INFANT/CHILD MORTALITY AND FERTILITY RATES IN WESTERN PROVINCE OF KENYA

BY

OMURUNDO, JOHN KWENDO

This thesis is submitted in Partial Fulfilment of the Requirement for the degree of Master of Science, Population Studies and Research Institute, University of Nairobi.

July 1989

DECLARATION

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

OMURUNDO, JOHN KWENDO

This thesis has been submitted for examination with my approval as University supervisor.

Signed ____________ 16/7/89
Dr. Zibeon Muganzi DATE

ACKNOWLEDGEMENTS

The completion of this study would not have been realised had it not been for the valuable guidance and assistance that I received from many people in various ways. To them all, I am sincerely and greatly indebted.

My most profound and heartfelt appreciation is owed to my University Supervisors Dr. Zibeon Muganzi, Senior Lecturer at the PSRI and Prof. J.A.M Ottieno, of the Department of Mathematics and PSRI. Their invaluable suggestions technical guidance and constructive criticisms inspired, challenged, built and steered me throughout the entire course of this study. I would also like to express my sincere and heartfelt gratitude to Dr. Candice Bradley, Visiting Senior Research Fellow at the PSRI and to all the Lecturers and Senior Lecturers at the Population Studies and Research Institute for their most kind counsel that saw me through the course, not to forget the assistance I received from the Library Staff at the Institute: Mr. Mwaniki and Mrs. Wesa. I would also like to thank my colleagues who contributed in their unique ways, not to forget Mr. Mwaurah for his excellent typing of the entire thesis.

I am indebted to the generous sponsorship I received from the University of Nairobi - both for the financial assistance and the opportunity to learn.

ABSTRACT

The main objectives of this thesis are three-fold. Firstly, to study infant and child mortality rates in Western Province by region and by the differentials of education, marital status and residence. Secondly, to show that the expectation of life at birth in the province is influenced by the level of education, type of marital union and nature of residence, and finally to estimate the fertility rates in the province at divisional level by employing various techniques, viz: Coale-Trussell, Gompertz and Coale-Demeny.

The data used in the analysis was drawn from the 1979 National Census.

The thesis has been broken down into five chapters. Chapter one is the general introduction in which the objectives, literature review as well as the theoretical framework have been outlined. The second chapter deals with the infant/child mortality rates using the Coale-Trussell model. Lifetables are also constructed for each variable under study. It is found that infant/child mortality rates in divisions of Busia and its neighbourhood is overally higher than in the other divisions of Kakamega and Bungoma, and that the higher the infant/child mortality rate, the lower the expectation of life. The third chapter pays particular attention to the estimation of fertility rates using the Coale-Trussel model. The fertility rate by each variable is calculated. The fourth chapter is ideally an

DEDICATION

In loving memory of my late Grandfather Jairo Lusasi Omurundo, whose fond memories and love have always kept my spirits high!

extension of the third chapter, with the additional advantage that it introduces two new techniques altogether: the Gompertz relational model and Coale-Demeny procedure. A comparison of the results obtained by all the three methods is undertaken. It's found that the Coale-Trussel method gives high values followed by the Gompertz model and that Coale-Demeny values are the lowest. The final and fifth chapter discusses the major findings and attempts to give some specific recommendations.

The study has emerged with some pertinent findings, viz. for the period 1969-1979 that:

(i) it is an acknowledged fact that infant/child mortality rates are quite high in Western Province as a whole and in the divisions of Busia in particular.

(ii) Fertility for the single is quite significant in virtually all the divisions in Western province, and in the division of Bungoma in particular.

(iii) Secondary education and above acts as an effective contraceptive as it lowers fertility in the Province.

(iv) Expectation of life is highest in the divisions of Hamisi and Vihiga.

(v) Comparatively, fertility is quite high in the divisions of Bungoma, and fairly low in the divisions of Busia with the divisions in Kakamega coming midway between the two in this respect.

TABLE OF CONTENTS

CHAPTER 1

CHAPTER 2

CHAPTER 3

CHAPTER 4

CHAPTER 5

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

GENERAL INTRODUCTION

1.1 INTRODUCTION

Many Third World Countries are currently experiencing fertility rates and population growth rates which are unparalled historically. Kenya has remarkably high fertility rates and population growth rates for Africa. The 1969 Population Census gave a crude birth rate of about 50 per 1000 and a population growth rate of about 3.3% per annum (CBS, 1976). More recent estimates indicate even higher rates; a birth rate of about 54 per 1000 and an annual growth rate of about 4.1% (Population Reference Bureau, 1983) implying that the country's population would double in about 17 years.

One of the best mortality indicators that is sometimes used as a measure of the level of development of a country is Infant Mortality Rate (IMR). So important is this index that it occupies a central part in both mortality and fertility studies. The overall mortality rate of most countries has a huge chunk of it occurring between the ages of 0-1 year. Countries where the per capita income is low, illiteracy rate high and agricultural output meagre, among other factors are found to have very high IMR. Anker and Knowles (1982) document that high IMR leads to high fertility as there is a tendency to replace dead children as in these countries children are regarded as a major source of old age security besides carrying on the family lineage. It has been observed that among the factors contributing to the decline of infant mortality in Kenya and elsewhere are the better management of diseases due to , improved medical technology, better nutrition, reduced level of illiteracy among the public, provision of clean and piped drinking water,improved medical services and better standards of living, in contrast to what the situation was prior to independence.

The sustained high levels of fertility and declining mortality experienced in the Country will give rise to a youthful population. At the moment it's estimated that 51% of the population is below 15 years of age (CBS, 1979).

It's in view of the foregoing that it was deemed desirable to look at some of the different variables that may affect fertility and infant/child mortality rates in Western Province of Kenya where the climate is conducive to high agricultural yield and ironically IMR is among the highest in the country, after Nyanza and Coast Provinces.

1.2 STATEMENT OF THE PROBLEM

Most Studies that have been undertaken in Kenya on fertility and mortality have mainly been done either at Provincial or District level. Way back in 1984 the

Government of Kenya decided to decentralise the administration by taking it to the district, otherwise called District Focus For Rural Development where the DDC (District Development Committee) is given the mandate, power and funds to render services to the people at the District level. Given that a district is made up of several divisions, what will be decided upon at the district will very much depend on the priorities at the divisional level.

Some of the major priorities that affect people are the provision of such facilities as schools, roads, hospitals (clinics, dispensaries), markets and administrative centres among others. In view of the fact that all these affect the lives and standards of living of the people, it will be seen that in one way or another they will have an effect on the fertility or mortality of the people. It's with this in mind that this study focuses on some of the variables that appear to affect mortality and fertility right from the "grassroots" - the divisional level, for it's at this level that the major administrative weight begin. Furthermore, in a region such as Western Kenya where fertility and mortality appear to be quite high and given that most constituencies are based on divisional boundaries, it's imperative and pertinent to look at how the various variables affect mortality and fertility rates at divisional level.

1.3 OBJECTIVES

General Objectives

1(a) To show that fertility rates differ by division and by the differentials of education, marital status and residence within each division.

(b) To show that life expectancy is affected by residence, marital status and education.

2. To show that infant and child mortality rates differ by division and by differentials of education, marital status and residence within each division.

Specific Objectives

1. To examine the fertility and infant and child mortality rates among various divisions of Western Province of Kenya.
2. To construct lifetables for each division and district of Western Province for each variable under study. From the lifetable, IMR and expectation of life can be obtained.
3. To derive new estimates of the levels and differentials of fertility and infant/child mortality rates for Western Province at the District and Divisional levels through the application of the Coale-Trussel and Brass's P/F Ratio Models to data drawn from the 1979 Census data.
4. To employ q(x) values to show the level of infant and child mortality rates in each division.

5. To examine the influences of female schooling on fertility and mortality rates.

6. To make recommendations for further research and future population policy formulation in the province under discussion.

1.4 STUDY JUSTIFICATION

The study of differences in fertility that exist among various subgroups within national populations is widely recognised to be an important aspect among other types of demographic research. On the one hand knowledge of fertility rates aids in estimating growth rates for various segments of the population and in gauging the likely changes in population composition to be expected in the future. On the other hand and more importantly, assessing the extent of differences among various groups in a population is often the first step in identifying important determinants of fertility behaviour. Information on fertility rates also provides a basis for projecting the changes in the overall level of fertility which may be expected with shifting social and economic conditions (UN 1977).

Studies on mortality rates are useful in at least three ways. First, such studies provide information for assessing inequality among people with respect to longevity and health. Second, data on mortality rates help to identify those under-privileged segments of the population who experience high mortality levels. These groups are appropriate targets of policies and programs of improving health conditions and survival chances. Finally these studies improve our understanding of the determinants of mortality and their interrelationships, on the basis of which proper policy measures for reducing mortality are developed, selected and improved. (UN 1985)

Turning to this study, it's anticipated that its results will be of great value to the government for purposes of economic and social planning. The study is intended to identify areas of high infant/child mortality and hence create some amount of awareness in so far as regions which need special attention with regard to disease control and provision of health facilities. The study is also intended to bring to light those regions in Western Province where fertility is high. Knowledge of this will help the planners in knowing these areas for the purpose of increasing the facilities that are needed by high density areas as schools, hospitals, administrative centres and the like.

The pattern and trend of mortality and fertility will highlight the areas in which infant/child mortality is highest as well as the ages of women in which births are most frequent. This will, it's hoped, guide the health planner interested in the health issues in the area to know where to control diseases or provide information to the people concerned.

The construction of lifetables would help in understanding the general life expectancy from one division to another and therefore be able to recognise areas with lowest life expectancy and perhaps lead to measures that can be taken to improve the existing socio-economic and health conditions.

1.5 BACKGROUND INFORMATION TO THE STUDY AREA

1.5.1 Bungoma District:

Bungoma District is located on the Southern slopes of Mt. Elgon, which also forms the apex of the District. It borders the Republic of Uganda to the North-West, Trans Nzoia district to the North-East, Kakamega district to the East and South-East, and Busia district to the West and South-West.

It has an area of 30074 km^2 of which 547 km^2 are forest reserve, and 2 km^2 form a National Park. As per the 1979 census, the district was divided into 5 administrative divisions, viz:, Tongaren, Elgon, Kimilili, Sirisia and Kanduyi.

Topographically, the district is within the lake Victoria Basin, rising from 1200m in the West and South-West to over 4000m to the North of Mt. Elgon. Apart from Mt. Elgon region, the rest of the district is underlain by granites which form basement system.

Annual rainfall follows a seasonal pattern ranging from 1250mm to over 1800mm p.a. The district therefore gets sufficient rainfall to support most agricultural activities. The cash crops grown in the area are coffee, cotton, tobacco, sugar, sunflower, pyrethrum and wheat while the food crops are maize, bananas, beans, millet, cassava, groundnuts and sorghum.

Turning to the demographic profile, it is worthy noting that the district is predominantly populated by the Luhya tribe. According to the 1979 census, there were 503935 people in the district of whom 409977 (81.4%) were Luhya, 50132 (9.9%) were Kalenjin, and 20577 (4.1%) were Teso. There were also 7670 Kikuyu, 5788 Luo, and 9791 others.

In 1962, the district's population was 241900 rising to 345226 people in 1969. This represented a growth rate of 5.2% p.a. Between 1969 and 1979, the population rise represented an increase of 158709 or a growth rate of 3.85% p.a. This was above the Western Province annual growth rate and slightly above the national growth rate of 3.8% p.a for the same period.

On the education side, there were only 19 Government maintained secondary schools out of which only 7 had A-levels. Of these schools, only 6 were girl schools with 3 of them having A-levels.

There were three hospitals, nine health centres and sixteen dispensaries in operation in the district. Some of these facilities like Bungoma District Hospital, Lugulu and Misikhu Mission Hospitals, and Kimilili Health Centre are over-utilized in that they experience a lot of congestion.

Communication in the district was rather below standard compared to other districts like Kiambu and Nyeri. There was a total road network of 1436.3km of which 118.6km were bitumen, 621.2km were gravel surface and 696.5km were earth standard. Some roads in the district, especially in Elgon division became impassable during the rainy season due to the nature of the soil and lack of murram nearby.

It was estimated that about 100km of roads in the district were under-utilized because of lack of river crossings, proper bridges and murram.

1.5.2 Busia District

Busia is the newest of the three districts comprising Western Province. It was created in 1963 when Marachi, Bukhayo, North Teso and South Teso location, formerly under Elgon Nyanza (now Bungoma) district, and Samia, and Bunyala then under Central Nyanza (now Siaya) district, were brought together to form its constituent locations. Hence it borders Bungoma district to the North, Kakamega on the Eastern, and Siaya district of Nyanza province on the south. On the West, the district borders the Republic of Uganda.

The district occupies an area of approximately 1866km^2, including 137km^2 of permanent water surface. 1287km^2 are available for agricultural development while another 32km^2 can be made available through drainage.

Administratively, as of 1979 census, the district comprised 4 divisions, viz:, Northern Busia (Amagoro), Central Busia (Nambale), Southern Busia (Hakati) and Busia Township.

80% of the district lies within the 1270 - 1789mm rainfall range. On the average, rainfall in the district is good enough to sustain the agricultural industry.

Almost the whole of Busia lies in an agro-ecological zone, classified as "upper cotton West of Rift Valley". About 90% of the dry land area is of high potential agriculturally and cotton, sugarcane, sunflower, simsim, groundnuts, soya beans, maize, robusta coffee, citrus pulses, millet, sorghum, cassava, etc. are successfully being grown on small-scale farms. The entire distict is also suitable for rearing of exotic livestock.

The district is populated by two major tribal groups: the Luhya and the Teso. According to the 1979 census, the district had a population of 297841, out of whom 90159 (30%) were Teso and 177330 (or 60%) were Luhya. Other tribes present comprised Luos (about 6.7%), Kikuyus (0.7), Kalenjin (0.5), Kisii and other (about 2%).

Kwashiokor and marasmus, resulting from poor feeding are very common among the children in the district. This fact has been confirmed by the Butula Family Life Training Centre and the Nangina Nutrition Centre. Although figures are not available, the incidence of these conditions is very high. Malnutrition is a sign of poor feeding among the community and reflects the extent of poverty in the district.

Communication in the district is very poor as compared to the other two districts in the province. As at 1979, the district had about 544.9km of classified roads. As at 1983, the number of classified roads remained the same.

As of 1979, there were only 12 Government maintained schools in the whole district. Only one girls school with A-levels - Chakol Girls existed at the time.

On health facilities, there were 20 units in the district. Of these, five are hospitals (i.e. Busia District Hospital, Alupe Hospital, Nangina Mission Hospital, Butula Mission Hospital and Port Victoria Hospital), seven are health centres and the remaining eight dispensaries. The district is poorly served by electricity, postal and telephone services. In fact the impact of Rural Electrification Programme has not been felt at all.

1.5.3 Kakamega District:

Kakamega district is bordered to the east by Rift Valley province, to the north by Bungoma district, while Busia district is to the West and Nyanza province is to the South. The equator crosses the Southern tip of the district.

