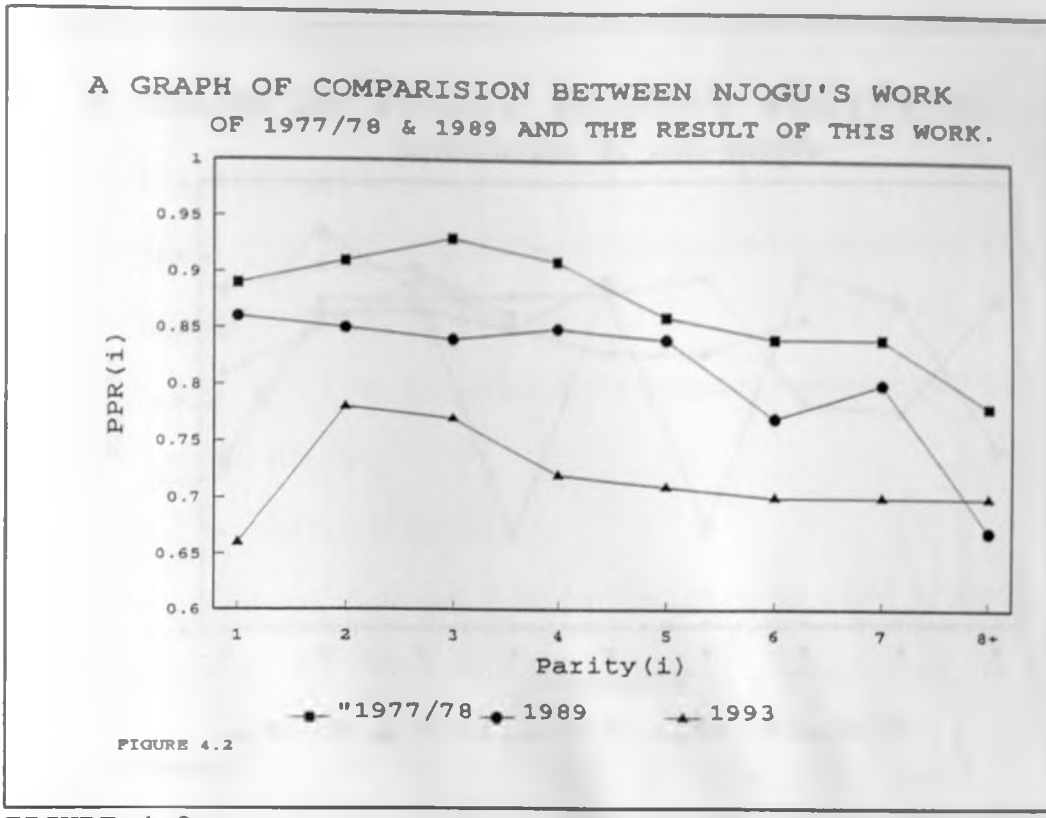


FIGURE 4.2

Source: Drawn from estimates of PPRs computed from KDHS, 1993.

5.4 ANALYSIS BY PPR'S DIFFERENTIALS .

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

5.4.1 AGE DIFFERENTIALS.

Analysis carried out through age cohorts displayed differentials. The following were the age cohorts considered ; 25-29, 30-34, 35-39, 40-44 and 45-49. Their results are displayed both in table 5.10 and figure 4.3.

The graphical evidence in figure 4.3 (drawn from table 5.10) display various patterns of PPRs for different age-groups. Among the age-groups considered are 25-29 and above because a Kenyan woman is considered to have achieved almost 60 percent of her total births by age 30 years (KDHS, 1993, pg.21).

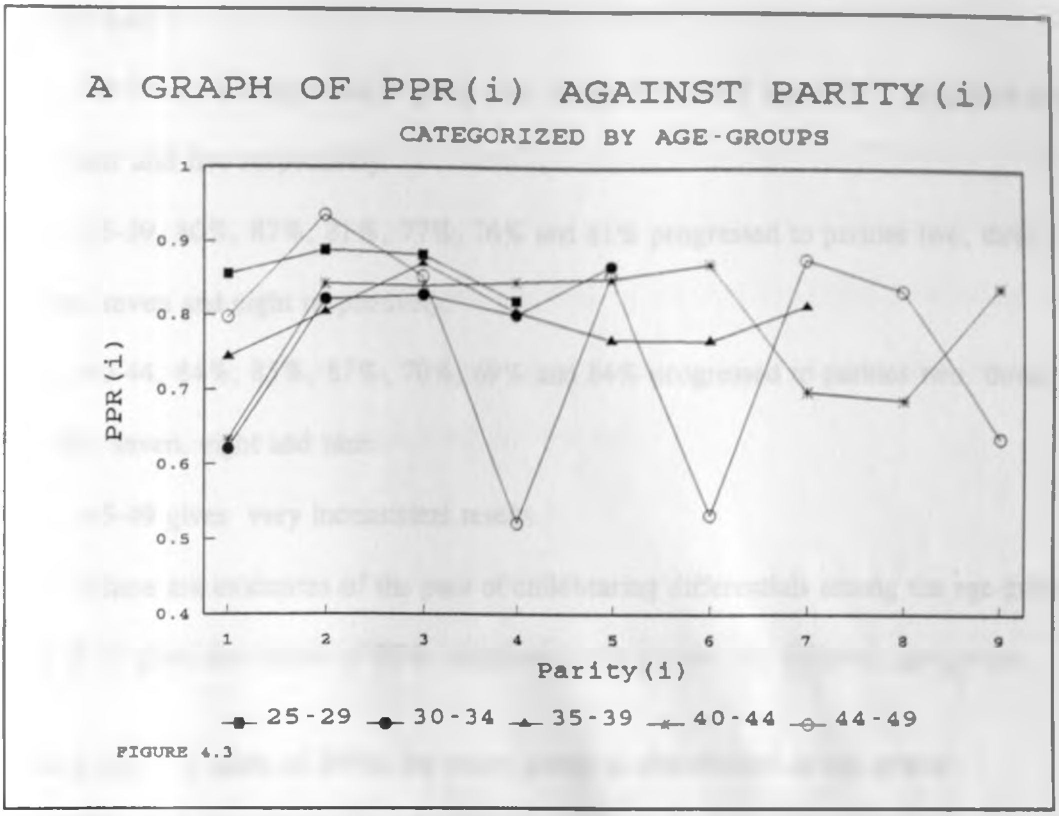


FIGURE 4.3

Source: Drawn from estimates of PPRs computed from KDHS, 1993.

These graphs indicated that only age-groups 25-29 and 35-39 showed a consistent decline in PPRs values, however for age-group 35-39 the attenuation was observed in parity seven and this could be due to errors such as memory lapse, digit preference, age misreporting or due to many fertile women considered in that group of sample. Attenuations were observed to be a common feature in these graphs, most especially 30-34, 40-44 and 45-49 age-groups and these could be attributed to the same sources as ones mentioned for the other age-groups. The most affected age-groups were 40-44 and 45-49. The age factor therefore provided no clear pattern of process as measured by PPRs. However, the truncated study at parity four suggested that all the age-group cohorts had the same trend of childbearing in the lower order births except for age-group 40-44 which showed a negative deviation.

However, the tabular information given in table 5.10 suggest that age-groups;

(1). 25-29, 89% of women progressed to parity two, 88% to parity three and 82% moves to parity four.

(2). 30-34, 82% progressed to parity two, while 83%, 80% and 87% progressed to parities three, four and five respectively.

(3). 35-39, 80%, 87%, 81%, 77%, 76% and 81% progressed to parities two, three, four, five six, seven and eight respectively.

(4). 40-44, 84%, 85%, 87%, 70%, 69% and 84% progressed to parities two, three, four, five, six, seven, eight and nine.

(5). 45-49 gives very inconsistent results.

These are evidences of the pace of childbearing differentials among the age-groups. Table 5.10 gives the values of PPRs distributed with parities for different age-groups.

Table 5.10: A table of PPRs for every parity (i) distributed as age-group

Parity (i)	(1) 25 - 29	(2) 30 - 34	(3) 35 - 39	(4) 40 - 44	(5) 45 - 49
1	0.85537	0.62092	0.74399	0.63204	0.79719
2	0.88834	0.82189	0.80473	0.84228	0.93505
3	0.88248	0.82740	0.87027	0.83958	0.85269
4	0.82023	0.80147	0.80530	0.84589	0.52168
5	-	0.86800	0.76818	0.85095	0.85504
6	-	-	0.76689	0.87009	0.53275
7	-	-	0.81402	0.69854	0.87700
8	-	-	-	0.68661	0.83469
9	-	-	-	0.83861	0.63665

Source: Computed from 1993 KDHS.