Kakamega has an area of approximately 3520km^2. As of 1979 census, the district was composed of 9 divisions, viz:, Mumias, Butere, Vihiga, Hamisi, Ikolomani, Lurambi, Kabras, Lugari, and Kakamega Forest.

The rainfall increases both with altitude and with the rainfall belt. It varies from 1250mm to 2000mm. It is very reliable and adequately distributed, with the highest averages found in the central part of the district. Rainfall is highest between March and October, having maxima in April/May and August/September, with no dry season.

The district is populated by a virtually homogeneous group, the Luhya. The 1969 population census showed that the district had 782586 people. This figure increased to 1030887 people according to the 1979 population census. Of the 1979 district population figures, 94.6% were Luhya, 2.3% Luos, 1% Kalenjin and 2.1% others.

The district's population growth rate poses a threat to future economic development. The pressure on land is great and will worsen in future if measures are not taken to reduce the population growth rate. The overall population density for the district was 295 persons per km^2 in 1979 and had increased to 349 in 1983 and 415 in 1988 (CBS, 1988).

The table below shows the comparative population densities by administrative divisions for the years 1969 and 1979 and the respective population growth rates within the given period 1969 - 1979. Some of the administrative divisions such as Ikolomani, Vihiga, Hamisi, and Butere experienced very low growth rates between 1969 and 1979. This might have been prompted by the already heavy densities of populations in those divisions in 1969. In effect, those densely populated divisions in the district might have experienced out-migrations both to areas outside the district such as Kapkangani in Nandi district and movements to other divisions within the district such as Lugari, Lurambi and Mumias. Movements into these areas was due to greater prospects of earning more income from land and avoiding situations of landlessness in the home area.

Table 1.5.1 Population Densities and Growth Rates by Divisions

Name of Division	Population Density 1969	1979	Growth Rate %	Population Increase
Vihiga	589	692	1.7	38277
Butere	301	362	2.1	21664
Mumias	141	233	6.6	52755
Ikolomani	357	402	1.3	16067
Hamisi	517	612	1.9	15156
Kabras	164	226	3.7	27909
Lurambi	136	270	9.9	53691
Lugari	75	128	7.0	28397

Source: CBS, Kenya Population Census, 1979 Vol. I.

The high population pressure on arable land is a very critical factor in Kakamega district's planning and development. A good evidence of this can be given in Vihiga division where the average size of the holdings is less than 0.5 ha. per person which is far below the FAO/UN accepted acreage for subsistence purposes of 1.4 ha. per family.

Most farmers in the district are small-scale mixed farmers. However, in Lugari and Kabras divisions, farm sizes are bigger and dairy and crop farming are carried out on a large-scale basis. Cash crops include coffee, cotton, tea, sugarcane, and sunflower, while subsistence crops comprise maize, beans, sorghum, millet, Irish potatoes, bananas, pawpaw, and vegetables.

There were twelve mission-sponsored hospitals and one Government-sponsored as of 1979. There was a fairly even distribution of the hospitals in the district. However, two divisions, viz:, Kabras and Lugari had no hospital.

All in all, there were a total of 85 health facilities in the district of which 13 were hospitals, 28 health centres and 44 dispensaries.

The district has a good road network of a total distance of 1907.3km, of which 1603.5km are classified roads, 253.7km unclassified roads under the Rural Access Roads Programme and 50km roads constructed under the Rural Works Programme of the Rural Development Fund. Of the 1603.5km of classified roads, 195.8km are of bitumen (tarmac) standard, 757km are of gravel and 650.7km are of earth standard.

On the side of education, the district is well served with secondary schools. As of 1979, there were 30 Government-maintained secondary schools, of which 12 were girls schools out of which 6 hand A-levels.

Fig. 1 LOCATION OF WESTERN PROVINCE IN KENYA

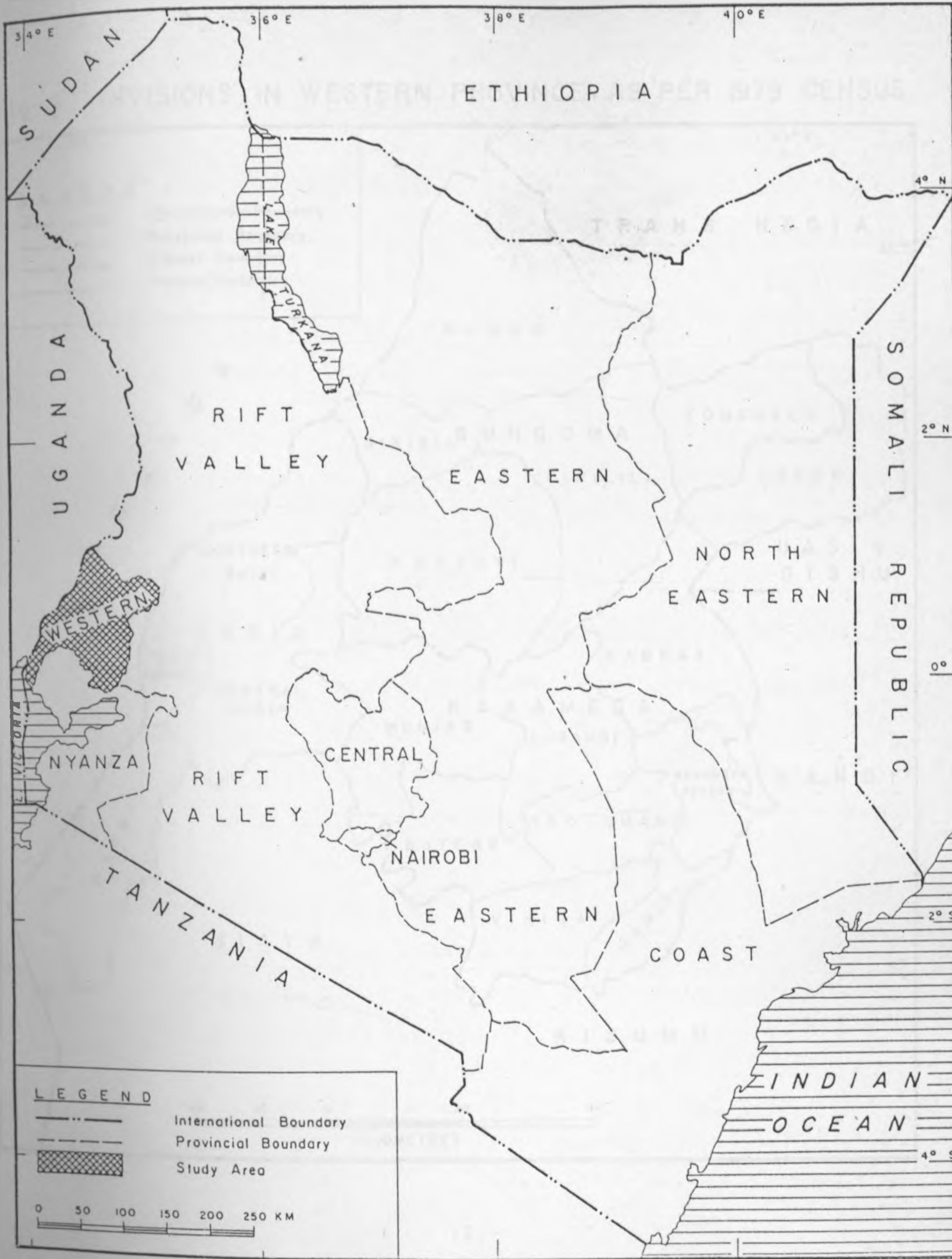
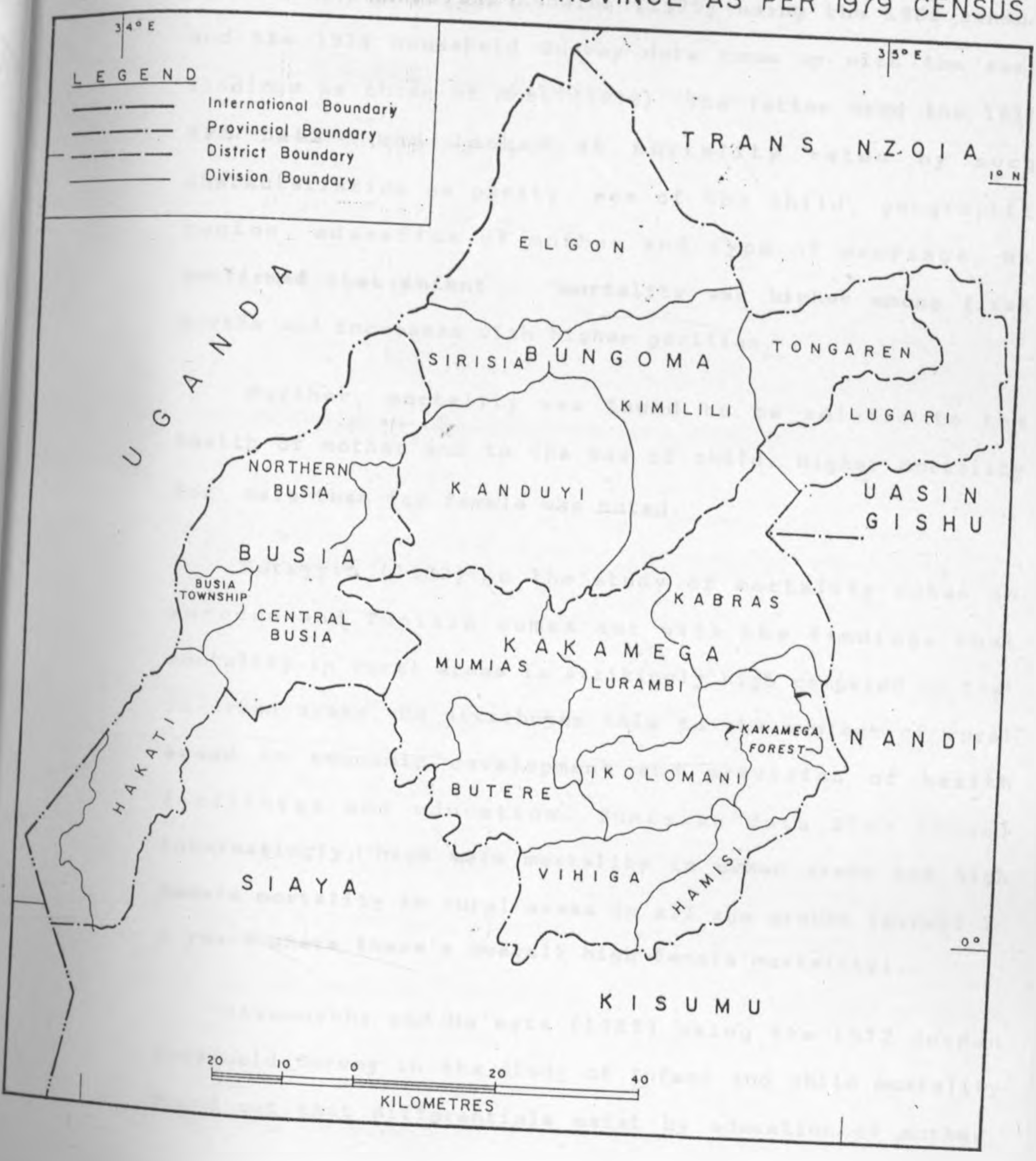


Fig. 2 DIVISIONS IN WESTERN PROVINCE AS PER 1979 CENSUS



1.6 LITERATURE REVIEW

Infant Mortality studies undertaken in Kenya have more-or-less confirmed observations of similar studies undertaken elsewhere. Anker and Knowles (1979) using the 1969 census and the 1974 Household Survey data came up with the same findings as those of Mott (1979). The latter used the 1977 KFS Data and looked at mortality rates by such characteristics as parity, sex of the child, geographic region, education of mother and type of marriage. He confirmed that infant mortality was higher among first births and increases with higher parities.

Further, mortality was found to be related to the health of mother and to the sex of child. Higher mortality for male than for female was noted.

Huzayyin (1982) in the study of mortality rates in Morocco and Tunisia comes out with the findings that mortality in rural areas is strikingly high compared to that in urban areas. He attributes this to the neglect of rural areas in economic development and provision of health facilities and education. Tunisian data also reveal interestingly, high male mortality in urban areas and high female mortality in rural areas in all age groups (except 1-4 years where there's overall high female mortality).

Sivamurthy and Ma'ayta (1982) using the 1972 Jordan Household Survey in the study of Infant and child mortality found out that differentials exist by education of mother, by socio-economic status of the household and by religion; in addition to the rural-urban differentials. It's further observed that the level of this mortality is inversely related to the educational level of the mother and to the socio-economic condition of the household. Also the data suggest that babies of mothers who are married once and are living with their husbands have a better chance of surviving than those of mothers who are married more than once or whose husbands are not present in the household. Regarding differentials by religion, the study corroborates that mortality is higher among Muslims than among Christians (though there may be other factors than religion per se to account for this).

Gamrah (1982) investigating fertility differentials by mother's education comes up with the revelations that education has an inverse effect on fertility regardless of the official policy toward fertility behaviour. It's further evident from his research that fertility declines as educational attainment rises in Egypt which is over-populated and has low income per capita, and similarly in Kuwait which is under-populated and has one of the highest per capita incomes in the World. Therefore, it's expected that fertility will decline in all Arab countries as a result of increase of education. Nevertheless, the research concludes, it's noteworthy that fertility of the same xeducational group differs from one country to another which means that although education exerts negative effect on fertility, it's not the sole determinant of fertility.

There is a general contention among many researchers in Africa that educational attainment of parents is inversely related to infant mortality (Caldwell, 1979, 1981; Cochrane, 1980; Farah and Preston,1981). This inverse association has been attributed to many factors among them:

(a) breaks with traditional childbearing practises

(b) decreased mortality brought about by illness e.g. measles and increased use of modern medical facilities

(c) better utilization of available foods and increased availability of higher quality foods made possible by increased income, and

(d) more personal and intensive attention by the mother with increased amounts of family resources spent on the child.

In the analysis of Kenya's 1979 census data, Ewbank et al (1986) found out that infant mortality rate for males is about 89/1000 while the rate for females is about 81/1000. This differential was found to be similar in all the provinces suggesting that the sex differentials in infant and child mortality are largely determined by inherent biological differences between the sexes rather than by cultural practices which lead to differential child care for sons and daughters. This conclusion was found to be consistent with the 1977/78 Nutrition Survey which found no difference between the nutritional statuses of boys and girls when they were compared with sex-specific standards based on the US children. However, the major exception to this generalisation about sex differences in infant and child mortality was Turkana district, which reported higher mortality among females.

Kichamu (1986) came up with the finding that contrary to the general trend of higher infant and child mortality in the rural than urban areas, certain districts, mainly in central Province as well as some parts of Rift Valley Province of Kenya do exhibit exactly the opposite trend. In these Provinces, the urban areas have higher infant and child mortality than the rural areas. The plausible explanation to this could be that poverty in these urban areas is more severe than that experienced in the rural areas. Whereas the urban dwellers depend on income for the purchase of various items including foodstuffs, the rural poor do not have to buy most of their foodstuffs as these can be obtained directly from their "shambas". Furthermore the quality of their foodstuffs may be much higher leading to better nutrition among the rural folks. These districts also have high agricultural land with both cash and food crops.