Table 5.11 gives the absolute differences of the proportion of women moving to the next parity truncated at parity four. Using 25-29 age group as a standard reference to compare the pace of childbearing, because it is a more recent age cohort, the following observations were realized; (1) the values of PPRs for this group (25-29) are so high for almost every parity, (2) the values of absolute differences decreased as the parity increased. This observation suggest that while the pace of childbearing was high in the earlier parities there was a possibility of this pace of childbearing slowing suddenly as the others progressed. This evidence is shown by the pattern of decrement in the values of absolute differences. Abnormality was only experienced in the last column {(1) - (5)} and this could be attributed to memory lapse among the group. Table 5.10 gives the details of pace of childbearing (PPR's) with parities. From the observation made in table 5.10a the slowing in fertility could therefore be attributed to limiting of family sizes in lower age - groups since the pace of childbearing was observed to be high up to higher parities for groups considered to have completed their parities.

Table 5.11: The table of absolute differences

Parity (i)	abs.diff. (1)-(2)	abs. diff. (1)-(3)	abs.diff. (1)-(4)	abs. dif. (1)-(5)
1	0.23445	0.11138	0.22333	0.05818
2	0.06645	0.08361	0.04606	- 0.04671
3	0.05508	0.01221	0.04290	0.02979
4	0.01876	0.01493	-0.0257	0.29855

__Source:__ Computed from 1993 KDHS

5.4.2. EDUCATIONAL DIFFERENTIALS.

Educational levels provided three categories (no education, primary, and secondary) for the study.

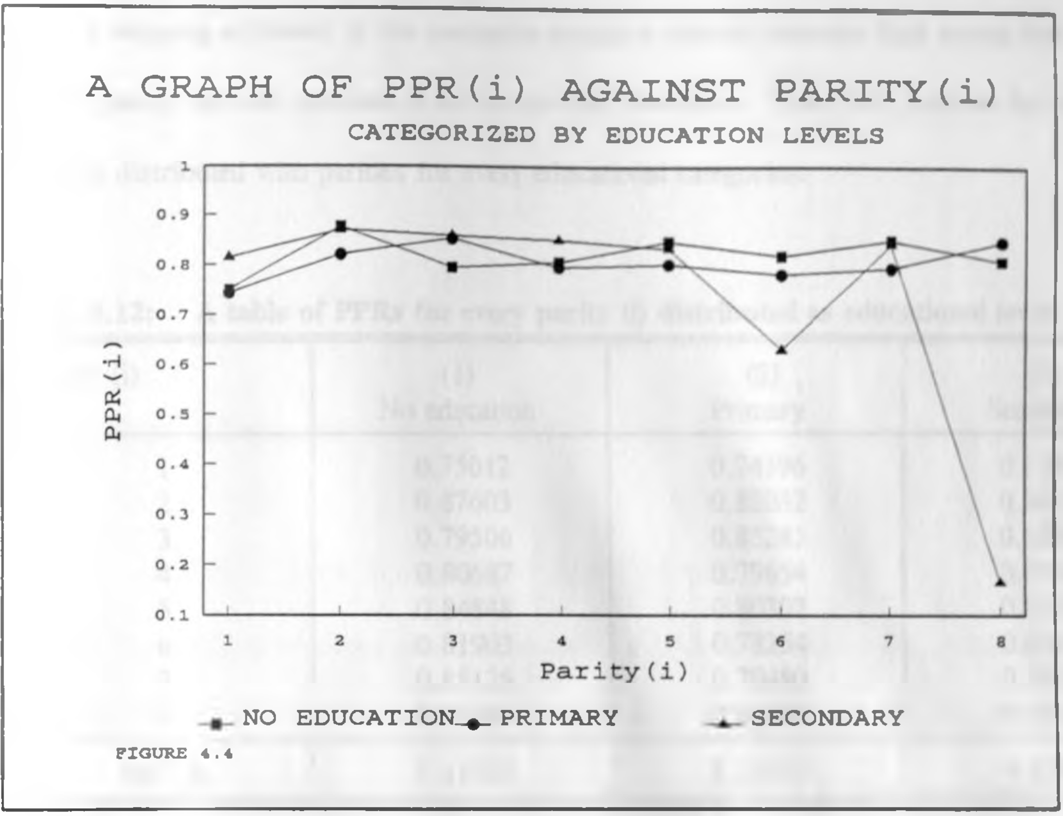


FIGURE 4.4

<u>Source</u>: Drawn from estimates of PPRs computed from KDHS, 1993.

It was noted from the graphs displayed in figure 4.4 that secondary category had a high propensity of childbearing in the lower parities up to parity five than any other group. 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 high values of PPRs in the lower parities indicated that because of later marriages by these groups many of them get children faster due to shorter birth intervals. 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. There is need to point out that both no education and primary categories would have reflected the same pattern on the pace of childbearing. However, the pace remained high for those categories and many still progressed to nine plus parities. The level of stopping exhibited by the secondary category was not uniquely high noting that the highest parity that was reported in the survey was seventeen. Table 5.12 provide the values of PPRs distributed with parities for every educational categories.

Table 5.12: A table of PPRs for every parity (i) distributed as educational levels

Parity (i)	(1) No education	(2) Primary	(3) Secondary
1	0.75012	0.74396	0.81451
2	0.87603	0.82032	0.86938
3	0.79506	0.85285	0.85903
4	0.80687	0.79654	0.85086
5	0.84848	0.80302	0.83488
6	0.81903	0.78254	0.63175
7	0.85126	0.79480	0.84335
8	0.81009	0.84866	0.16643
MCEB	5.31502	5.25096	4.62979

<u>**Source:**</u> Computed from 1993 KDHS.

Table 5.13 provide the information on absolute differences for parity progression ratios according to levels of education. When no education was used as a reference for comparison, the secondary category was observed to be significantly different. The value of absolute difference for parity eight was obtained to be very significant and this confirmed the early stopping of childbearing. Thus fertility level was found to be so much associated to limiting family size than spacing.

Table 5.13: A table of absolute differences for parity progression ratios according to level of education.

Parity (i)	absolute difference (1) - (2)	absolute difference (1) -(3)
1	0.00616	- 0.0644
2	0.05571	0.0066
3	- 0.05779	- 0.0640
4	0.01033	- 0.0440
5	0.04546	0.0136
6	0.03649	0.1873
7	0.05646	0.0079
8+	- 0.03857	0.6437

Source: Computed from 1993 KDHS.

5.4.3 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.

The evidence provided by figure 4.5 shows that urban category had higher values of PPRs from parity two to parity seven. From parity seven the trend dropped suddenly and steeply. The study therefore showed that the urban women had a high pace of childbearing. The graphs showed that while there was a sudden drop in the pace of childbearing for urban women, the rural women progressed to parity nine plus at a high pace of childbearing. The sudden drop could be attributed to limiting of family sizes while the high pace of childbearing could be associated with short birth intervals. Urban factor therefore has a lowering effect on the level of fertility.

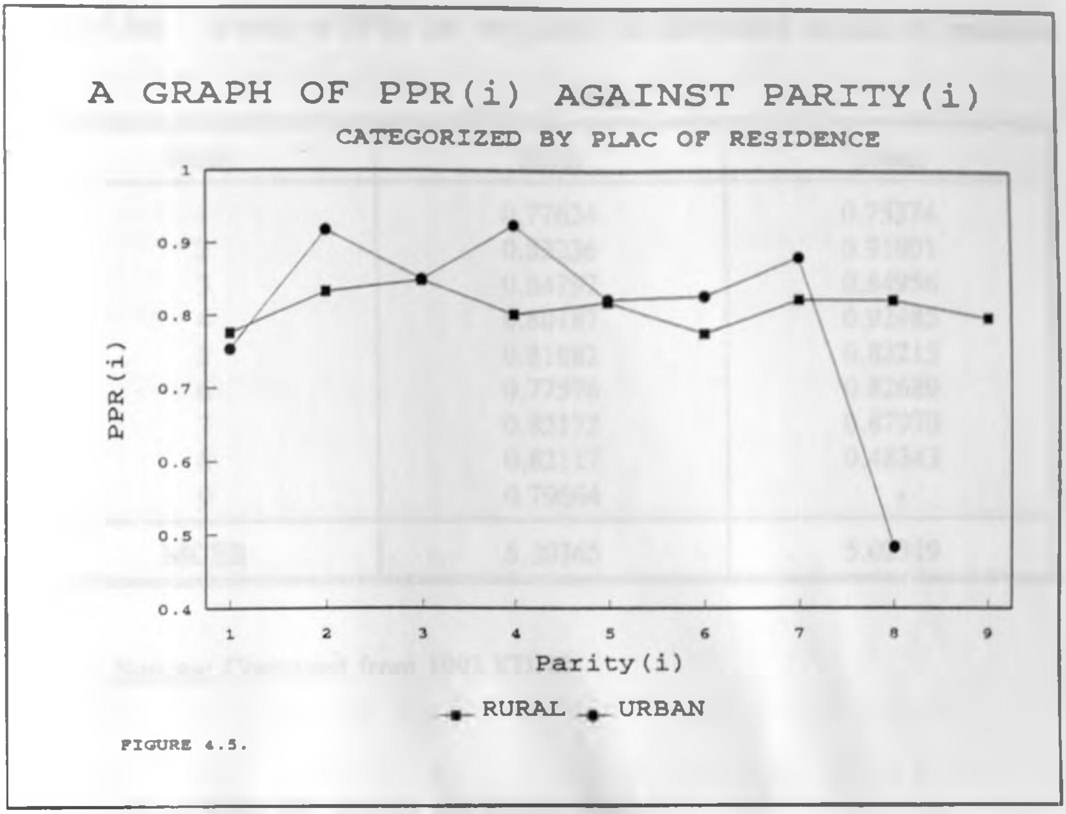


FIGURE 4.5

Source: Drawn from estimates of PPRs computed from KDHS, 1993.

Table 5.14 shows that while 80 percent of the rural women progressed to get a ninth child only 48 percent of the urban women progressed to eighth parity.

Table 5.14: A table of PPRs for very parity (i) distributed as place of residence

	PPRs	
Parity	Rural	Urban
1	0.77624	0.75374
2	0.83236	0.91801
3	0.84797	0.84956
4	0.80187	0.92485
5	0.81882	0.82215
6	0.77576	0.82689
7	0.82172	0.87970
8	0.82117	0.48343
9	0.79664	-
MCEB	5.20365	5.02319

Source: Computed from 1993 KDHS.

5.5. ANALYSIS BY MCEB DIFFERENTIALS .

Examining the relations between the mean children ever born (MCEB) and the factors (educational level and place of residence) included in the study, the results support the findings that have been discussed already. Table 5.14 shows the values of MCEB for every category of both the educational level and place of residence.

Under the educational level the low values of MCEB (4.62979) of the secondary category supports the findings that women with secondary education have earlier stopping. The finding suggest that women falling in the primary category had a high value of MCEB (5.25096), summary measure of fertility. These results agree with the results obtained by the conventional methods.

Considering the place of residence factors, it is noted that the value of MCEB (5.02319) for the women in the urban is lower than the value of MCEB (5.20365) for the rural women and this further confirms that the urban women had an early stopping of childbearing.

Table 5.15: A table of some socio-economic variables with their MCEB.

Variables	$MCEB = 1 + P_1 + P_1P_2 + P_1P_2P_3 \ldots + \frac{P_1P_2P_3P_4 \ldots P_n}{1 - P_n}$
1. Educational level	
No Education	5.31502
Primary	5.25096
Secondary	4.62979
2. Place of Residence	
Urban	
Rural	5.02319
	5.20365

Source: Computed from 1993 KDHS.

The study of these factors i.e educational level, place of residence and the age factor showed the existence of fertility decline and the revelations points out that inspite of the positive outcome in the study many women still progressed to higher parities despite their status.

CHAPTER SIX

BIRTH - INTERVAL ANALYSIS.

6.1 INTRODUCTION

Studies carried out on the relationship between the birth - interval (both open and last closed) and the pace of childbearing indicate a direct relation. In this study observation has been made on both the open and last closed intervals and how they influence the pace of childbearing and the family size. In this thesis these intervals are discussed in three different categories i.e when all women are grouped together, categorized by their place of residence and by their level of education.

6.2 NON - CATEGORIZED BIRTH - INTERVALS

Table 5.1 provide 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 intervals (LBI) and open birth intervals (OBI) which are all distributed with respect to parities. The lengths of the intervals were observed to be flat i.e. about five years for OBI and three years for LBI. Although the lengths at higher parities were slightly longer as was expected because of the age effect, the differences were insignificantly small to prompt a comprehensive deduction. A study of birth interval differentials therefore stands to provide an insight for the relationships.

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

6.3 EDUCATIONAL DIFFERENTIALS

According to the levels of education considered (no education, primary and secondary) the tables **A13** to **A15** in appendix **(A)** provide the distributions of ACBI, LBI and OBI with respect to parities. The ACBI, LBI distributions indicated a flat length of intervals of approximately three years (36 months). While OBI showed almost a constant length of four years (48 months). Only for OBI was a growing trend realized with a clear pattern emerging for secondary category. When the mean intervals (ACBI, LBI and OBI) were computed it was noticed that for both the all closed and last closed birth intervals the duration of the lengths were approximately three years. However, the lengths of the intervals (ACBI and LBI) for secondary category were slightly shorter than for other categories i.e primary and no education. Table 6.1 displays the distributions of the mean intervals against education levels.

Table 6.1: Mean birth intervals against educational levels

Educational Level	ACBI (YEARS)	LBI (YRS)	OBI (YRS)
No education	3.4236	3.3412	4.0036
Primary	3.4509	3.3193	4.1546
Secondary	3.2710	3.2502	3.9710

Source: Computed from 1993 KDHS.

Open birth interval for secondary category was the shortest. From the table secondary category showed a higher speed of childbearing.

6.4: PLACE OF RESIDENCE DIFFERENTIAL

When the place of residence (urban and rural) were considered (see tables **A16** and **A17** in appendix **(A)**) it was observed that for all parities the lengths of ACBI and LBI were approximately three years (36 months) both for urban and rural women. Thus the trends over parities were observed to be rather flat. For both the urban and rural women the OBI were approximately four years (48 months). When the mean intervals were calculated according to table 6.1, it was observed that for urban category all the intervals (ACBI, LBI OBI) were shorter than their corresponding rural birth intervals. Thus the urban women displayed a higher speed of child bearing.

Table 6.2: Mean birth intervals against place of residence

Place of residence	ACBI (Yrs)	LBI (Yrs)	OBI (Yrs)
Urban	3.328	3.098	3.771
Rural	3.439	3.354	4.107

<u>Source:</u> Computed from 1993 KDHS.

According to table 5.2 the mean open birth interval for urban women was found to be shorter than their counterparts.

6.5 DISCUSSION OF THE RESULTS

A general look at the speed or proportion of women progressing to the next birth or parities both by education level and place of residence, various trends were observed. Secondary category, as a level of education, reflected a high but stable PPR'S until parity five with a significant or sharp drop from parity six. However, attenuaty was noted in parity seven and this could be attributed to age misreporting or digit preference among that cohort. Among the no education and primary categories, the trends were marked with attenuation which could be explained on the same background as the above. When urban category (as a place of residence) was considered, the trend indicated that lower parities were marked by attenuation up to parity four, from then a drop was observed to higher parities. The attenuations at early parities could be explained by factors such as contraceptive practices or subfecundity due to natural causes, memory lapse or digit preference. This trend was observed to be contrary to the rural trend which was marked by attenuations through out. These attenuations could be attributed to the same reasons as has been outlined for urban women.

In conclusion the spacing was observed to be stable and relatively short among the secondary women progressing to the next parity. The mean length of ACBI was noted as 3.27 years and was found to be slightly shorter than the two categories, i.e. no education and primary education. In terms of the pace of childbearing in secondary category, the process was stable and high in the lower parities and a sharp drop in the high parities. This could be due to limiting of family sizes through the contraceptive use or infecundability due to natural causes. On the other hand it was observed that among the place of residence categories i.e. urban and rural, the proportion of urban women moving to the next parity in lower parities were found to be very high but unstable with spacing of approximately of 3.33 years while for rural women it was 3.44 years. A sharp drop was observed among the urban women in higher parities and this could be an indication of existence of limiting of family size. From the above evidences the attainment of the current fertility level may be attributed to limiting of family sizes than birth spacing. Considering the measures of the family size ie MCEB, table 5.12 shows that secondary had the lowest value, of MCEB (4.63) than the other categories. Similarly urban category, for place of residence also gave the lowest value of MCEB(5.02).

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

Considering the educational levels, secondary category showed a high pace of childbearing in the lower parities with a shorter spacing of approximately of 3.27 years and a sudden drop in parities six and eight respectively. The high pace of childbearing in early parities could be due to late marriage because of long time in school while the sudden drop in the pace was because of limitation of family size. The quantum of family size showed that this category had the lowest family size (4.63) as measured by MCEB.

According to the place of residence the results indicated that the pace of childbearing was faster among urban women in their early parities also their spacing was shorter (3.33 years). It was noted that in the higher parities there was a sudden drop indicating a limitation of family size. The value of MCEB (5.02) was lower than the rural value of 5.33 children per woman.