Using the data obtained from a Survey conducted in Nairobi in July/August 1978 by the Egypt based Cairo Demographic Centre, Gasana (1985) looks at various variables differentials and assess their overall effect on fertility in Nairobi. Taking age at first marriage and duration of marriage as a nuptiality differential, Gasana observes that women who marry at younger ages (under 17) are seen to have achieved higher fertility than those who married at 20 or above for all age groups. The situation changes, however, when duration of marriage is the variable under study. It was also found out that fertility levels are virtually the same for all ages at marriage at any given marital duration. Gasana offers two possible reasons for this situation :Firstly, women marrying at older and more fecund ages very easily "catch up" with those who married at younger relatively less fecund ages (Coale et al 1979). Secondly, fertility itself may be influencing the ages at which stable marital unions begin, rather than the other way round.

Omer Mohamed El Jack (1985) using data that was provided by the Sudan Fertility Survey of 1978/79, documents that women with no schooling have higher infant mortality rate of 112/1000 (both sexes) compared with those having incomplete primary education and primary education and over (101/1000 and 74/1000 respectively). He recommends that in view of these findings an important policy measure which is to concentrate on the education of women and until the female educational structure in the Sudan is significantly altered, illiterate mothers have to be educated through mass communication to become more aware of health care measures and adequate nutritional aspects. These findings are based on the fact that educated women have knowledge and accessibility to modern medicine as well as knowledge of mordern child care. Also educated people are more likely to enjoy higher incomes that make accessibility to good nutrition and medical care more possible.

Osiemo (1986) in the study of the Estimation of Fertility rates in Kenya concludes that rural women have higher fertility than the urban ones. He explains that the lower urban fertility is due to the high cost of living in urban centres which imposes heavy constraints on the urban folks forcing them to limit their fertility. Further, urban women have knowledge of the availability of and accessibility to contraceptives as these are within closer proximity to them in contrast to the case in rural areas; and that urban women also marry late. Exceptions to the results of this variable exist in all the districts of North Eastern Province as well as other nomadic districts such as Turkana, Isiolo, Samburu and Marsabit, he notes. As regards the variable of marital status, Osiemo observes that both marital as well as non-marital fertility have a significant contribution to the rise of fertility in Kenya. He explains that from the high marital fertility stems the early and stable marriages which together lengthen the reproductive period. Finally, he concludes, the non-marital fertility is cultivated by the old age security as well as the love that women derive from their children.

Kichamu (1986) in the study of mortality Estimation in Kenya documents in his conclusions that child mortality for the widowed mothers is the highest in general followed by the divorced/separated. He goes on to note that for single mothers, it's lower than for the married mothers in most of the cases considered although a few exceptions to these patterns exist. These results could be mainly due to cultural norms, the level of education and the socio-economic status.

According to Caldwell (1980), education affects fertility through restructuring of family relationships and the direction of flow of wealth. He further argues that during the first generation of mass education, traditional or household mortality persists and wealth continues to flow from the younger to the older generation. In this respect, traditional morality begins to crumble during the second generation of mass education when children and their mothers are educated. In this case the bond between husband and wife is reinforced and children consider themselves as belonging to a wider society and economy. He concludes by noting that formal education rather than the duration of schooling among those who have attended school is the most important force behind fertility decline. This, he points out, is particularly so when it involves the majority of the populace, more so females.

In a multivariate analysis of the education-fertility relationship across nations, Bogue (1969) showed that among the nine indices of mordernisation,education and literacy had the highest impact on fertility. Stressing the same point, he observed that the variable, education, is so universal and consistent that it's desirable to hold it constant before assessing the effects of the other factors.

Mwobobia (1982) in the study of fertility rates in Kenya considered in detail the effect of female employment and urbanization on total fertility as a dependent variable. He came up with the revelation that female employment and urbanization were negatively related to the total fertility rate. On the other hand, urbanization was found to be the principal factor behind the negative association between female employment and the total fertility.

The empirical analysis of Kenyan fertility at the district level by Anker and Knowles (1982) provides a number of interesting insights into the determinants of fertility rates in Kenya. Rates of urbanization and primary sterility exhibit significant negative relationships with fertility while adult male educational level exhibits a significant positive relationship. The results of life expectancy at birth and primary school enrolment rates are somewhat less conclusive, although they indicate that increases in school enrolment have a negative effect on fertility, and that increases in life expectancy at birth have a monotonic effect on fertility. In conclusion, the district level results imply that fertility rates in Kenya are not at a biologically or socio-culturally determined maximum but instead are systematically related to socio-economic conditions. At the same time the macro-district level results indicate that fertility rates are also significantly affected by biological constraints on fecundity, at least in certain parts of the country. The authors note that the sum total of the results imply that fertility rates in Kenya are not likely to fall significantly in the near future, regardless of the pace of socio-economic development, since while rising levels of school enrolment and urbanization may tend to suppress fertility rates, the results of the study indicate that these effects would be counter balanced by rising health and income levels.

The timing of entry into union or commencement of exposure to the risk of conception is among the basic components of nuptiality, which in turn is a fundamental determinant of fertility. Hamed (1988) looking at levels trends and variables of infant and child mortality shows that there's a negative effect of age at first marriage on infant and child mortality. He reckons that the risk of mortality for children whose mother's age at first marriage was 18+ is less than that for those whose mother's age was less than 16 by 44% and 60% for infant and child mortality respectively. This inverse relationship may be explained by the differences in physical and biological maturity of mothers marrying at younger and older ages. Mothers marrying at higher ages are better in administrating their homes, caring for their babies and are more experienced and exposed to the social and health services and other aspects of life than those marrying at younger ages. In addition, education which is usually known to be associated with higher age at first marriage may have contributed.

Brass (1959) embarked on a study in six East African Communities. The theme of the study was to explore how the marriage experience of mothers discriminates child mortality. The mortality measure used was child mortality rate (for ages 0-4), while marital indices,included number of times married (stability of marriage) and the number of wives of husband (type of union- monogamous, polygynous). The study concluded that mothers in polygynous union and those whose marriages were unstable (those married more than once) experienced higher child mortality than those in monogamous union and stable marriage.

Increased education of father if it raises purchasing power, may improve housing and sanitation facilities and the quality of food and clothing and enable parents to take better advantages of health care. Although paternal schooling is thought to operate primarily as a proxy for level of living, it may also reflect other aspects of the family's life such as beliefs about the origin and cure of disease.

Farah and Preston (1982) suggest that father's education like that of the mother has an important "direct" effect because education impacts knowledge about health and undermines traditions that are associated with higher child mortality. However certain other studies that studied more variables have found that the impact of paternal education is as large or larger than that of maternal education.

Anker and Knowles (1982) carried out an indepth study on the fertility determinants in Developing Countries with a focus on Kenya. The two mainly used the 1969 Kenya Census data, especially for estimates of the demographic variables. The results of the study indicate that there are sizeable differentials in fertility by education, place of residence and amount of land owned. Accordingly, it is consistently lower in urban areas than in rural areas which tends to confirm the observed rural-urban differences at the district level. Further, fertility is negatively related to the wife's education-once she has completed at least standard five- indicating that some form of fertility control is probably being practised by the better educated women. Finally the results also reveal a positive relationship in rural areas between fertility and the amount of land owned, the most important rural economic asset suggesting that, at least in rural areas fertility increases with wealth, and therefore most probably, with the household's standard of living.

The significant relationships observed provide indirect evidence that fertility rates in Kenya are not at a biological or a socio-cultural maximum beyond the control of individual couples. Instead it seems that even at the extremely high fertility levels found in Kenya fertility rates are determined at least in part, by choice as well as by such involuntary factors as extended lactation, sterility, widowhood and poor health.

Mutai (1987) estimated the q(2) values for Kericho district at locational level. His study centered on the differentials by education, marital status and place of residence. He used the 1979 Kenya Population Census data. To estimate the infant and child mortality, Mutai applied the Trussel's Technique. His study reveals that in all locations with both urban and rural populations (other than Techoget location) infant mortality is higher in the urban centres and suggests that this could be due to the fact that these locations having high agricultural potential do, on the whole, have a better developed rural infrastructure. Consequently the rural population is better nourished than the urban. He also found out that, the differential by education has the highest infant and child mortality among mothers with secondary education and over. For marital status, he came up with the conclusion that the highest child mortality is found among the divorced, followed by the married, then the widowed, and lastly the single women. He is quick to point out that the widowed, did not show higher proportions, as is generally believed because this happens more to communities where the family is totally dependent on the father's income. However, in the case of rural communities of Kericho where the production of food crops and livestock care are women's responsibilities, this could not be the case.

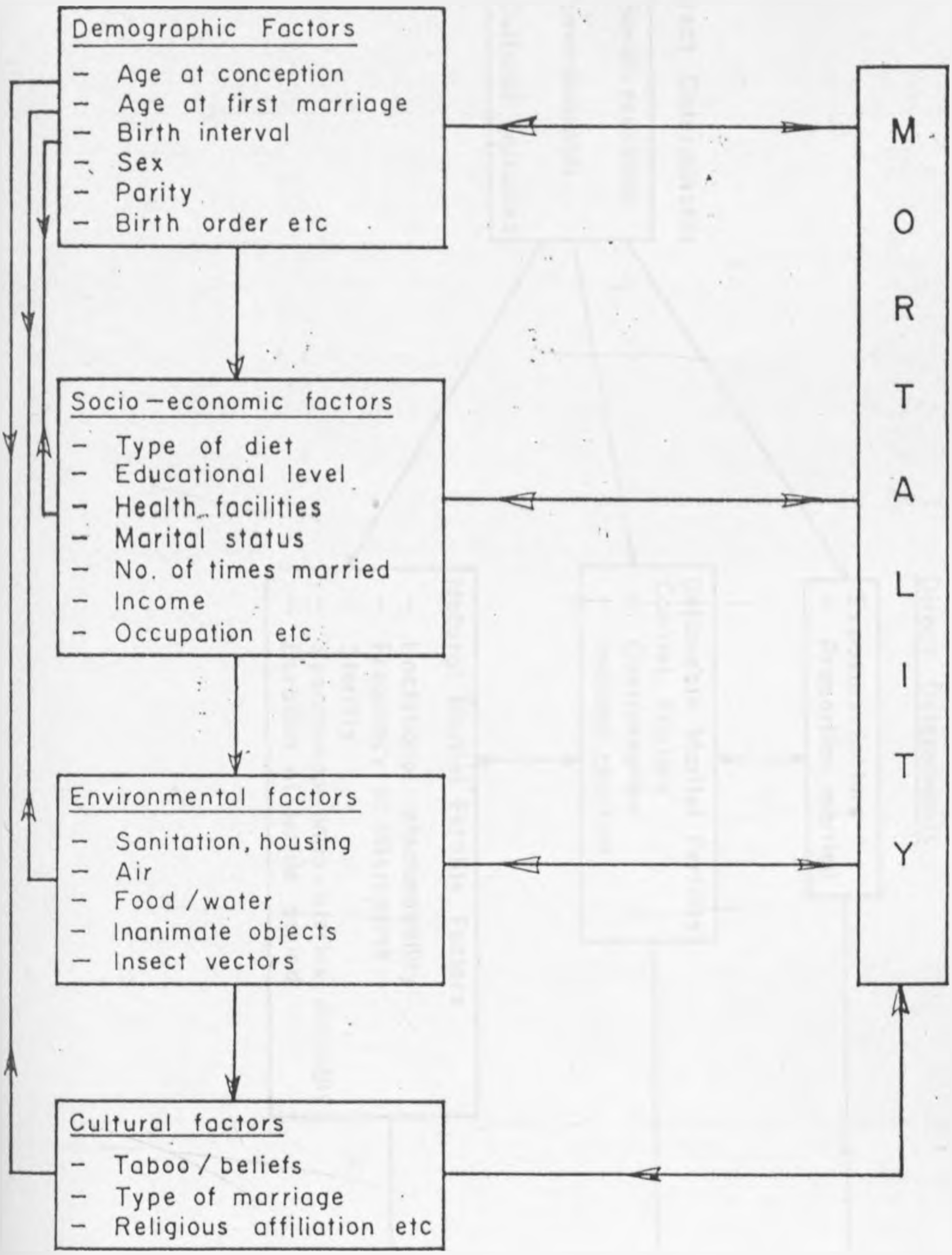
1.7 THEORETICAL FRAMEWORK

From the foregoing Literature Review, it's indeed evident that environmental factors like housing, sanitation, urban or rural residence, weather etc have featured prominently as agents for the spread of disease and consequently death. Demographic variables such as parity, sex of child, migration as well as total fertility rate, order of birth and others have a great infuence on infant/child mortality and fertility. Finally, mortality and fertility are influenced by such socio-economic and cultural factors as place of residence, education, marital status, occupation, religious beliefs, contraceptive practice and type of marriage,among others.

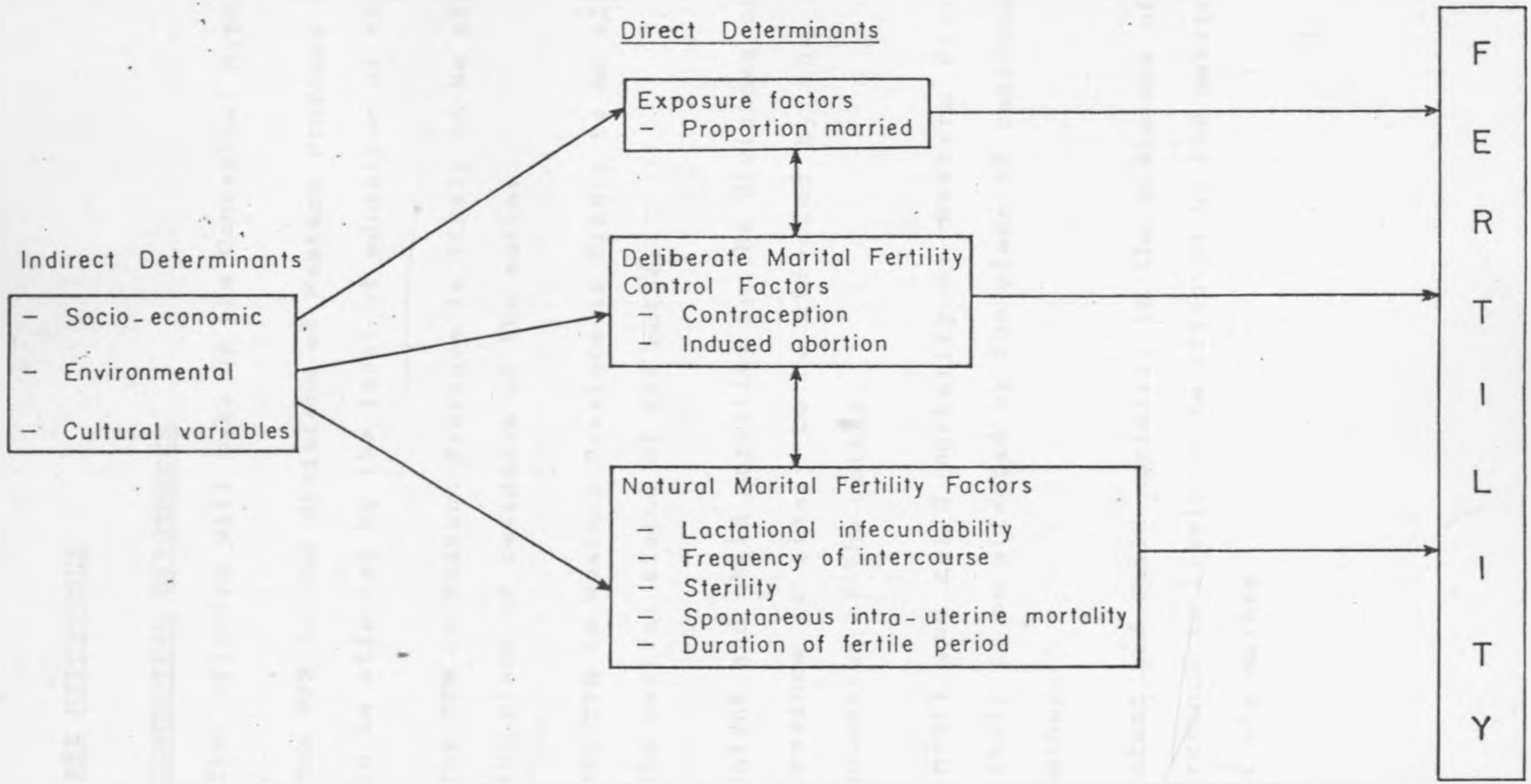
The folowing are thus the schematic models onto which this theory is built:

CONCEPTUAL MODELS:

(i) Mortality Model



(ii) Fertility Model



1.8 THE HYPOTHESES

1.8.1 CONCEPTUAL HYPOTHESES

The following will make up the Conceptual Hypotheses

1) The TFR in the divisions of Western Province is likely to be affected by the level of education of the mother.