From the two categories discussed above it was realized that the fertility level in Kenya depended on limitation of family size rather than birth spacing.

CHAPTER SEVEN

SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 SUMMARY

The aim of this thesis was to study/analyse the Kenya's fertility levels and tempo using data from Kenya Demographic and Health Survey (KDHS) for the year 1993.

The procedure was based on the information of birth interval distribution for women categorized by the number of children ever born which was defined through out the work as parity(i). The birth interval distribution used here were open birth interval and the last closed birth interval. The study adopted no adjustment of the data but underlined the possibility of the result of the study not being very good due to some errors discussed in chapter three, under the topic of checking the quality of data on closed and open birth intervals.

Yadav and Bhattacharya's modification to Srinivasan model described in chapter three was the main method in estimating the proportion of women progressing from parity (i) to parity (i+1). It was selected for the study because of the availability of its data requirements. The application of this method depends on the assumption of choosing a particular period of time from the time of the survey within which the progression from a particular parity (i) to parity (i+1) is considered very negligible. The estimated proportions of women called PPRs was used as an indicator or pace of fertility within a given parity group.

In chapter four, the quality of the data on birth interval (closed and open) were analysed to ascertain the level of its quality. The analysis focused on:

1. The standard error of the variables used which indicated a good quality.
2. Also included in the analysis was the digit preferences of these variables at parity levels.

The quality of the data was found to be very high in terms of sampling design, and by the standard error level. However with respect to digit preferences the level of quality was established to be slightly low and therefore had high possibilities of influencing the result.

Chapter five presented the results of application of the method to Kenya's data. The results are presented at national level, by level of education, place of residence and age-groups. Chapter six discussed birth interval and its relation to pace of childbearing.

At national level the values of PPR's falls between 0.78228 at parity (2) and 0.69574 at parity (8). Parity eight was considered as the highest value since there were fewer cases beyond that value. The values of PPR's were observed to decline, from parity two steadily to parity eight. The value of MCEB (3.515) was not very far from KDHS 1993 observed value (3.17), however the difference in the two can be explained on the background of the methods.

The results due to educational levels were analysed in three different categories, identified as no education, primary and secondary. No education category revealed inconsistent result, primary category provided the values of PPR's falling between 0.82032 for parity (2) and 0.78254 for parity (6). The secondary level category showed that only 17 percent of the women had the eighth child and this sharp drop indicated the evidence of limitation of family sizes.

Using the place of residence as a factor in the analysis, the study was conducted on the basis of urban and rural category. It was noted that under the rural category the results were very unstable and about 80 percent of women who had the eighth child progressed to get the ninth child. Under the urban category there was no ninth child and only about 48 percent of the women had the seventh child moved on to get the eighth child, could be due to the existence of limitations in family size.

Computations made according to cohorts by age-groups also provided the same information. The analysis of 25-29, 30-34, 35-39, 40-44,and 45-49 age-group revealed that the 35-39 results (pprs) were more consistent in comparison to others except the 25-29 age-group. Table 5.11 showed that the values of absolute differences between 25-29 age-groups and other age-groups were dropping very fast indicating a fast drop in family size for 25-29 age - group.

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 (4.63), followed by primary category with a value of MCEB(5.29) and no education category of MCEB (5.32). On the other hand, the urban category had a value of MCEB (5.02) and the rural category had a value of MCEB (5.20). These values were used to estimate differences in pace (tempo) and quantum of childbearing.

Considering the birth interval analysis done in chapter five, the study on the speed of childbearing as measured by birth spacing showed that among the educational levels (no education, primary and secondary) secondary category depicted the highest speed (tempo) of childbearing in lower order births with a shorter birth spacing of 3.27 years. Similarly, the same observation was made among the urban women. They also showed a higher speed of childbearing in lower order births with a birth spacing of 3.33 years. This was infact shorter than the rural birth spacing of about 3.44 years.

7.2 CONCLUSION

The birth intervals provided another way of looking at fertility rather than concentrating on what happens in between. It translated into pace of childbearing as observed from the proportion (PPRs) of women progressing to higher order births. On the side of tempo of childbearing, the national last closed birth interval was computed to be approximately three years. However, the figures for this interval varied with parities and socio-economic backgrounds. It therefore helped to explain faster childbearing patterns experienced by different socio-economic backgrounds.

The values of PPRs obtained from birth intervals distribution provided an insight of what happens at the parity levels in terms of pace of childbearing. It provided the information about the propensity of childbearing for women defined by different backgrounds. For the levels of fertility, the summary measure, PPRs aggregated to provide MCEB both at national level and differential levels. Thus PPRs provided a more analytic approach to the study of fertility lacking in the conventional methods.

The model of analysis appeared good enough for the estimation of fertility level since the overall result obtained were plausible with the ones obtained from the empirical approach based on observed proportion of fertile women. The method reduces the chances of truncating the fertile women by lengthening the open birth interval.However, the method is sensitive to errors due to reporting of vital events.

The quality of data was established to be fair because it recorded a slight digit preference. It was observed that the values of DPQ_1 and DPQ_2 were lower than 50 percent for all the variables. However, the survey data normally suffer the error due selection bias and the results into fewer cases of respondents with higher order births. Nevertheless, the standard errors of birth intervals indicated a high degree of sampling. According to this analysis the data was reasonably good.

The results of the study obtained outlined the achievements of the objectives of the study. Although the results were obtained, the limitation in time resulted into fitting of data to a particular model. This limited the scope of the study, hence denied the study a chance to compare the applicability of the other models.

7.3 RECOMMENDATIONS

The results of the estimates of the parity progression ratios and their behaviour across the parities strongly indicated the existence of fertility decline though the pace and quantum of childbearing were still high.These high figures at higher parities suggest that many women still have propensity to give birth even at higher parities. The results also indicated that education and place of residence played a positive role in slowing the pace of childbearing. Similarly, since fertility change is an important demographical characteristic because it points at the pace of family formation, more research is needed to establish other socio-economic factors that might further explain the determinants of pace (tempo) of fertility change.

Appendix **(A)**, tables **A4** and **A6** showed that within the level of education, secondary category had the lowest ACBI followed by primary category and then lastly no education category, on the other hand the values of calculated MCEB, refer table 5.12 chapter 4 showed that secondary category had the lowest value of MCEB (4.629) followed by primary category with a value of MCEB(5.251)and lastly no education category with MCEB of (5.315). The relation between ACBI and level of fertility suggest that the short length of LBI and low value of MCEB among the secondary women is either due to limiting practices encouraged by family planning programmes or later age of onset to reproduction (Otieno, 1989). Following this argument it is necessary to suggest:

1. To the family planners that there is need to teach the none educated and least educated women the benefit of increasing the age at first birth so that their long inter live birth can play a role in reduction of fertility.

2. That the government should have an integrated approach towards policies to reduce fertility not only through family planning programme but also enhancing higher education for women since the study has revealed that the fertility decline is very clear among women with secondary education.

Considering the results based on the place of residence, the study shows that the urban women have lower mean ACBI (3.33 yrs)and also lower MCEB. This relation shows that the urban women tend to be more receptive to family planning for limiting of births, thus there is need for family planners to intensify the limiting approach in their campaign of fertility reduction among the urban women to ensure that there is no unmet need for family planning among the urban women. On the other hand the rural women tend to be receptive to birth spacing , which is 3.33 yrs, between the consecutive births .There is the need for family planners to educate these women on the benefits of extending their birth intervals (because they already value it) with an aim of reducing fertility level and having good health.

On the methodological issues, the method was used because all the variables required were contained in the data. It is therefore necessary that more research should be done based on the primary data so that all the needed variables can be collected for the application of other methods for an excellent analysis. Thus a thorough work is needed to analyse the three sets of data (KFS, KDHS 1989 and 1993) using various models of parity progression ratios with an aim of establishing their applicability. This will justify whether or not there is need to carry out special surveys which can accommodate the applicabilities of these models.

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Appendix A: **Closed birth Interval and open birth interval**

Tabulation of Mean children ever born, last closed interval, all closed birth interval and open birth interval

This appendix contains tables - 1.1 to 1.12 on

(a) Mean children ever born (MCEB) by

(i) highest educational level

(ii) Age 5 - years group

(iii) Type of place of residence

(b) Last closed birth interval by

(i) highest education level

(ii) Age 5 - years group

(iii) Type of place of residence

(c) All closed birth interval by

(i) highest educational level

(ii) Age - 5 - years group

(iii) Type of place of residence

(d) Open birth interval by

(i) highest educational level

(ii) Age - 5 - years group

(iii) Type of place of residence

(e) Mean birth intervals by

(i) highest educational level

1 - No education

2 - Primary

3 - Secondary

(ii) Types of place of residence

1 - Urban

2 - Rural

Table A1: A table of mean children ever born with the highest education level

Education level	Mean (YRS)	Std dev. (YRS)	Cases
No education	5.7502	3.3344	1297
Primary	2.9281	3.0227	4449
Secondary	1.9203	2.1308	1757
Higher	1.0811	1.2775	37

Source: KDHS 1993

Table A2: A table of mean children ever born by Age 5 - years group

Age group	Mean (YRS)	Std. Dev. (YRS)	Cases
15-19	1.5691	2.7103	1759
20-24	2.1726	2.4751	1564
25-29	2.9856	2.2980	1179
30-34	3.9399	2.6984	1082
35-39	4.8027	3.1203	730
40-44	5.3469	3.5421	640
45-49	5.9229	3.9121	426

Source: KDHS 1993

Table A3 Mean children ever born by type of place of residence

Place of residence	Mean (YRS)	Std. Dev (YRS	Cases
Urban	1.9888	2.2858	1161
Rural	3.3845	3.2389	6379

Source: KDHS 1993

Table A4 Last closed birth interval by highest educational level

Educational level	Mean (YRS)	Std. Dev. (YRS)	Cases
No education	3.3412	1.5464	1096
Primary	3.3193	1.5344	3623
Secondary	3.2502	1.4853	1423
Higher	3.4375	1.8997	32

Source: KDHS 1993

Table A5: Last closed birth interval by Age 5 - years group

Age group	Mean (YRS)	Std. Dev. (YRS)	Cases
15-19	3.2422	1.4521	1412
20-24	3.3249	1.5006	1308
25-29	3.2658	1.4992	997
30-34	3.3431	1.5320	924
35-39	3.2952	1.5950	603
40-44	3.4764	1.6410	552
45-49	5.9229	1.6308	364

Source: KDHS 1993

Table A6: Last closed birth interval (LCBI) by type of place of residence

L C B I

Place of residence	Mean	Std. Dev	Cases
Urban	3.0980	1.3210	1061
Rural	3.3538	1.5604	5450

Source: KDHS 1993

Table A7: All closed birth interval (ACBI) by Highest educational level

A C B I

Educational level	Mean (YRS)	Std. Dve. (YRS)	Cases
No education	3.4236	1.6463	229
Primary	3.4509	1.5649	1333
Secondary	3.2710	1.4771	749
Higher	3.5385	1.0245	26

Source: KDHS 1993

Table A8: All closed birth interval (ACBI) by Age 5-years group

Age group	Mean (YRS)	Std. Dev. (YRS)	Cases
15-19	3.4152	1.5581	684
20-24	3.2928	1.4823	584
25-29	3.4670	1.5856	379
30-34	3.4187	1.5279	289
35-39	3.4162	1.6167	185
40-44	3.1716	1.4894	134
45-49	5.6739	1.8163	92

Source: KDHS 1993

Table A9: All closed birth interval (ACBI) by type of place of residence

A C B I

Place of residence	Mean (YRS)	Std. Dev (YRS)	Cases
Urban	3.3328	1.4880	1244
Rural	3.4390	1.6094	1246

Source: KDHS 1993

Table A10: Open birth interval (OBI) by Highest educational level

O B I

Educational level	Mean (years)	Std. Dev. (years)	Cases
No education	4.0036	2.8858	550
Primary	4.1546	2.8942	1352
Secondary	3.9710	2.7673	482
Higher	3.0909	2.5082	11

Source: KDHS 1993

Table A11: Open birth interval (OBI) by Age 5-years groups

Age group	Mean (YRS)	Std. Dev. (YRS)	Cases
15-19	3.7174	2.8004	322
20-24	4.3618	2.9441	445
25-29	3.8886	2.7803	440
30-34	4.0070	2.7886	426
35-39	4.2103	2.9717	290
40-44	4.2171	2.8659	281
45-49	4.1754	2.9192	171

Source: KDHS 1993

Table A12: Open birth interval (OBI) by type of place of residence

Place of residence	Mean (YRS)	Std. Dev. (YRS)	Cases
Urban	3.7711	2.6208	166
Rural	4.1069	2.8799	2320

Source: KDHS 1993

Table A13 Mean Birth intervals by No education level categorized by parity

Birth intervals in years

Parity (i)	ACBI	LCBI	OBI
1	2.5454	3.7407	4.5652
2	2.9653	3.5238	3.6757
3	3.4808	3.5138	4.2286
4	2.5602	3.4731	4.1800
5	3.3948	3.1215	3.8281
6	2.8948	3.2417	4.0615
7	3.6778	3.2083	3.8696
8	3.3473	3.3738	4.1791
9	1.9815	3.3232	4.2391

Source: KDHs 1993

Table A14 Mean Birth intervals by primary level categorized by parity (i)

Parity (i)	ACBI	LCBI	OBI
	Birth intervals in years		
1	3.1595	3.2910	4.5827
2	3.1756	3.2602	4.0679
3	2.7888	3.4157	3.8200
4	3.2370	3.3114	4.2595
5	3.0057	3.3643	4.2343
6	3.4548	3.1818	4.3485
7	2.5778	3.4224	4.2737
8	2.9633	3.4511	3.9178
9	3.5602	3.6040	4.4000

Source: KDHs 1993

Table A15 Mean Birth intervals by Secondary level categorized by parity (i)

Parity (i)	ACBI	LCBI	OBI
	Birth intervals in years		
1	2.9915	3.2431	4.1429
2	2.7534	3.1832	3.7013
3	2.7988	3.3609	3.7625
4	2.6551	3.2393	3.8485
5	2.8333	3.1687	3.9750
6	2.6923	3.3509	5.1212
7	2.9167	3.5000	3.8667
8	3.1875	3.3125	6.2857
9	1.4167	3.5000	3.8000

Source: KDHs 1993

Table A16 Mean Birth intervals of urban women categorized by parity (i)

Birth intervals in years

Parity (i)	ACBI	LCBI	OBI
1	3.0192	3.1954	4.5185
2	2.9728	3.1223	3.1071
3	2.7673	3.1509	3.8235
4	2.6303	3.2031	3.0667
5	2.9675	2.9412	3.1250
6	3.004	3.1500	4.0000
7	2.6402	3.0000	3.5000
8	3.9667	2.8000	5.6667
9	2.5833	4.1667	4.3333

Source: KDHs 1993

Table A17 Mean Birth intervals of urban women categorized by parity (i)

Birth intervals in years

Parity (i)	ACBI	LCBI	OBI
1	3.0464	3.3372	4.4000
2	3.1138	3.3127	4.0000
3	3.0106	3.4680	3.8589
4	3.5298	3.3361	4.2230
5	3.0599	2.3163	4.1027
6	3.4098	3.2325	4.3850
7	3.1458	3.3643	4.0904
8	3.2500	3.4481	4.1181
9	2.7600	3.4643	4.3010

Source: KDHs 1993

Appendix B Digit Preference Quotients Tabulation

This appendix contains Digit Preference Quotients (Q_1 and Q_2) for different types of birth intervals, classified by educational levels and place of residence.

Table B1: Digit Preference Quotients (DPQ_1) for All Birth Intervals classified by Education

Characteristics of women Educational status	ACBI	LCBI	OBI
No Education	0.176 (192)	0.162 (1002)	0.205 (525)
Primary	0.427 (708)	0.291 (2547)	0.293 (1211)
Secondary	0.511 (408)	0.336 (914)	0.276 (388)

Source: KDHs 1993

Table B2: Digit Preference Quotients (DPQ_2) (parity 1 to 6), DPQ_2 (Parity 7 to 12) for all birth intervals classified by Educational levels

Characteristics of women Educational status	ACBI		LCBI		OBI	
	P(1-6),	P(97-12)	P(1-6)	P(7-12)	P(1-6)	P(7-12)
No Education	0.054	0.287	0.184	0.270	0.119	0.254
Primary	0.280	0.373	0.072	0.356	0.102	0.331
Secondary	0.333	0.418	0.165	-	0.346	-

Source: KDHs 1993

Table B3: **Digit Preference Quotients (DPQ_1) for all birth intervals classified by place of Residence**

Place of Residence	ACBI	LCBI	OBI
Urban	0.082	0.354 (617)	0.318 (104)
Rural	0.375	0.271 (3858)	0.253 (2030)

Source: KDHs 1993

Table B4: **Digit Preference Quotients OPQ_2 (Parity 1 to 6), DPQ_2 (Parity 7 to 12) for All Birth Intervals classified by place of Residence**