2) The TFR in Western Province is likely to be affected by the place of residence of the mother.

3) The TFR in Western Province is likely to be affected by the marital status of the mother.

4) Infant and child mortality in the divisions of Western Province is likely to be affected by the level of education of the mother.

5) Infant and child mortality in Western Province is likely to be affected by the place of residence of the mother.

6) Infant and Child mortality in the divisions of Western Province is likely to be affected by the marital status of the mother.

1.8.2 OPERATIONAL HYPOTHESES

The following are the operational hypotheses that emerge:

1) Marital education is likely to lower the TFR.

2) TFR is likely to be lower in urban than in rural areas.

3) TFR is likely to be lower for single and married women than for the divorced, separated and widowed women.

4) Maternal education tends to lower infant and child death.

5) Infant and child death rate is likely to be lower in urban areas than in rural areas.

6) Infant and child death rate is likely to be lower for single and married women than for divorced, separated and widowed women.

1.9 SCOPE. LIMITATIONS AND DATA SOURCE

It's proposed that the study will cover all the divisions in Western Province as per the 1979 Kenya Population Census. Three variables: marital status(single, married, separated/ divorced, widowed); education (none, primary, secondary +) and place of residence (rural, urban) are considered. This, indeed, becomes one major limitation of the study since as is well known, there're numerous other factors, viz., socio-economic, environmental, biological, cultural, religious, to mention but just a few that play a major role in the determination of the levels, trends and patterns of infant and child mortality as well as fertility in any given society. The non-coverage of all these variables was caused by lack of sufficient time, funds, personnel as well as lack of primary data. In view of all these reasons, the study is therefore going to focus on only the three aforementioned variables, and secondary data from the 1979 Population Census will be relied on heavily.

1.10 DEFINITION OF MAJOR TERMS USED IN THE STUDY

Fertility: Actual reproductive performance, or the bearing of a live child by a woman.

Fetal Death: A spontaneous abortion, miscarriage, or other development that terminates the life of a fetus (or pregnancy) before birth.

Infant Mortality Rate: The number of deaths of children, under one year of age in a given year divided by the total number of live births registered in the same year. Often this rate is broken down into the number of deaths during the first month of life (neonatal deaths) and deaths during the remainder of the year (post neonatal deaths).

Life expectancy : The average number of years of life remaining to each of a group of persons, reaching a particular age. At age zero (or birth), this measure, which is derived from a lifetable, is heavily influenced by survival rates during infancy.

Lifetable: A statistical table that converts age-specific mortality information into measures of survival and life expectancy at given ages.

Literacy : The ability to read and write in some language.

Marital Status : Matrimonial condition, typically broken down into single (never married), currently married, divorced, separated, and widowed. Among the currently married, legal and consensual marriages are sometimes differentiated.

Mortality : Death of members of a poulation.

Rural Population : The number of people living in communities smaller than a given size or in areas not classified as urban: it's often broken down into the number of people living on farms and in rural non-farm areas.

Urban Population : The number of people living in communities larger than a given size or in areas closely integrated with such places.

Socio-economic Status : A classification of people or groups on the basis of such social and economic variables as their educational level, occupation, income and place of residence.

Total Fertility Rate : The average number of children that would be born alive to a woman (or group of women) during her lifetime if she were to pass through all her childbearing years conforming to the age-specific fertility rates of a given year.

1.11 THE METHODOLOGY

It's proposed that this work will heavily rely on the Coale-Trussel and Brass's P/F Models for the analysis.

Coale-Trussel Model:

This Model is based on the assumption that marital fertility either follows natural fertility (if deliberate birth control is not practised); or it departs from natural fertility in a way that increases with age according to a typical pattern. Therefore denoting marital fertility at age X by (X) and natural fertlity at the same age by h(x), in a population where fertility is controlled voluntarily,

$$\Phi(x) = M\, h(x)\, \delta(x) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where M= a parameter indicating the level of natural fertility that a population would experience in the absence of all voluntary control and (x) is a function of age indicating the typical pattern of departure from natural fertility when voluntary control is exercised.

By examining the function $\delta(x)$ calculated for several populations, Coale and Trussel found that it could be represented by $\delta(x) = \exp(mv(x))$ ....(2)

where the fuction of v(x) was very nearly the same for different populations and the parameter M changed from one population to another. V(x) represents the typical pattern of deviation from natural fertility when deliberate birth control is practised while M measures the degree to which the control is practised. The final model is derived from (1) and (2), and has the form:

$$\Phi(i) = M\, h(i) \exp(mv(i)) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where the index i is used in place of age x to indicate that, in general, only data referring to five year age groups are used.

Thus, this model can be fitted to any population whose marital fertility rates are known by just identifying the values of the parameters M and m. Coale and Trussel suggest two possible ways of estimating M and m. According to the first and simplest procedure, $M = \Phi(2)/h(2)$ ....(4).

and $m = 0.2 \sum_{i=3}^{7} \ln [\Phi(i) / M\, h(i)] / \gamma(i)$......(5).

i.e. the level of marital fertility M is defined by the relationship between the observed marital and natural fertility rates at ages 20-24, at which ages voluntary control of fertility is deemed to have no effect on pattern; while m is just the mean of m(i) values that can be estimated directly from the observed $\Phi(i)$ once M is known.

CHAPTER 2

INFANT/CHILD MORTALITY ESTIMATION

2.1 INTRODUCTION

In this chapter, estimates of infant and child mortality by socio-economic variables at Divisional level of Western Province as per the 1979 census are made. The variables used are education, place of residence and marital status.

Education is hereby split into three categories based on the years of schooling the respondents have spent. These are those with no education, those with primary education and finally those with secondary education and above. The place of residence is classified into two categories: those residing in urban areas and those in rural areas. The strange fact about this differential is that most divisions, especially in Kakamega and Busia districts were classified as only rural i.e. they had no urban status with them. However, Busia township division was found to be wholly urban - a very strange phenomenon indeed.

The marital status variable described the mother's status at the time of the census. There were four such categories, viz., single, married, widowed, and divorced/separated.

The infant mortality rates are measured in terms of probability of dying between age 0 and 1. This estimate is denoted by either $_1q_o$ in the lifetable or simply as IMR which is derived by multiplying $_1q_o$ by 1000. For the case of child mortality, the study will rely on two measurements: q_x which is the probability of dying at age x whose values are 1, 2, 3, 5, 10, 15 and 20. Another child mortality index is $_4q_1$ and this is obtained from the lifetable directly. It's the probability of dying between ages 1 and 5. All these estimates mentioned above are obtained using the Coale-Trussel technique which is an extension of the Brass child mortality technique. The coefficients applied are those of the West mortality model of the Coale-Demeny lifetables.

2.1.1 <u>Background Information</u>

Western Province is among some of the provinces in Kenya with the highest infant and child mortality. This is mainly due to the tropical climate experienced in this area, the low socio-economic development (Kichamu, 1986), the mosquito prevalence (due to the area's proximity to Lake Victoria) which has become quite endemic, among other factors. Briefly, Busia's proximity to water surfaces such as Lake Victoria, River Yala and River Nzoia have normally caused serious flooding during the rainy season. The direct and indirect effects of these floods are numerous, amongst them: malnutrition, malaria, diarrhoea, loss of property and lives, destruction of crops and livestock.

Further, the stagnant water surface is an environmental hazard as this is a habitat for breeding of mosquitoes and bilharzia worms (schitosomes). Due to these, diseases such as malaria, kwashiokor, marasmus and water related diseases have been confirmed in the area. Gastroenteritis is the major scourge for infants, while respiratory tract infections is the major scourge for children. In the case of Kakamega, the DDC report (1978-79) showed that malaria and helminth infections are the commonest infectious diseases. Other infectious diseases frequently reported are measles, diptheria, whooping cough, tuberculosis and tetanus. In Bungoma, 78% and 19% of all infant and children's deaths were ascribed to respiratory and diarrhoeal diseases respectively (Registrar General's Report, 1977). The complexity and diversity of these morbidity structures in these regions make the control of these diseases a difficult process.

2.2 Estimation of Child Mortality Using Data Classified by Age

Trussel's method, which is the most recent version of the original Brass estimation procedure is employed. Estimates of q(1), q(2), q(5), q(10), q(15) and q(20) are obtained from data on children born classified by age of mother. Here it's assumed that fertility patterns remain constant.

2.3 DATA REQUIRED

The data required for this method are as follows:

(i) The number of children born (CEB), classified by five year age group of mother.

(ii) The number of children dead (CD) classified by five year age group of mother.

(iii) The total fem e population (FPOP) classified by five year a group. It should be stressed that all women, and not *merely* married women are consid .

2.4 COMPUTATIC ROCEDURI

Use is made of the dat entral Busia in the tab below to compute the probabilities of dying.

To calculate the said probabilities, the following steps are followed.

Table 2.4.1 Mortality by Residence in Central Busia

			Rural				
Age Group	FPOP	CEB	CD	P(i)	D(i)	K(i)	q(x)
15-19	6871	2643	487				
20-24	4956	10838	2261				
25-29	3835	15460	3663				
30-34	3353	20516	5731				
35-39	2799	20305	[illegible]135				
40-44	2691	20826	7048				
45-49	2474	19709	7395				

Step 1: Calculation of average parity per woman. Parity (P1) refers to age group 15 - 19, P(2) to 20 - 24 and P(3) to 25 - 29

P(i) = CEB(i)/FPOP(i)

Where CEB(i) denotes the number of children born by women in age group i; and FPOP(i) is the total number of women in age group i. In our case for Central Busia.

$$P(1) = \frac{2643}{6871} = .384660$$

$$P(2) = \frac{10838}{4956} = 2.186844$$

$$P(3) = \frac{15460}{3835} = 4.031290$$

: : :

: : :

$$P(7) = \frac{19709}{2474} = 7.966451$$

Step 2: Calculation of proportion of children dead for each age group of mother. The proportion of children dead, D(i), is defined as the ratio of reported children dead to children ever born, i.e -

D(i) = CD(i)/CEB(i)

Where (CEB(i) is as defined in Step 1; and CD(i) is the number of children dead reported by women in age group i.

Thus $D(1) = CD(1)/CEB(1)$

$$= \frac{2261}{2643} = .184260$$

$D(2) = CD(2)/CEB(2)$

$= 2261/10838 = .208617$

:

:

$D(7) = CD(7)/CEB(7)$

i.e. $$D(7) = \frac{7395}{19709} = .375209$$

<u>Step 3</u>: Calculation of multipliers. The table below presents the necessary coefficients for the West mortality model to estimate the multipliers, k(i), according to the Trussel variant of the original Brass method, as well as the estimation equations

Table 2.4.2 WEST MORTALITY MODEL

Age group	Index i	Mortality ratio q(x)/D(i)	a(i)	b(i)	c(i)
15-19	1	q(1)/D(1)	1.1415	-2.7070	.7663
20-24	2	q(2)/D(2)	1.2563	-.5381	-.2637
25-29	3	q(3)/D(3)	1.1851	.0633	-.4177
30-34	4	q(5)/D(4)	1.1720	.2341	-.4272
35-39	5	q(10)/D(5)	1.1865	.3080	-.4452
40-44	6	q(15)/D(6)	1.1746	.3314	-.4537
45-49	7	q(20)/D(7)	1.1639	.3190	-.4435

Estimation Equations $k(i) = a(i) + b(i)\, P(1)/P(2) + c(i)P(2)/P(3)$

$$q(x) = k(i)\, D(i).$$

Source: Manual X, P. 77

Applying this to the Central Busia data for rural residence we have

$$k(1) = a(1) + b(1)\, P(1)/P(2) + c(1)\, P(2)/P(3)$$

$$= 1.1415 + (-2.7070)\left(\frac{.384660}{2.186844}\right) + .7663\left(\frac{2.186844}{4.031290}\right)$$

$$= .665345$$

$$k(2)= a(2)+b(2)\, P(1)/P(2) + c(2)\, P(2)/P(3)$$

$$=1.2563+(-.5381)\ \frac{.384660}{2.186844} +(-.2637)\left(\frac{2.186844}{4.031290}\right)$$

$$=1.018600.$$

: : :

$$k(7)= a(7)+b(7)P(1)/P(2) +c(7)P(2)/P(3)$$

$$=1.1639+(.3190)\frac{.384660}{2.186844} + -.4435\left(\frac{2.186844}{4.031290}\right)$$

$$=.923315.$$

Step 4: Calculation of probabilities of dying.

Estimates of the probability of dying, q(x), are obtained for different values of exact age x as the product of the reported proportions dead, D(i) and the corresponding multipliers, K(i).i.e. q(x) = D(i).K(i). Note that x takes the values respectively 1, 2, 3, 5, 10, 15 & 20, as it is related in broad terms to the average age of the children of women in age group i.

The probabilities of dying in Rural Central Busia are thus computed as follows:

$$q(1) = K(1).D(1)$$
$$= (.665345)(.184260) = .122596$$
$$q(2) = K(2).D(2)$$
$$= (1.018600)(.208617) = .212498$$

.