Place of Residence	ACBI		LCBI		OBI	
	P(1-6)	P(7-12)	P(1-6)	(7-12)	P(1-6)	P(7-12)
Urban	0.278	0.343	0.276	0.300	0.135	-
Rural	0.283	0.292	0.073	0.300	0.051	0.323

Source: **KDHs 1993**

Table B5: **Digit Preference Quotient, q_1, for All Birth Intervals classified by Educational Level**

Educational Levels	ACBI	LCBI	OBI
No education	2.739	3.569	4.503
Primary	6.867	6.411	6.451
Secondary	7.680	7.400	6.072

Calculated from KDHS 1993

Table B6: **Digit Preference Quotient, q_2, for All Birth Intervals classified by Educational Level**

Educational Levels	ACBI Parity (1-6)	ACBI P(7-12)	LCBI P(1-6)	LCBI P(7-12)	OBI P(1-6)	OBI P(7-12)
No edu.	0.537	2.032	1.191	2.541	1.839	2.701
Primary	2.796	2.291	1.024	3.312	0.728	3.557
Secondary	3.330	-	2.463	-	1.65	-

Calculated from KDHS 1993

Table B7: **Digit Preference Quotient, q_1, for All Birth Intervals classified by Place of Residence**

Place of residence	ACBI	LCBI	OBI
Urban	7.874	7.788	7.000
Rural	8.292	5.9596	5.578

Calculated from KDHS 1993

Table B8: **Digit Preference Quotient, q_2, for All Birth Intervals classified by Place of Residence.**

Place of residence	ACBI P(1-6)	ACBI P(7-12)	LCBI P(1-6)	LCBI P(7-12)	OBI P(1-6)	OBI P(7-12)
Urban	2.580	3.000	2.760	3.00	1.346	-
Rural	2.688	2.920	0.729	2.997	0.508	3.234

Calculated from KDHS 1993

Appendix (C): Graphs of different values of "C"

This appendix contains graphs based on different values. The values considered here are C = 12, 13, 14 and 15 years. Also contained in the section is a graph of MCEB against different values of C

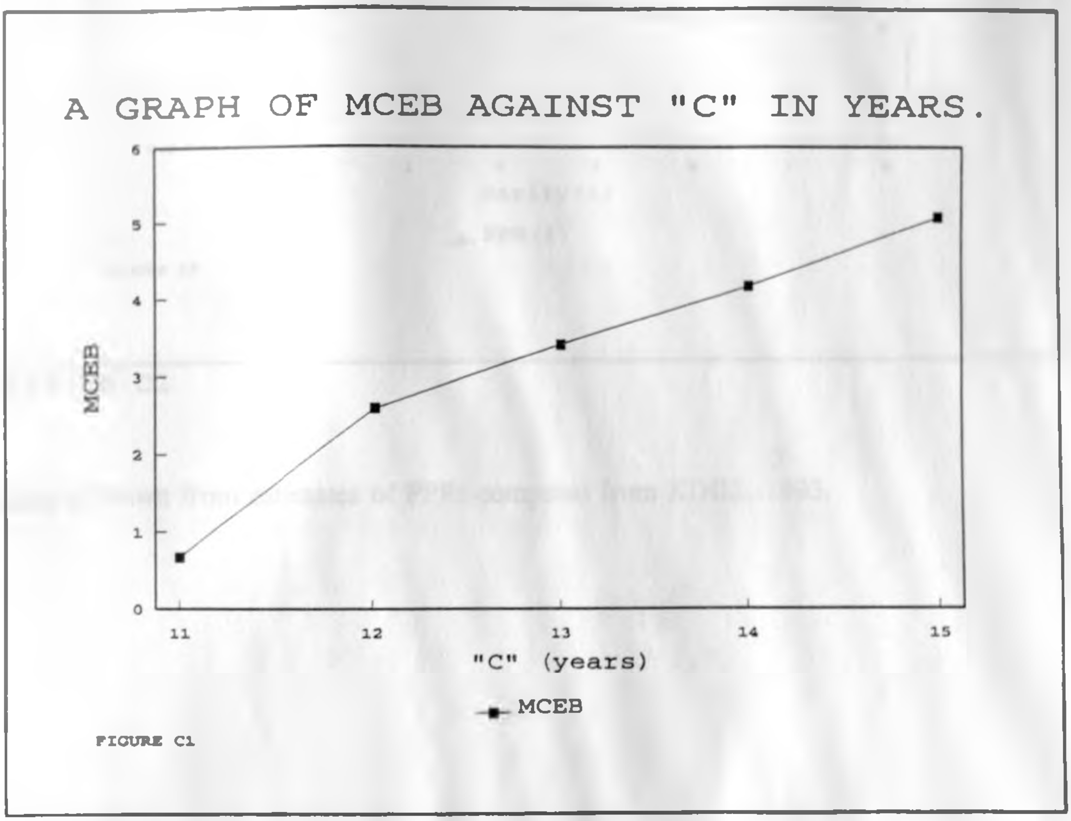


FIGURE C1

Source: Drawn from estimates of PPRs computed from KDHS, 1993.

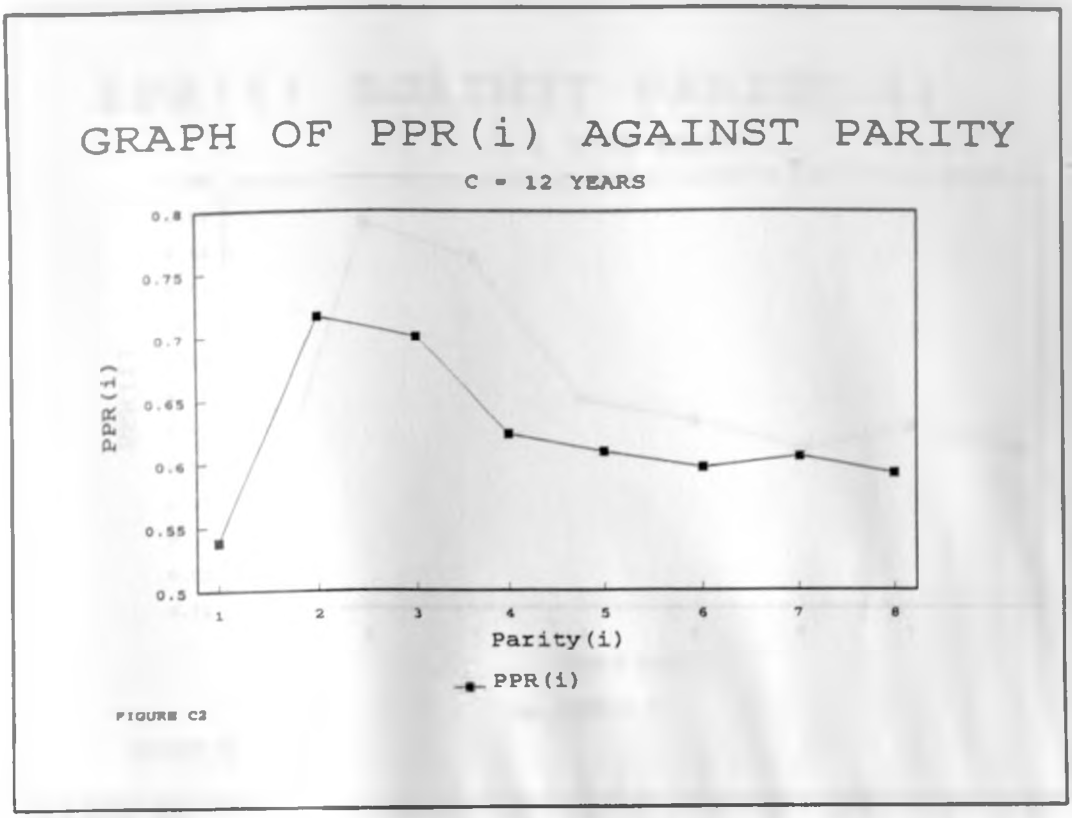


FIGURE C2

<u>Source</u>: Drawn from estimates of PPRs computed from KDHS, 1993.

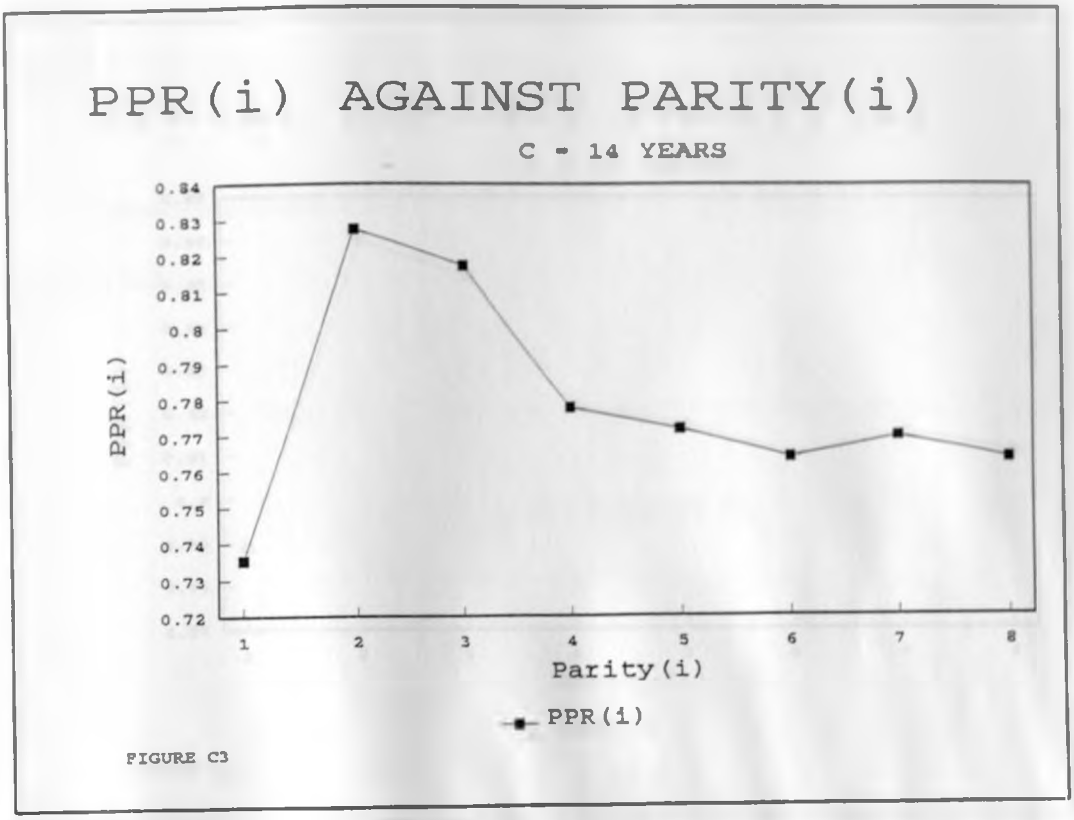


FIGURE C3

Source: Drawn from estimates of PPRs computed from KDHS, 1993.

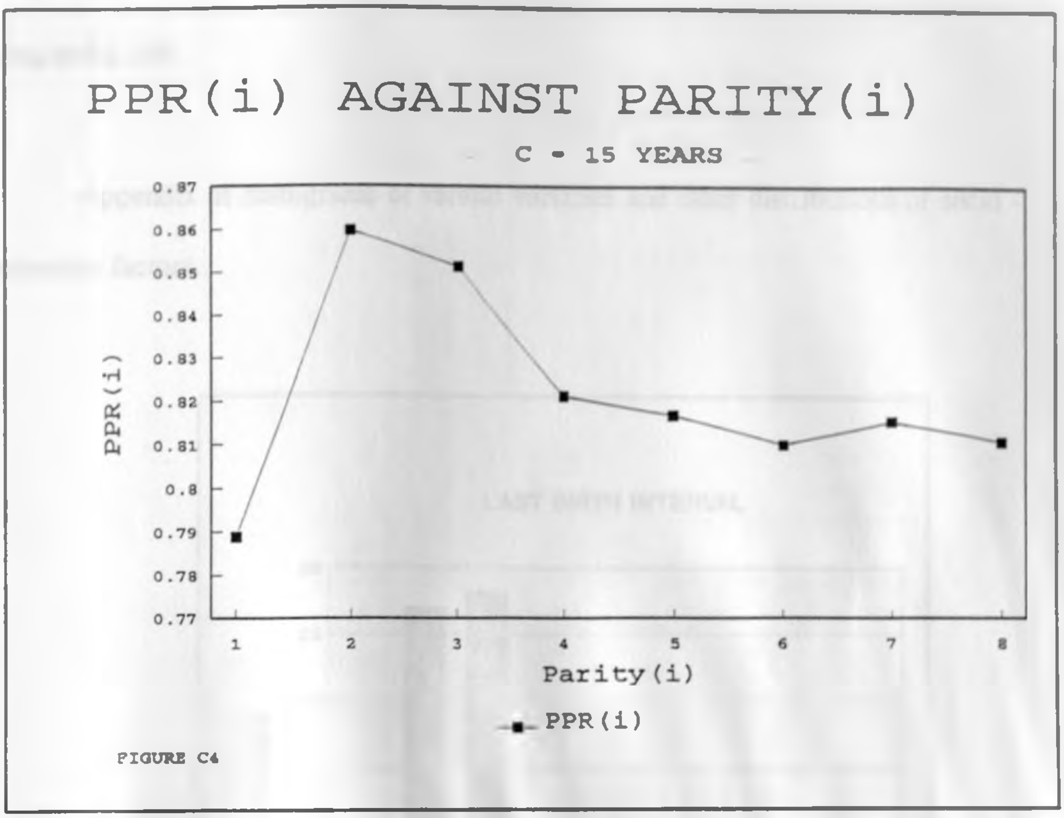


FIGURE C4

Source: Drawn from estimates of PPRs computed from KDHS, 1993.

Appendix (D)

Appendix of histograms of various variables and other distributions of socio - economic factors.

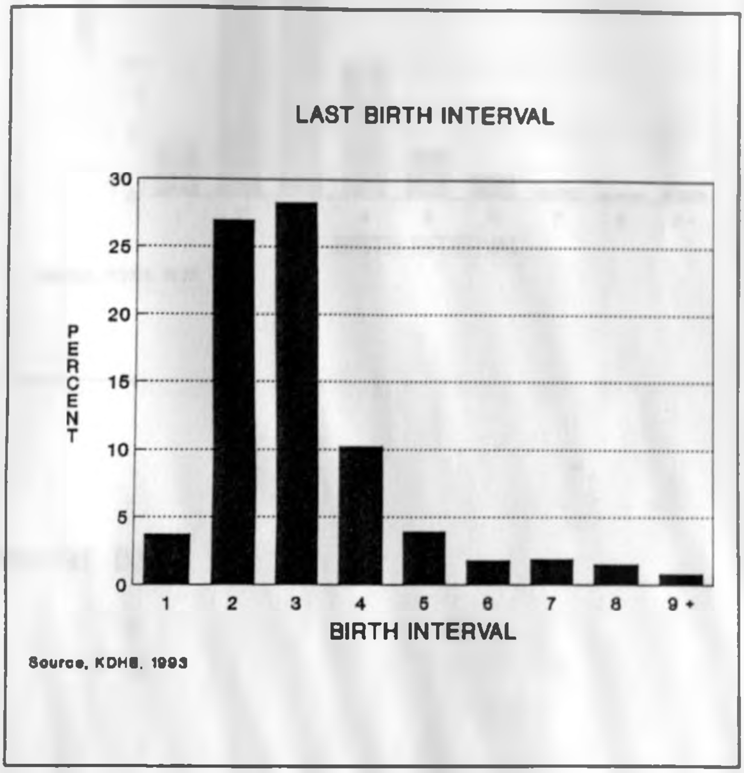


FIGURE D1

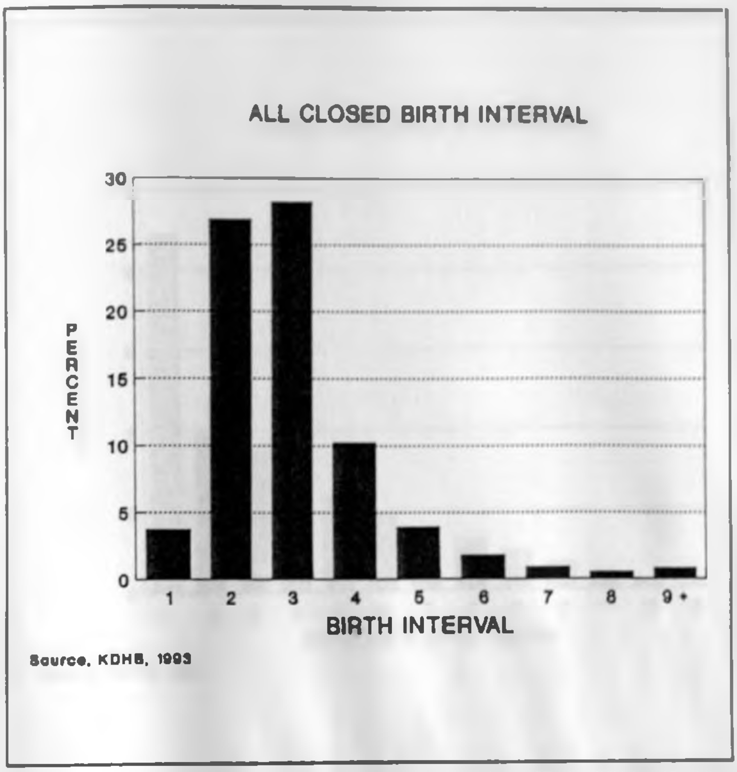

ALL CLOSED BIRTH INTERVAL
PERCENT
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9 +
BIRTH INTERVAL
Source. KDHS, 1993