.

$$q(20) = K(7).D(7)$$
$$= (.923315)(.375209)$$
$$= .346436$$

Once q(x) is estimated, its complement p(x), the probability of surviving from birth to exact age x, is readily obtained as

$$p(x) = 1.0 - q(x)$$

2.5 Child Mortality Estimation by Mother's Education.

It has been observed that one factor which is of surprising importance in the explanation of child mortality levels in the divisions was mother's education. In this section, I have analysed the levels of child mortality in the divisions of Western Province with reference to the educational attainment of mothers. Maternal education has been considered, rather than Paternal on three grounds. First, maternal education is an index of socio - economic status. Secondly, it gives an idea of how much effect educational programmes have on child mortality. Finally data on paternal educational levels is rarely available, more so, it was not available in the 1979 census, (Kibet, 1981).

In the discussion of infant and child mortality rates for the divisions of Western Province in relation to the variables of education, marital status and residence, we have chosen to confine ourselves to the q(2) mortality estimates and the e_o values. It should be borne in mind that any other values , viz, q(3), q(5), q(1) and q(4) would have been used as estimates since they are equally accurate. However, the reasons why q(1) and q(10) are not preferred is that the former is unreliable while the latter is based on the memory of remote events by women whose responses are not representative of current mortality experience (Kibet 1981).

The table below lists the q(2) values per 1000 live births and by education of mother for each division.

Table 2.5.1 IMR Per Division, Western Province, 1979

DIVISION	No Education	Primary	Secondary+
Western Province	--	107	71
BUNGOMA	--	104	70
Central Busia	219.87	195.96	143.86
Hakati	221.82	188.40	114.55
Busia Township	200.21	159.88	131.32
Northern Busia	181.56	147.22	72.49
Tongaren	131.53	115.06	104.35
Elgon	176.98	125.21	62.53
Kimilili	155.05	134.32	87.63
Sirisia	171.72	165.10	97.54
Kanduyi	176.52	144.97	93.68
Kakamega Forest	134.33	62.68	N/A
Mumias	201.51	190.46	133.29
Lugari	101.97	99.26	79.05
Hamisi	110.84	94.82	72.25
Lurambi	173.13	148.86	84.12
Butere	174.05	135.24	105.17
Kabras	136.47	138.92	73.65
Ikolomani	144.60	127.47	62.71
Vihiga	124.34	101.84	65.43

The estimates in the table above show that child mortality levels vary greatly with the educational attainment of the mother. The child mortality levels are very high for those whose mothers had no education at all.

The levels drop for those mothers with primary education. It's also evident that the mortality levels for mothers with secondary education and beyond is almost one and a half times lower than that for mothers with no education.

Whether considering q(2), q(3) or q(5) values, our estimates have shown that there exist some strong link between maternal education and child survival. The children of mothers with higher formal education have higher chances of survival as compared to those whose mothers have low or no formal education at all.

There are several possible reasons that attribute to this kind of trend. Education is generally considered a principal factor which is related to development as it affects mortality. This relationship is viewed as indirect since it works through health. In a way, education of mothers affects post-neonatal mortality for infants and young children, since survival rates at early ages are largely affected by the social and educational conditions of the mothers, which in turn determines their diet and nature of their child care. For instance, mother's education may lead to the practice of boiling water which can lead to a reduction in the incidence of diarrheal diseases and, consequently, reduce infant and child mortality. There is an observation that educated females do normally get married to educated males and this has its advantage of raising the per capita income and promoting health awareness in the family; especially to mothers as they are considered first level health care providers for children. Their activities and attitudes influence the health of children and all family members (Caldwell, 1986).

The mechanism through which maternal education could affect infant and child mortality has been discussed by many scholars. This includes a heightened perception of health problems and an increased sense of one's capacity to solve the problem, creation of better knowledge on positive health, sanitary practices; and changing of the relative status of women in the household, e.g. improved maternal education can also reduce child mortality by changing the patterns of child bearing, with the assumption that educated mothers are likely to space births and control them.

Besides the mechanisms discussed above, education of the mother influences child survival in Kenya because it influences place of residence. This is not surprising because educational opportunities for rural women are more limited than those of urban women. Rural women with education are more likely to move to urban areas in search of employment. The fact that most women with high education are urban residents is another advantage for they are likely to enjoy the socio-economic infrastructural advantages.

There is also a general consensus that that educational attainment is to be associated with a decline in infant mortality (Caldwell, 1979; Anker and Knowles, 1977; Brass, 1979). The inverse association between educational attainment and infant mortality is to be attributed to many causes. These include the likelihood that more education is associated with:-

(i) breaks with traditional family raising practices

(ii) Less fatalism about illness,

(iii) More effective child care and medical alternatives,

(iv) better utilization of available foods, from a nutritional perspective, and

(v) more personal and intensive attention by the mother with more of the family resources spent on the child.

The above data portrays that:

(i) Central Busia, Hakati, Busia Township and Mumias register high IMR of over 200 for mothers with no education.

(ii) Lugari registers the lowest IMR for mothers with no education, followed by Hamisi, and then Vihiga - all in Kakamega district.

(iii) Apart from Northern Busia, all the divisions of Busia as well as Tongaren, Mumias and Butere register IMR of over 100 for mothers with secondary education plus.

2.6 Mortality Estimation by Marital Status

The table below gives the q(2) values (i.e. the probability of dying at age 2) for all the categories of marital status, viz., the single, married, widowed and divorced/separated as per every division under discussion

Table 2.6.1 Probability of Dying at age 2 q(2) values

DIVISION	Single	Married	Widowed	Divorced/ Separated
Central Busia	.15364	.18805	.36963	.17122
Hakati	.15169	.182254	.25046	.21918
Busia Township	.16787	.15410	.22492	.26340
Northern Busia	.07595	.15296	.09572	.17241
Tongaren	.03725	.13925	.07251	.06447
Elgon	.0599	.1064	.08856	.10369
Kimilili	.11203	.11561	.12197	.11983
Sirisia	.12191	.13564	.12677	.21098
Kanduyi	.11976	.13780	.13153	.12628
Mumias	.13082	.17714	.29372	.20334
Lugari	.08476	.09731	.06602	.11206
Hamisi	.09421	.08512	.20513	.10790
Lurambi	.11706	.14081	.26148	.10416
Butere	.12110	.14561	.40139	.14845
Kabras	.07280	.11937	.16280	.12437
Ikolomani	.09689	.12036	.11230	.12064
Vihiga	.06818	.09656	.22272	.07175

In all the divisions other than Busia Township, Hakati and Central Busia, the probability of dying of a child for single women is the lowest. Tongaren has the lowest probability of dying of .03725 and Busia Township has the highest of .16787. In Hamisi the married women have the least child mortality estimates of about 85 deaths per 1000 live births, while the widowed and divorced/separated women generally have higher mortality estimates in most divisions. Lugari and Tongaren stand out different among the widowed registering low estimates of respectively 66 and 72 deaths per 1000 live births. This could be explained by saying that since the two divisions are settlement schemes, it is possible that most women return to their original homes after the death of a husband who had migrated to these schemes (Munala, 1988).

The general observed pattern is that the single and married women do on the average experience low infant and child mortality estimates while the widowed and divorced/separated have higher values. This pattern could be explained by noting that most of the single mothers are educated and hence work outside their homes. This enables them to have more income and a better understanding of the society and health requirements. The single also have an advantage of having low fertility, as most of them normally have a TFR of 2 or 3 and therefore can easily take care of their children medically, socially and parentally or otherwise.

Further, studies have shown that the single attach a lot of attention to their children in that the security and Protection which they would have obtained from their husbands become displaced to these children. Consequently ,the single Mother sees to it that the children get everything that she's able to provide, as she also tries to play the role of the Father by filling the empty gap.

For the married, the mortality estimates are bound to be low because both parents are there. In most cases, either one of them or both are working and the income so obtained is put to full use to see to it that the children are well taken care of.

Where neither is in gainful employment ,both of them may try to look around and get some source of income for as they say two are better than one. All in all, there's attention from each spouse all directed to their children.

Data on separated/divorced and widowed is fairly doubtful and could be subject to a lot of errors in classfication. Most Mothers who are divorced/separated or widowed do not like to state their actual and true status. They would prefer to refer to themselves as married. For most places in Western province, the widowed have a tendency of getting re-married upon the death of their husbands. As a result, the "new" husband will only be interested in the children he will bring forth with the widow. As a result, the children left behind by the late husband are almost abandoned. This is likely to result in higher mortality estimates for these children. In the case of the divorced/separated, the children are left to suffer as the woman and the man are both pre-occupied in searching for fresh partners at the expense of the health of the children. They may therefore not detect any cases of sickness, malnutrition and neglect in their children. This, too, leads to higher mortality of the children.

2.7 Mortality Estimation by Place of Residence

This variable refers to maternal place of residence at the time of the census. From the table below, it is apparently evident that where both rural and urban areas exist as per the 1979 census, child mortality levels are appreciably lower in the urban as opposed to the rual areas, where such levels are seen to be higher.

Table 2.7.1 IMR for each Division, Western Province, 1979
1000. q2 Values

Division	Rural	Urban	Combined cases
Central Busia	212.50	151.24	183
Busia Township	------	174.26	174.26
Northern Busia	169.67	------	169.67
Hakati	206.97	------	206.97
Tongaren	123.16	80.65	123.99
Elgon	112.88	-----	112.88
Kimilili	133.21	136.38	133.80
Sirisia	161.49	67.78	160.86
Kanduyi	159.29	143.03	156.48
Mumias	198.23	------	198.23
Lurambi	173.12	130.82	160.23
Butere	167.31	------	167.31
Hamisi	102.05	------	102.05
Lugari	101.36	------	101.36
Kabras	136.20	------	136.20
Ikolomani	138.21	------	138.21
Vihiga	110.25	93.08	110.02

This excess rural over urban mortality is attributable to the differential distribution of socio-economic characteristics in the urban and the rural areas. Better educated and higher income people do in a greater proportion live in urban rather than in rural areas.

The concentration of health facilities and manpower in the urban centres as well as the provision of the basic community amenities such as clean piped water, sewerage disposal systems and the like, among others are very well known to reduce the spread of diseases. For instance Kanduyi Division is served by a district hospital situated in its urban area, tarmac roads, electricity, piped water and several private clinics. The same applies to Lurambi - urban, Vihiga urban, Sirisia urban and Kimilili urban to mention only a few. This contrasts sharply with their corresponding rural areas where there may not even be access road or medical facilities, leave alone clean drinking water.

Thus, in the case of a patient falling sick in the rural areas with impassable roads, it becomes very difficult to administer proper first aid. Most of these patients die before they get any medical attention due to poor communication and lack of medical facilities among other factors.

Another manifestation of the inequality existing between rural and urban areas is the inequitable distribution of medical personnel. It was estimated that in

Kenya during the 1976/77 fiscal year, 90% of all physicians were located in urban areas leaving only 10% of the physicians to take care of more than 10 million people in rural areas giving a ratio of 1 doctor per 10000 patients! (UN, 1982). Indeed this must be a grave fact.

Many infants in Kenya die from preventable or curable diseases because they and their mothers get little or no medical care before, during or after birth. Neonatal tetanus, which is a major killer of infants in some parts of Western Kenya is commonly the result of unclean hands or instruments used during child birth. This cause of death is quite common in rural areas where there are scarce health facilities or lack of trained health personnel. In rural areas, a good proportion of people are trapped in poverty. They are consequently more susceptible to diseases in part, owing to malnutrition, less access to immunization and poor environmental sanitation. Malnutrition has been found to claim a lot of lives in rural areas because it lowers resistance to infectious and parasitic diseases that could not be threatening to a well nourished child. Just as malnutrition prepares the child for infection, diseases undermine the nutritional status of a child. A sick child often loses appetite so that its food intake is reduced just when it needs more nutrients than usual to fight illness (Newland, 1981).

2.8 INTER-DIVISIONAL VARIABILITY - Combined Cases

There is a wide infant and child mortality differences in the divisions under study as indicated by the table.

Table 2.8.1 Classification of Divisions by Size of Mortality at Age 2 - 1000 q(2)

Divisions with given Range of Deaths per 1000 Births

100 - 119	120 - 139	140 - 159	160 - 179	180 - 219
Elgon	Tongaren	Kanduyi	Busia Township	Hakati
Hamisi	Kimilili		Northern Busia	Mumias
Lugari	Kabras		Sirisia	Central Busia
Vihiga	Ikolomani		Lurambi	
			Butere	

Elgon, Hamisi, Lugari and Vihiga fall in the first category with the lowest chid mortality of between 100 - 119 deaths per 1000 live births. Of the four divisions in this category, all are from Kakamega district save for Elgon which is from Bungoma district, and whose inhabitants are mainly Kalenjin (90%) unlike the other divisions where the inhabitants are Luhya. Lugari division is a settlement scheme with a very low population density of 128 people per square km.

The division boasts of being the granary of the district. Hamisi and Vihiga are divisions with the highest population densities in the whole province of 612 and 692 respectively and ironically very low infant mortality rates. The high population densities means very high economic activities in these areas for survival purposes, leading to high productivities which enhances high child survival.

In the second category, there is Tongaren in Bungoma district, also a settlement scheme, Kimilili in Bungoma also, as well as two divisions from Kakamega: Kabras and Ikolomani, while the third category contains only Kanduyi where ironically a district hospital exists. The fourth class holds, Busia Township, Northern Busia (in Busia), and Lurambi and Butere (both in Kakamega district). Once again, Lurambi does not seem to benefit from the services of the provincial hospital in its precincts as well as the numerous dispensaries in its urban setting. Finally, Mumias a sugarcane zone in Kakamega and Central Busia and Hakati in Busia lie in the fifth and last category. The classification reveals that the child mortality situation is badly off in the divisions of Busia district and that apart from Sirisia and Kanduyi (in Bungoma) the other divisions of Bungoma are at a great advantage in that there are more child survival chances in Bungoma than in the other two districts of the province. Perhaps this is due to the population densities in the region whereby we find that Bungoma as a district is the least peopled with a density of 163 people per square kilometre followed by Busia (183) and Kakamega (294). All in all, it can be concluded that Mumias and Hakati are the most disadvantaged divisions in the whole province in-so-far as the child mortality situation is concerned and that Elgon, Hamisi, Lugari and Vihiga are the most advantaged in this respect. Furthermore Lugari has the least figure while Hakati has the highest.

Fig. 3 1979 INFANT MORTALITY RATES PER 1000 LIVE BIRTHS — COMBINED CASES: WESTERN PROVINCE

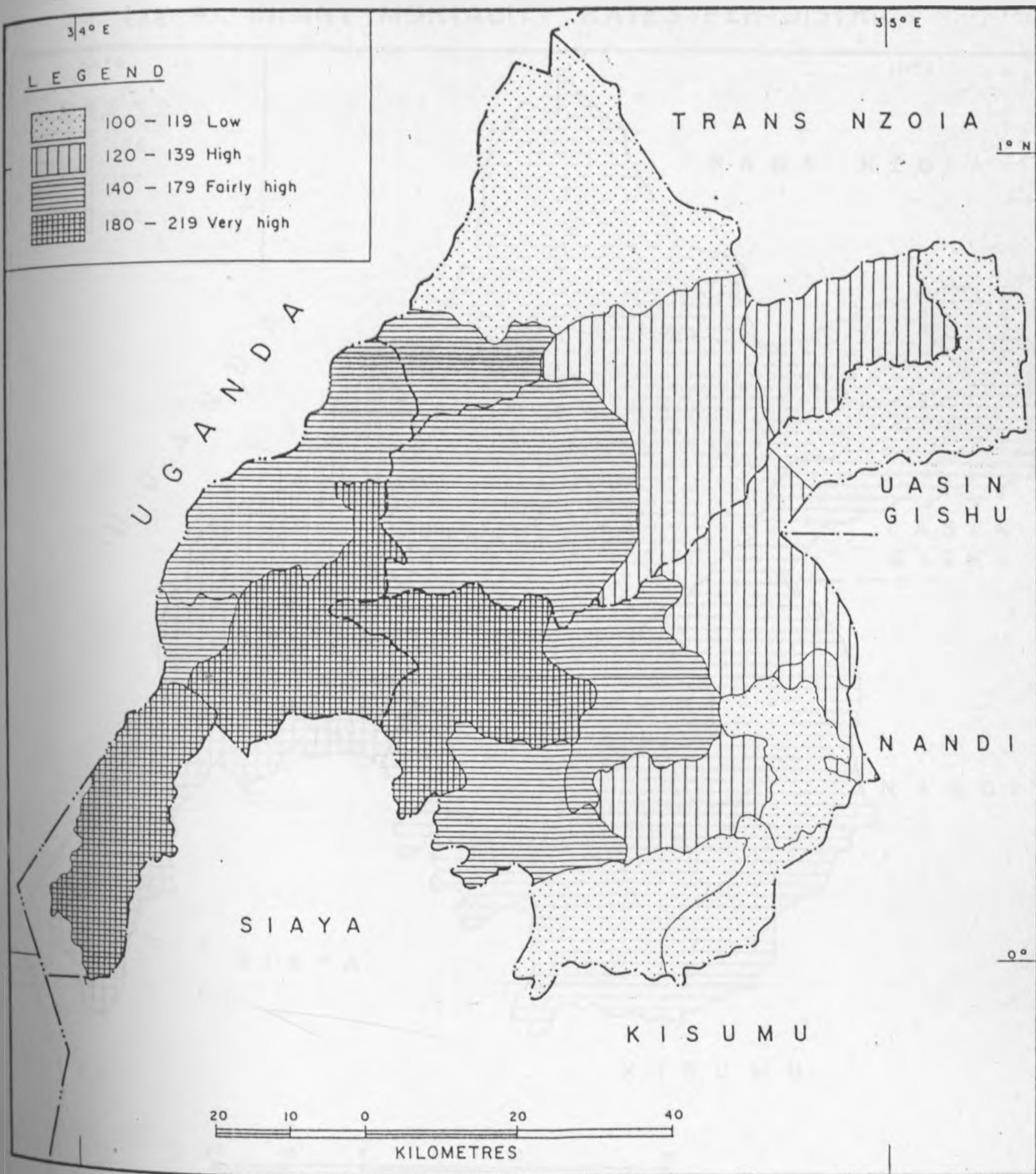
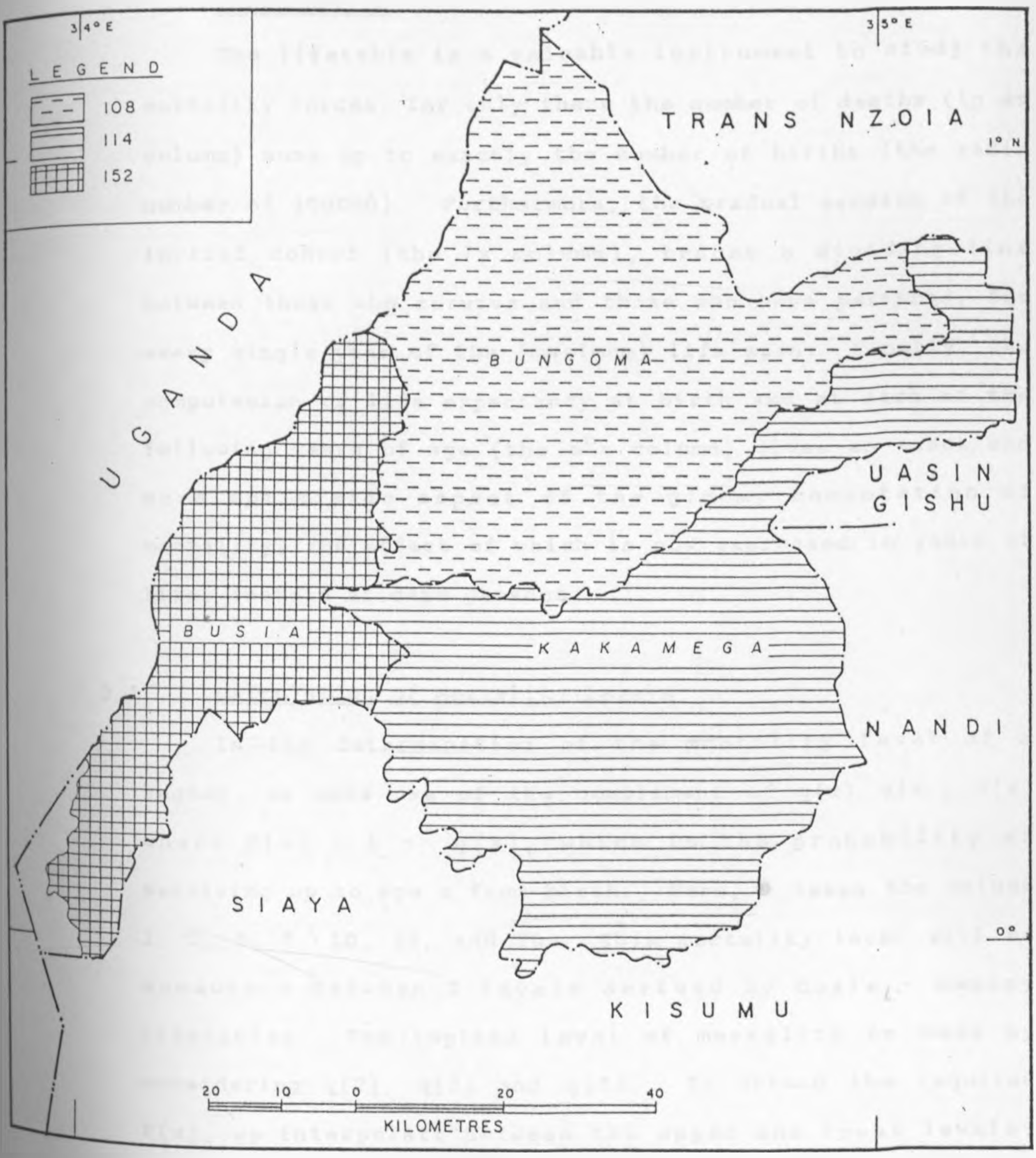


Fig. 4 INFANT MORTALITY RATES PER DISTRICT



2.9 LIFETABLE CONSTRUCTION

2.9.0 Introduction

The lifetable is a valuable instrument to study the mortality forces, for only there the number of deaths (in dx column) sums up to exactly the number of births (the radix number of 100000). Furthermore, the gradual erosion of the initial cohort (the lx column), traces a dividing line between those who survive and those who have perished, for every single year of the (maximum) life span. Finally, the computation of life expectancy at birth and at each of the following years of age (the $e^{o}x$ column) gives an exact and more optimistic aspect of the gloomy connotation of mortality, the effect of which is now expressed in years of life, instead of dead persons.

2.9.1 Calculation of Mortality Levels

In the determination of the mortality level of a region, we make use of the compliment of q(x) viz., P(x) where P(x) = 1 - q(x), which is the probability of surviving up to age x from birth. Here, x takes the values 1, 2, 3, 5, 10, 15, and 20. This mortality level will be somewhere between 2 levels derived by Coale - Demeny lifetables. The implied level of mortality is made by considering q(2), q(3) and q(5). To obtain the required P(x), we interpolate between the upper and lower levels. The linear interpolation is based on the concept of the gradient of a line. Suppose that the rectangular coordinate (x(1),y(1)) refers to the lower mortality level with its corresponding probability of survival. Further, let (x(2),y(2)) be the upper mortality level with its corresponding probability of survival. Let (x,y) be a point in between, then

$$\frac{(y(2) - y(1))}{(x(2) - x(1))} = \frac{y - y(1)}{x - x(1)} \quad \ldots\ldots\ldots\ldots(1)$$

In practice x(2) - x(1) = 1, since x(2) and x(1) represent two contiguous mortality levels. Thus , if y is known, then

$$x = x(1) + \frac{y - y(1)}{y(2) - y(1)} \quad \ldots\ldots\ldots\ldots(2)$$

If however, x is known, then y is easily determined by the formula y = y(1) + (y(2) - y(1))(x - x(1)) .... (3)

2.9.2 Construction of Abridged Model Life Table

The average mortality level so obtained will help us to construct a lifetable. We first calculate the probability of surviving y = P(x), using equation (3). Each P(x) is then multiplied by the radix l_0 to obtain the number of survivors at age x i.e. l_x. Other lifetable functions can then be computed as under:

(1) nPx : The probability of surviving between age x and x + n is given by the formula

$nPx = l_{x+n}/l_x$

(2) nQx : The probability of dying between age x and age x + n, and is given by the formula

nQx = 1 - nPx

(3) $_nd_x$: the number of persons who die between age x and x + n, and is given by

$$_nd_x = l_x - l_{x+n}$$

(4) $_nL_x$: The person years lived between age x and age x + n, and is generally denoted by

$$_nL_x = \frac{n}{2}[L_x + L_{x+n}]$$

where n is the width of the interval.

Special formulae are given for those aged 0 - 1, 1 - 4, and beyond 75 years. These are

$_1L_0 = 0.3l_0 + 0.7lL_1$: for ages 0 - 1

$_4L_1 = 1.3L_1 + 2.7L_5$: for ages 1 - 4

$_\infty L_{75} = l_{75}\log_{10}l_{75}$: for age 75 and beyond

(5) T_x : The total number of people from age x and is given by $T_x = T_{x+n} + {}_nl_x$, for all ages except the last age for which $T_x = L_x$

2.9.3 Computation of P(x) values

Here we are going to use data for Central Busia (combined cases). The q(x) values have been retrieved from the Coale - Trussel on mortality estimation (combined cases). The q(x) values and their corresponding complement P(x) values have been reproduced in the table below.

Table 2.9.1 P(x) Values for Central Busia: Combined Cases

X	q(x)	P(x) = 1 - q(x)
1	.121953	.878047
2	.212183	.787817
3	.226737	.773263
5	.262106	.737894
10	.285294	.714706
15	.314083	.685917
20	.346373	.653627

Step 1: Computation of interpolated levels:

From the Px values obtained above, we wish to obtain their corresponding mortality levels as expressed in the Coale - Demeny model life tables. As Coale - Demeny model life table mortality levels are in whole integers, some interpolation will be imperative. This is achieved through the application of the formula:

$$\text{Interpolated levels} = \text{lower level} + \frac{\text{Calculated Px} - \text{lower level Px}}{\text{upper level Px} - \text{lower level Px}}$$

This is done for P(2), P(3) and P(5) and then the mean is obtained to represent the average level.

Thus

$$P_2 = 9 + \frac{0.787817 - .77271}{0.79340 - .77271} = 9.73016$$

$$P_3 = 10 + \frac{0.773263 - .77315}{0.79468 - .77315} = 10.00525$$

$$P_5 = 9 + \frac{0.737894 - .72530}{0.75017 - .72530} = 9.50639$$

Hence, mean level = $\frac{P2 + P3 + P5}{3}$

$$= \frac{9.73016 + 10.11525 + 9.50639}{3}$$

$$= 9.74727.$$

Step 2: Computation of Interpolated l_x (Survivors)

To compute the interpolated l_x we retrieve the probabilities of survival for the lower level and upper level by using the actual number of the average level as the lower level and the next one as the upper level. In our case 9 is the lower level and 10 is the upper level as the table below illustrates.

Table 2.9.2 <u>Interpolation Levels</u>

Age (X)	l_x Level 9	l_x Level 10	$_nP_x$ Interpolated Level
1	.91004	.91977	.91731
5	.96983	.97289	.97212
10	.96937	.97240	.97163
15	.96060	.96435	.96340
20	.95331	.95769	.95658
25	.94737	.95226	.95102
30	.94123	.94659	.94524
35	.93552	.94117	.93974
40	.92911	.93484	.93339
45	.91438	.92073	.91913
50	.88914	.89676	.89483
55	.84812	.85780	.85535
60	.78945	.80143	.79840
65	.70999	.72375	.72027
70	.60062	.61594	.61207
75	.36575	.37567	.37316

To obtain the interpolated levels in the last column in the above table, we employ the formula below:-

$$\text{Interpolated } P_x = \text{lower } P_x + (\text{Upper } P_x - \text{lower } P_x)\left[\frac{\text{mean level} - \text{lower level}}{\text{upper level} - \text{lower level}}\right]$$

Thus

$$X = P_1 = \text{lower } P_1 + (\text{upper } P_1 - \text{lower } P_1) \left[\frac{\text{mean level} - \text{lower level}}{\text{upper level} - \text{lower level}} \right]$$

$$\text{i.e. } P_1 = .91004 + (.91977 - .91004) \left[\frac{9.74727 - 9}{10 - 9} \right]$$

$$= .91004 + (.91977 - .91004)\ (.74727)$$

$$= .91731.$$

$$P_5 = \text{lower } P_5 + (\text{upper } P_5 - \text{lower } P_5) \left[\frac{\text{mean level} - \text{lower level}}{\text{upper level} - \text{lower level}} \right]$$

$$= .96983 + (.97289 - .96983 \left[\frac{9.74727 - 9}{10 - 9} \right]$$

$$= .96983 + (.97289 - .96983)\ (.74727)$$

$$= .97212$$

They are these survivorship probabilities calculated for ages 0 - 1, 1 - 4, 5 - 9 ...... 70 - 74 that are used as the initial life table function from which all the others are derived. The survival probability for ages 75 and over is assumed to be zero. While the corresponding $_nQ_x$ will be assumed to be 1 as the table for central Busia, combined cases below illustrates

Table 2.9.3 Lifetable for Combined Cases: Central Busia

Age Group	nQx	nPx	Lx	$n^{d}x$	nLx	Tx	e_x
0-1	0.08269	0.91731	100000	8269	94211.7	4505920.	45.05920
1-4	0.02788	0.97212	91731	2557.460	360018.8	4411708.	48.09397
5-9	0.02837	0.97163	89173.53	2529.853	439543.0	4051689.	45.43600
10-14	0.0366	0.9634	89173.53	2529.853	439543.0	4051689	45.43600
15-19	0.04342	0.95658	86643.68	3171.158	425290.5	3612146.	41.68967
20-24	0.04898	0.95102	79848.15	3910.962	389463.3	2778544.	34.79798
25-29	0.05476	0.94524	75937.18	4158.320	369290.1	2389091.	31.46141
30-34	0.06026	0.93974	71778.86	4325.394	348080.8	2019801.	28.13921
35-39	0.06661	0.93339	67453.47	4493.075	326034.6	1671720.	24.78330
40-44	0.08087	0.91913	62960.39	5090.607	302072.9	1345685.	21.37352
45-49	0.10517	0.89483	57868.78	6086.060	274128.7	1043612.	18.03411
50-54	0.14465	0.85535	51782.72	7490.371	240187.7	769483.7	14.85985
55-59	0.2016	0.7984	44292.35	8929.339	199138.4	529296.0	11.95005
60-64	0.27973	0.72027	35363.01	9892.097	152084.8	330157.5	9.336238
65-69	0.38793	0.61207	25470.92	9880.934	102652.2	178072.7	6.991217
70-74	0.62684	0.37316	15589.98	9772.427	53518.86	75420.46	4.837750
75+	1	0	5817.559	5817.559	21901.60	21901.60	3.764740

2.9.4 Expectation of Life at Birth

We now want to look at how life expectancy in Western Province is affected by the level of education of the mother, the marital status of the mother as well as her place of residence.