FIGURE D2

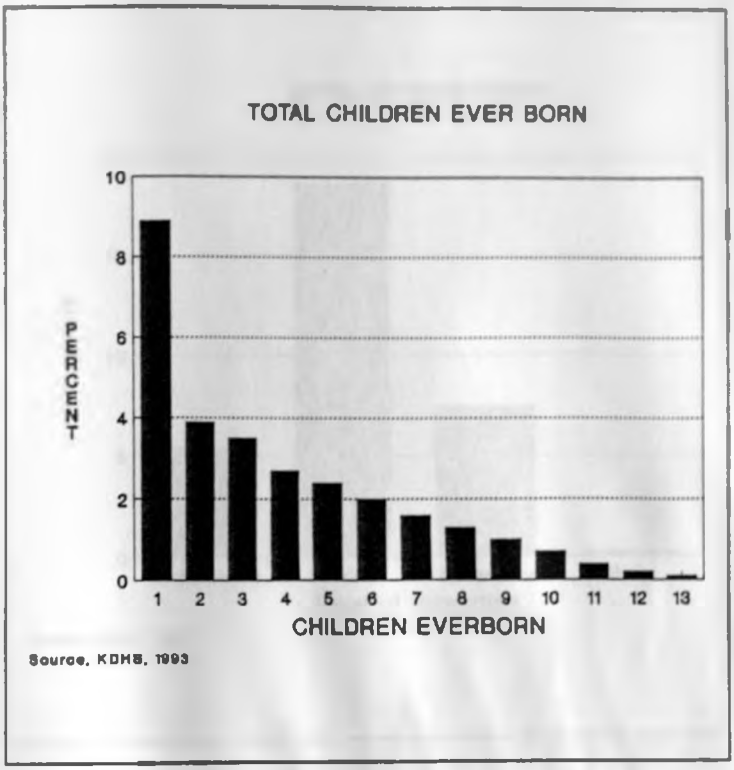
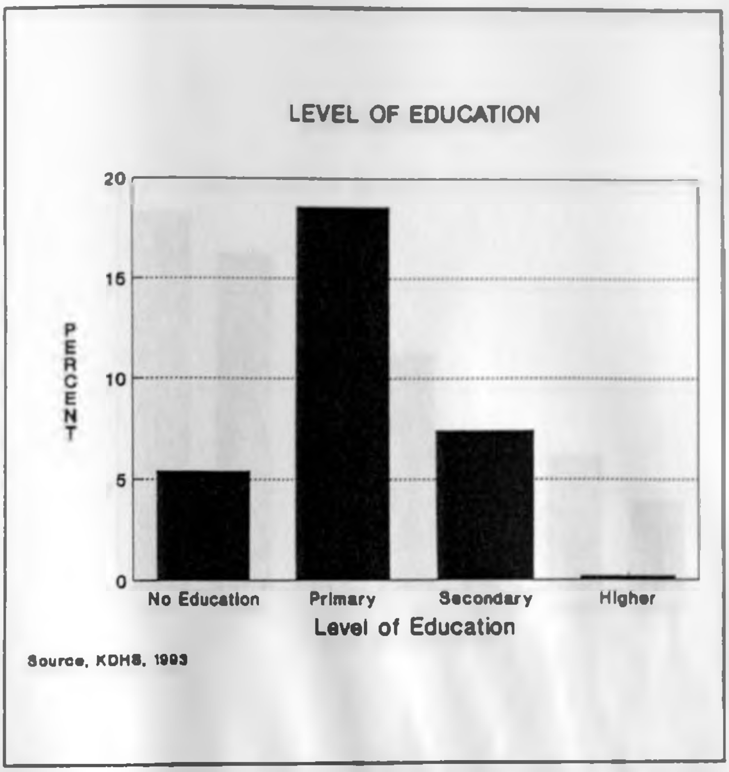

TOTAL CHILDREN EVER BORN
PERCENT
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
CHILDREN EVERBORN
Source, KDHS, 1993

FIGURE D4

FIGURE D5


LEVEL OF EDUCATION
20
15
10
5
0
PERCENT
No Education
Primary
Secondary
Higher
Level of Education
Source. KDHS. 1993

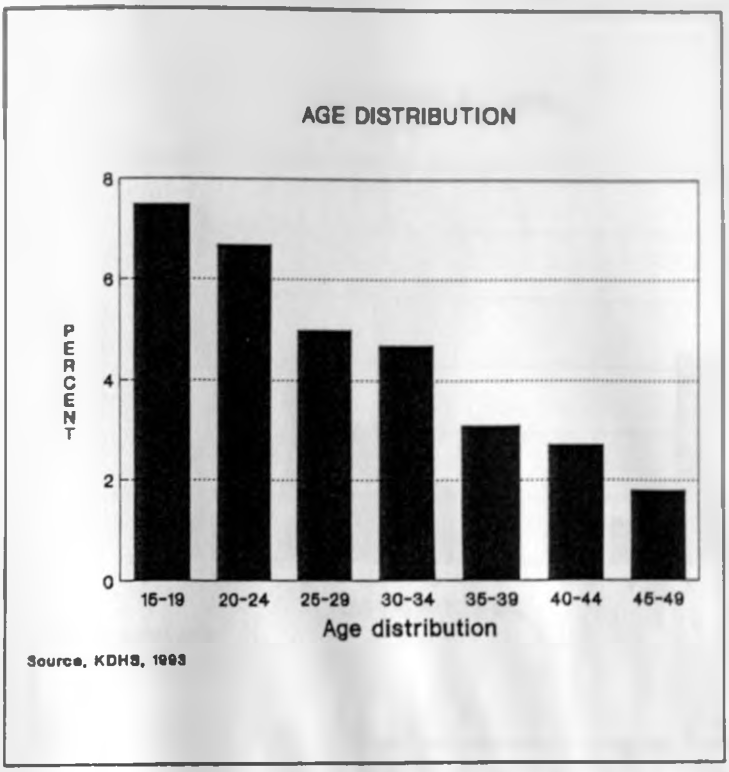
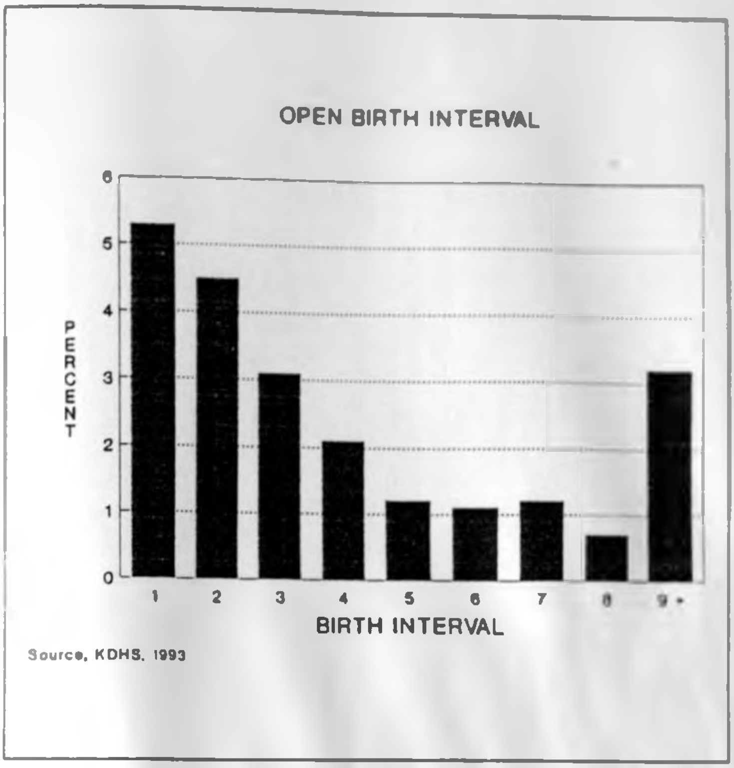

AGE DISTRIBUTION
PERCENT
8
6
4
2
0
15-19
20-24
25-29
30-34
35-39
40-44
45-49
Age distribution
Source, KDHS, 1993

FIGURE D6



Source, KDHS, 1993