2.9.4.1 Expectation of Life at Birth By Education

Table 2.9.4 Expectation of Life at Birth by Education

Division	No Education	Primary Ed.	Sec.+ Ed.
Central Busia	43.77	48.53	55.33
Hakati	42.56	48.86	54.81
Busia Township	45.92	51.23	56.36
Northern Busia	47.29	51.90	58.41
Tongaren	52.89	55.64	58.23
Elgon	52.41	54.26	58.19
Kimilili	50.51	53.33	58.85
Sirisia	49.15	51.65	56.77
Kanduyi	48.30	52.42	56.93
Mumias	44.46	48.45	54.50
Lugari	54.66	56.56	59.21
Hamisi	53.82	56.01	60.04
Lurambi	48.16	52.87	58.79
Butere	46.23	51.74	57.54
Kabras	50.50	52.51	58.60
Ikolomani	50.50	53.42	59.58
Vihiga	51.94	55.92	58.99

The table above gives the life expectancy in years for each division by the education differential. It is clearly evident that there is a substantial gain in life expectancy with increased level of education. In othar words, the children of mothers with secondary education can expect to live for a relatively longer period than those of mothers with no education. As an illustration, looking at Central Busia, the gain in life expectancy from No education to primary education is 4.76 years, and the gain in life expectancy from primary to Secondary education and above is 6.80 years, whereas the gain in life expectancy from No education to secondary education is 11.56 years - which is a substantial gain indeed. It can therefore be concluded that secondary education and above enhances the longevity of life.

2.9.4.2 Expectation of Life at Birth by Marital Status

The table below shows the expectation of life at birth by marital status. It looks apparent from the figures that the children of the married have a clear advantage over the rest viz., they live for a much longer period compared to those of the rest of the categories, and that those of the widowed women are the most disadvantaged, viz., they live for the shortest period in contrast with the other categories. Thus, marriage stability provides a conducive environment for the enhancement of life expectancy

Table 2.9.5 Life Expectancy by Marital Status

DIVISION	Single	Married	Widowed	Divorced/ Separated
Central Busia	44.98	47.11	42.51	46.45
Hakati	46.61	47.57	40.16	45.62
Busia Township	48.84	51.45	47.29	48.17
Northern Busia	49.20	50.54	46.82	48.13
Tongaren	55.00	58.32	52.51	54.71
Elgon	53.79	55.96	52.11	52.80
Kimilili	53.10	53.69	50.84	51.25
Sirisia	49.32	56.01	50.71	51.01
Kanduyi	49.87	51.03	48.70	49.25
Mumias	47.17	49.58	44.75	47.35
Lugari	52.78	56.21	51.21	54.10
Hamisi	56.01	56.19	48.07	51.83
Lurambi	51.61	53.31	48.83	50.22
Butere	52.12	54.52	50.22	51.65
Kabras	53.25	56.60	51.56	52.58
Ikolomani	51.88	52.64	49.77	49.42
Vihiga	49.42	54.90	48.61	53.81

2.9.4.3 Expectation of Life at Birth - Residence

The discussion of life expectancy by residence is somewhat inconclusive as most of the divisions being dealt with have only one category of residence - rural. A good comparison between rural and urban therefore, does not arise in cases where the division is solely rural or urban (in the case of Busia Township). However, in the few divisions where the classification is both rural and urban, it is abundantly clear that life expectancy is higher in the urban as opposed to the rural areas. There are several reasons that contribute to this trend, among them being the existence of a better infrastructure in urban as compared to the rural areas, provision of piped and clean drinking water in the urban areas, existence of medical and health centres in urban areas, to mention only a few.

Table 2.9.6 Life Expectancy by Residence

DIVISION	Rural	Urban	Combined Cases
Central Busia	45.03	53.83	45.06
Hakati	44.50	---	44.50
Busia Township	---	48.64	48.64
Northern Busia	48.69	---	48.69
Tongaren	54.76	59.87	54.05
Elgon	52.37	---	52.37
Kimilili	52.97	52.50	52.72
Sirisia	50.75	55.96	50.78
Kanduyi	49.79	51.88	50.10
Mumias	45.71	---	45.71
Lugari	53.33	---	53.33
Hamisi	55.58	---	55.58
Lurambi	48.57	55.09	50.42
Butere	49.47	---	49.47
Kabras	51.80	---	51.80
Ikolomani	51.59	---	51.59
Vihiga	54.27	53.59	54.09

2.9.5 Summary of Results

Table 2.9.7 Relationship between IMR and e_o (Combined cases)

DIVISION	IMR	e_o
Central Busia	183	45.06
Busia Township	174	48.64
Northern Busia	170	48.69
Hakati	207	44.50
Tongaren	124	54.05
Elgon	113	52.37
Kimilili	134	52.72
Sirisia	129	50.78
Kanduyi	156	50.10
Mumias	198	45.71
Lugari	101	53.33
Hamisi	102	55.38
Lurambi	160	50.42
Butere	167	49.47
Kabras	136	51.80
Ikolomani	138	51.59
Vihiga	110	54.09

The table above gives the Infant Mortality Rate per 1000 births as well as the expectation of life at birth in years, for all the divisions under study. At the onset, it looks abundantly clear that there is a direct relationship between infant mortality rate and the expectation of life at birth, in that where the IMR is high, the e_o is correspondingly low.

It can be inferred that in as far as IMR is concerned, Vihiga, Tongaren, Hamisi and Lugari are the most advantaged since their values are fairly low. Of these four, Tongaren and Lugari are settlement schemes with population densities of 130 and 128 people respectively per square kilometre which make these among the least populated divisions in Western Province (see Table 2.9.8 on population densities on page 81).

These divisions are also agricultural zones where maize, beans, milk, millet, among others are found in abundance. Given the low population densities and plenty of food production, it therefore follows that nursing mothers are well fed, resulting in healthy infants, hence the low IMR and high e_o. Vihiga on the other hand, is the most densely peopled division in the whole province. With a total population of 254,940 people and an area of 368 Km^2, giving rise to a population density of 692 people per square kilometre, one would agree that this is a very high population density indeed. Yet surprisingly, the expectation of life at birth is among the highest in the province and a low IMR. This could be attributed to many factors, among them the industry of the inhabitants, the number of kilometre of tarmac roads available, the number of medical facilities available within the division (it was among the divisions enjoying several medical facilities) and its ease of accessibility to Kakamega, Kaimosi and Kisumu where big hospitals exist. Consequently, there was a resultant low infant mortality rate in the division. The same applies to Hamisi where a mission hospital exists as well as the availability of district and provincial hospitals viz., Kakamega, Kapsabet, Nandi, Nyanza, etc. in the vicinity.

Another factor is the growing of a combination of cash and subsistence crops, namely maize, beans, wimbi, tea and coffee to ensure enough food to survive on, and a fair income from the cash crops. Further, the cash crops so grown especially tea could be harvested for several years without a waiting time to maturity as is the case with sugarcane found in the neighbouring Mumias and Butere divisions. Dairy farming based on zero grazing is also highly practised in these divisions giving rise to plenty of milk. Also Hamisi and Vihiga are perhaps the only divisions with the largest number of market centres in the province and such centres enhance, to a great extent the economic activities of the residents thereby raising their standard of living.

Central Busia, Hakati and Mumias are the divisions with the highest IMR (> 180‰) and low expectation of life at birth (≤ 45 years). In the case of Central Busia and Hakati, we can attribute this to malaria which is quite endemic in these areas. For Mumias, this could be due to the agricultural pattern of the area. Mumias cultivates mainly sugarcane which takes at least 2 years to mature for harvesting. Very few food crops like maize or beans are grown. Consequently the Mumias residents wait for at least 2 years before getting any earnings for their sugarcane crop. Most of the men in this division have a tendency of marrying more wives after getting the "boom" money from sugarcane. Others indulge in excessive drinking which consequently affects their health. There is thus little regard to the quality of the upbringing of their infants resulting in high IMR. The food consumed in this area is mainly "imported" from the neighbouring Bungoma district at exorbitant prices.

Overall, it can be noted that of the three districts in Western province, only the divisions in Bungoma seem advantaged; as the values of IMR are fairly low on average and e_0 values are high. Looking at population densities of the divisions in the district, it is clearly evident that the average is below 200 persons per square kilometre. For instance Sirisia (192), Kanduyi (203), Kimilili (126) etc. The climate and soil texture in the district favours high agricultural production - which indeed is the case. Dairy farming is also practised virtually in every homestead.

Table 2.9.8 <u>Population Densities</u>

		Female	Male	Total	Area Square Km	Pop Density
Kakamega	Vihiga	117693	137247	254940	368	692
	Hamisi	44615	50132	94747	154	612
	Lurambi	52580	55365	107945	399	270
	Ikolomani	66526	74122	140648	349	402
	Kabras	49554	52562	102116	451	226
	Lugari	34335	34330	68665	535	128
	Butere	58836	66290	125126	344	362
	Mumias	63223	69552	132775	568	233
	Kakamega (Forest)	2576	1349	3925	322	12
	KAKAMEGA	489938	540949	1030887	3495	294
Busia	Northern	39394	41688	81082	507	159
	Central	53409	60914	114323	644	177
	Nakati	35472	42107	77579	430	180
	Township	11867	12990	24857	44	557
	BUSIA	140142	157699	297841	1626	18[illegible]
Bungoma	Sirisia	23219	24621	47840	248	192
	Kanduyi	81854	86233	168087	825	203
	Kimilili	78497	81880	160377	1268	126
	Elgon	38895	39278	78173	354	220
	Tongaren	24376	25082	49458	378	130
	BUNGOMA	246841	257094	503935	3074	163
	WESTERN	876921	955742	1832663	8196	223

CHAPTER 3

3. FERTILITY ESTIMATION USING THE COALE - TRUSSELL MODEL

3.1 INTRODUCTION

The economic theory of fertility views children as having costs as well as yielding satisfaction (i.e. utility) to parents. Consequently, children are seen competing with other goods and leisure for the limited resources of the household (viz., time and wealth, among others). The theory draws a distinction between an income effect on the demand for children which is anticipated to be positive, and a substitution or price effect which is expected to be negative.

Empirically, the "price" of children is often represented by the wife's level of education, which is normally viewed as being a reasonable proxy for the opportunity cost of time consumed by child care, while the husband's level of education is sometimes used as a proxy for income or wealth (Anker and Knowles, 1982).

This chapter, therefore, reviews the effect of various variables (viz., education, marital status and residence) on fertility. The fertility index used here is the total fertility rate (TFR). The Coale - Trussel model is going to be employed.

One major limitation encountered from the 1979 census data is the classification of the data on residence. Some divisions which one would expect to be exceptionally rural have been found to have been classified as consisting of urban status. The feature that was based on in the classification of either urban or rural in this case is in fact just the presence of one or two shops; for instance in Tongaren and Sirisia in Bungoma district. On the other hand, some areas which one would have expected to have been classified in two categories of both urban and rural have been found to have only one status: rural. Such is the case in the divisions of Ikolomani, Mumias and Hamisi, to mention only a few. This kind of misclassification is bound to give rise to some spurious results as will be noted.

Another problem with this data emerges in the classification of women in the various classes of their marital status. This is particularly so among the categories of widowed and divorced/separated. In the case of widowed women, especially those in their tender ages of below 35 years, the reliability of their data is highly questionable. Most of such women in Western province are known to get re-married immediately which means that they are bound to give their status as married and not widowed as would be expected. This, too, will be found to have an effect on the results. Those who are divorced/separated feel that mentioning their true status is somewhat embarrasing, obnoxious and shameful. They are thus likely to hide under the umbrella of either single or married.

3.2.0 The Coale - Trussel Method on the Fertility Estimation

The original P/F ratio method or Brass method seeks to adjust the level of observed age specific fertility rates, which are assumed to represent the true age pattern of fertility, to agree with the level of fertility indicated by the average parities of women in age groups lower than ages 30 or 35, which are assumed to be accurate.

Measures of average parities equivalent, F, comparable to reported average parities, P, are obtained from period fertility rates by cumulation and interpolation (these measures are effectively averages of the cumulated fertility schedule over age groups). Ratios of average parities (P) to the estimated parity equivalents (F) are calculated age group by age group, and an average of the ratios obtained for younger women is used as an adjustment factor by which the observed period fertility rates are multiplied. It should be observed that P/F ratios are generally calculated for the entire age range from 15 to 49, even though not all the ratios are used for adjustment purposes. This practice is recommended because the pattern of the ratios with age may reveal data errors or fertility trends. In the course of successful application of this method, the age pattern of the period fertility rates is combined with the level implied by the average parities of younger women to derive a set of fertility rates that is generally more reliable than either of its constituent parts (Manual X).

3.2.1 DATA REQUIRED

The following data are required for this method:

(a) The number of children ever born (CEB) classified by five-year age group of mother.

(b) The number of children born during the year preceding the survey or census classified by five-year age group of mother, or the number of registered births in the year of the census, also classified by five-year age group of mother.

(c) The total number of women in each five-year age group.

3.2.2 COMPUTATIONAL PROCEDURE

For the purposes of illustration, the following data for rural Kimilili are used to arrive at the TFR using the Coale - Trussel model, whose steps are outlined.

Table 3.2.1 Fertility Estimation in Kimilili by Residence Rural

Age Group	Index i	FPOP(i)	CEB(i)	BL12M(i) (Births in the last 12 months to the period preceding the Survey)
15 - 19	1	8747	2406	914
20 - 24	2	6215	12011	2009
25 - 29	3	4233	16884	1468
30 - 34	4	3090	18751	994
35 - 39	5	2551	19746	610
40 - 44	6	2272	20635	342
45 - 49	7	1953	18199	78

Step 1: Calculation of reported average parities

The reported average parity of women in age group i is denoted by P(i). Its value is obtained by dividing the total number of children ever born to women in age group i by the total number of women in that age group; i.e.

P(i) = CEB(i)/FPOP(i)

Thus P(1) = CEB(I)/FPOP(I)

= 2406/8747 = .275065

P(2) = CEB(2)/FPOP(2)

= 12011/6215 = 1.932582

: : :

P(7) = CEB(7)/FPOP(7)

= 18199/1953 = 9.318484

Step 2: Calculation of a preliminary fertility schedule from information on births in the past year or from registered births.

The fertility rate of women in age group i is denoted by f(i). This value is computed for each i by dividing the number of births occurring to women in age group i during the year preceding the interview by the total number of women (whether childless or not, ever married or not) in that age group; viz.,

$$f(i) = BL12M(i)/FPOP(i)$$

where BL12M(i) refers to births occurring in the last 12 months preceding the survey (census) in age group i.

$$\text{Thus } f(1) = BL12M(1)/FPOP(1)$$
$$= 914/8747 = .104492$$

$$f(2) = BL12M(2)/FPOP(2)$$
$$= 2009/6215 = .323250$$

$$\vdots \qquad \vdots \qquad \vdots$$

$$f(7) = BL12M(7)/FPOP(7)$$
$$= 78/1953 = .039938$$

In the case of registered births, the births by age group recorded for a calendar year should be divided by an estimate of the mid-year female population of the age group (usually from a census).

Step 3: Calculation of cumulated fertility schedule for a period

To compute this schedule, denoted by Q(i), the fertility rates computed in step 2 above are added beginning with f(1) and ending with f(i). The value of this sum multiplied by 5 is an estimate of cumulated fertility up to the upper limit of age group i. The formal definition of Q(i) is given as

$$Q(i) = 5 \left[\sum_{i=0}^{7} f(i) \right]$$

Thus

$$Q(1) = 5[f(1)] = 5(.104492) = .52246$$

$$Q(2) = 5(f(1) + f(2))$$
$$= 5[.104492 + .323250] = 2.13871$$

$$\vdots \qquad \vdots$$

$$Q(7) = 5[f(1) + f(2) + ... + f(7)]$$
$$= 5[.104492 + .323250 + ... + .039938]$$
$$= 7.629068.$$

Step 4: Estimation of average parity equivalents for a period. Average parity equivalents, F(i), are estimated by interpolation using the period fertility rates f(i) and the cumulated fertility values Q(i) calculated in previous steps. Coale and Trussel* proposed fitting a second-degree polynomial to three consecutive values of Q(i) and estimating the average parity of women of an age group within the range by evaluating the integral of the polynomial.

A somewhat more accurate procedure is based on the following interpolation equation:

$$F(i) = Q(i - 1) + a(i)f(i) + b(i)f(i + 1) + c(i)Q(7).$$

Values of the parameters a, b and c were estimated by using least squares regression to fit the above equation to a large number of model cases constructed using the Coale-Trussel fertility model*.

The table below shows the values of the coefficients required for the use of the above equation.

Table 3.2.2 Coefficient for Interpolation Between Cumulated Fertility Rates to Estimate Parity Equivalents

Age Group	Index (i)	Coefficients a(i)	b(i)	c(i)
15 - 19	1	2.531	-.188	.0024
20 -	2	3.321	-.754	.0161
25 -	3	3.265	-.627	.0145
30 -	4	3.442	-.563	.0029
35 -	5	3.518	-.763	.0006
40 -	6	3.862	-2.481	-.0001
45 -	7	3.828	.016	-.0002

Note: b(7) should be applied to f(i - 1), not f(i + 1) that is to f(6) and not f(8).

Applying these to our data, we have:

$$F(1) = Q(0) + a(1)f(1) + b(1)f(2) + c(1)Q(7)$$

$$= 0+(2.531)(.104492)+(-.188)(.323250)+(.0024)(7.629068)$$

$$= .222010$$

$$F(2) = Q(1) + a(2)f(2) + b(2)f(3) + c(2)Q(7)$$

$$= .522464 + (3.321)(.323250) + (-.754)(.346798) + (.0161)(7.629068)$$

$$= 1.457320.$$

:

:

$$F(7) = Q(6) + a(7)f(7) + b(7)f(6) + c(7)Q(7)$$

$$= 7.429375 + (3.828)(.039938) + (.016)(.150528) + (-.0002)(7.629068)$$

$$= 7.583142.$$

Step 5: Calculation of a fertility schedule for conventional five year age groups.

When age-specific fertility rates have been calculated from births in a 12 - month period classifed by age of mother at the end of the period, they are specific for unorthodox age groups that are shifted by six months. A fertility schedule for conventional, five-year age groups, $f^{+}(i)$, can be estimated by weighting the rates referring to unorthodox age groups according to the equations below: i and ii.

$$f^{+}(i) = [1 - w(i - 1)]f(i) + w(i)f(i + 1) \ldots\ldots.(i)$$

where f(i) and $f^{+}(i)$ are respectively, the unadjusted and adjusted age specific fertility rates; and the weighted factor, w(i) is calculated as

$$w(i) = x(i) + y(i)f(i)/ Q(7) + z(i)f(i + 1)/Q(7) \ldots (ii)$$

Note that the coefficients to be used in (ii) are displayed in the table below.

Table 3.2.3 Coefficients for Calculation of Weighted Factors to Estimate Age-specific Fertility rates for Conventional Age groups from Age groups shifted by six months

Age Group	Index (i)	Coefficients x(i)	y(i)	z(i)
15 - 19	1	.031	2.287	.114
20 - 24	2	.068	.999	-.233
25 -	3	.094	1.219	-.977
30 -	4	.120	1.139	-1.531
35 -	5	.162	1.739	-3.592
40 -	6	.270	3.454	-21.497

The values of x(i), y(i) and z(i) were obtained by fitting equation (ii) by least squares regression to the same model cases used in deriving the coefficients presented in table (2). No weighting factor is needed for i = 7, as childbearing is assumed to cease after age 50; and $f^{+}(7)$ is therefore taken to be $(1 - w(6))f(7)$. Births reported to women under age 15 can be included among those reported by women aged 15 19.

Thus to apply equation (i), equation (ii) must be used first as follows:

$$w(1) = x(1) + y(1)f(1)/Q(7) + z(1)f(2)/Q(7)$$

$$= .031 + \frac{2.287\ (.104492)}{7.629068} + \frac{.114(.323250)}{7.629068}$$

$$= .063885$$

$$w(2) = x(2) + y(2)f(2)/Q(7) + z(2)f(3)/Q(7)$$

$$= .068 + \frac{.999\ (.323250)}{7.629068} + \frac{(-.233)(.346798)}{7.629068}$$

$$= .100456$$

: : : :

$$w(6) = x(6) + y(6)f(6)/Q(7) + z(6)f(7)/Q(7)$$

$$= .270 + \frac{3.454\ (.150528)}{7.629068} + \frac{(-21.497)(.039938)}{7.629068}$$

$$= .08600$$

Consequently, $f^{+}(i)$ values can now be computed by applying (i) as below:

$$f^{+}(1) = [1 - w(0)]f(1) + w(1)f(2)$$

$$= f(1) + w(1)f(2)$$

$$= .104492 + (.063885)(.323250)$$

$$= .125144$$

$f^{+}(2) = [1 - w(1)]f(2) + w(2)f(3)$

$= [1 - .063885] (.323250) + (.100456) (.346798)$

$= .337437.$

$f^{+}(7) = [1 - w(6)]f(7)$

$= [1 - (-.08600)] (.039938)$

$= .043373$

<u>Step 6</u>: Adjustment of period fertility schedule.

With the quantities computed in steps 1 and 4, the ratios P(i)/F(i) are calculated. Ideally these ratios should be fairly similar for different values of i, although if CEB are increasingly ommitted by older women, the ratios will tend to decrease as age increases (especially over ages 30 or 35). In practice, however, they are often far from being constant, even below age 35. A weighting factor K is thus obtained by getting the mean P/F. Once the adjustment factor K has been computed, an adjusted fertility schedule is computed by multiplying the fertility rates for conventional age groups, $f^{+}(i)$.

*The level of total fertility rates obtained by the Coale-Trussel P/F ratio method depended on the multiplying factor K. Originally the ratios P2/F2 or P3/F3 were considered to adjust age-specific fertility rates most accurately.

However, in this study, for almost all divisions, P(i)/F(i) ratios for younger age groups are rather high. Since they seem reasonably consistent, albeit higher than the anticipated average, for all age groups, age-specific fertility rates were adjusted by a factor obtained by the arithmetic mean of all P(i)/F(i).

Fertility schedules obtained by such an adjustment factor seem to provide reasonable estimates of total fertility by K, to yield adjusted f*(i) values, viz.;

$f^*(i) = Kf^+(i)$.

Once all the f*(i) values are available, one may calculate the total fertility, TF, which is defined as

$$TF = 5\left(\sum_{i=1}^{7} f^*(i)\right)$$

Turning to our data we have:

$$P(1)/F(1) = \frac{.337394}{0.253028} = 1.333427$$

$$P(2)/F(2) = \frac{2.062663}{1.550609} = 1.330227$$

: : :

$$P(7)/F(7) = \frac{8.723977}{0.253028} = 1.183138$$

$\therefore$ K = Mean P/F = $\dfrac{\sum P(i)/F(i)}{7}$

= 1.248262

$\therefore$ $f^*(1) = Kf^+(1) = 1.248262\ (.140192) = .174996$

$f^*(2) = Kf^+(2) = 1.248262\ (.341257) = .425979$

$f^*(7) = Kf^+(7) = 1.248262\ (.04784) = .058398$

Finally the TFR can be obtained as follows.

$$TF = 5\left[\sum_{i=1}^{7} f^*(i)\right]$$

$= 5[f^*(1) + f^*(2) + \ldots + f^*(7)]$

$= 5[.174996 + .425979 + .. + .058398$

$= 9.269820$

An estimate of the number of births b(i) can be obtained by multiplying the period fertility rate by the female population, i.e.

$b(i) = f(i)\ FPOP(i)$

Thus,

$b(1) = f(1)\ FPOP(1)$

$= (.104492)\ (8747) = 1377.645$

$b(2) = f(2)\ FPOP(2)$

$= (.323250)\ (6215)$

$= 2639.380$

:

$b(7) = f(7)\ FPOP(7)$

$= (.039938)\ (1953)$

$= 106.6090$

3.3.0 DISCUSSION OF RESULTS

3.3.1 FERTILITY ESTIMATION BY EDUCATION

The table below gives the TFR values for three categories of women: those with no education, those with primary level of education and those with secondary education and over for all the divisions under study.

Table 3.3.1 Total Fertility by Differential of Education

Division	None	Primary	Sec.+
Western Province	8.91	9.37	7.41
BUSIA DISTRICT	8.02	8.54	6.66
Central Busia	8.58	8.88	7.26
Hakati	7.38	8.00	6.61
Busia Township	7.01	7.57	7.28
Northern Busia	8.16	9.30	4.82
BUNGOMA	9.41	9.94	7.87
Tongaren	10.03	10.62	8.07
Elgon	9.16	7.73	6.46
Kimilili	9.39	9.93	7.88
Sirisia	9.19	9.33	8.22
Kanduyi	9.10	9.53	6.98
KAKAMEGA	9.08	9.28	7.34
Kak. Forest/ Lurambi	10.20	8.99	6.50
Mumias	8.46	8.62	5.39
Lugari	9.38	10.38	7.81

Division	None	Primary	Sec.+
Hamisi	8.89	9.27	7.10
Butere	8.76	8.98	7.84
Kabras	9.42	9.39	8.56
Ikolomani	8.64	9.49	7.19
Vihiga	7.90	8.87	7.06

Looking at the above table, it is clearly evident that women with primary education have a higher TFR than those with no formal education except those in Elgon division. There are two reasons for this: Firstly women with primary education may not be following the cultural norms of, for instance child spacing. The second reason is that primary education enables women to reduce pregnancy wastages through modern methods of hygiene on personal cleanliness as well as other basic health requirements. The fertility rate for those women with secondary education and above is found to be least, compared with those with no education as well as those with primary education. This is because a parent's educational level may affect fertility in a number of different ways (Cochrane, 1979; Graff, 1979; Holsinger and Kasarda, 1976).

First, secondary education may increase a parent's relative preference for consumption items not related to children and reduce preference for more traditional lifestyles which include a large family size. Second, secondary education should increase an individual's willingness to accept new products and to use new procedures more effectively. When this reasoning is applied to modern contraceptive methods, it implies that increases in higher education may reduce fertility by increasing the acceptability and effectiveness of contraceptives, thereby reducing the number of unwanted births. Thirdly, secondary education and above increases women's income-earning potential and thereby increases the opportunity cost of their withdrawing from the labour force in order to care for children.

In addition, women with secondary education and above have smaller families since due to the many years they spend at school, they are likely to marry late and are more likely to work or take time to find suitable husbands.

Cochrane (1979) has shown that female education is much more likely than male education to be inversely related to fertility. This, indeed, is confirmed by the WFS data by the unweighted average fertility for males and females in each education group. These average values show that there is a difference of 1.9 children over the education spectrum from non education to secondary schooling for females, and a difference of only 1.3 for males. Further, males with some education have higher fertility on average than those with no schooling 6.4 versus 6.2 (these values are reversed for females).

Another possibility of education affecting fertility is that the private rate of return to education which is already high in Kenya may be higher yet for children with educated parents, and this may provide an incentive for such parents to have more children. Finally, education may affect the women's health, since more educated women should be more knowledgeable about personal hygiene and proper dietary practices. Consequently, better educated women should be more fecund and less likely to have miscarriages (Frisch, 1974).

The data in the table also portrays the same trend for the divisions corresponding to their districts. It can be remarked that in Western province as a whole fertility is quite high as evidenced by all the categories of education. In fact, it would seem that education has not had a lot of impact in so far as suppressing of fertility is concerned. In other words, the fertility for those women with secondary education plus, can not be said to be significantly low enough as would be expected. This is more so in the divisions of Kakamega where many secondary schools for women of national repute such as Butere, Kaimosi, Mukumu, Bunyore etc. abound. It would be easier to comprehend why women with secondary education plus in both Busia and Bungoma divisions is still high. This can be attributed to the existence of fewer educational facilities for girls as compared to those for boys. In fact as by 1979, the whole of Busia district had only one girls school with A - levels: Chakol Girls, while Bungoma had only three such schools: Lugulu, Chwele Girls and Misikhu.

We may thus attribute such high fertility rates in the province to good agricultural yield and low levels of sterility rates in the women of the province.

3.3.2 FERTILITY ESTIMATION BY THE DIFFERENTIAL OF MARITAL STATUS

It is a well known fact that social and cultural factors constrain reproductive behaviour and reduce fertility rates to below their biological maximum, even in the absence of any conscious decisions to limit fertility. For instance, extended lactation elongates birth intervals on average by increasing the period of post partum amenorrhoea. Fertility is kept below natural levels by other factors as well. The separation of spouses for extended periods when husbands migrate temporarily in search of work is likely to suppress fertility. There are also certain factors which cannot be captured in an analysis of married women, because they affect whether or not women are in a marital union; for instance, some women remain celibate and some become widowed. Lastly, it is likely that polygamy reduces fertility per married women. The possible effects on fertility of these factors (polygamy, extended lactation, separation, non-marriage) are to be considered below.

The table below gives the TFR for all the divisions under study by marital status where four categories are considered, viz., single, married, widowed and divorced/separated.

Table 3.3.2 TFR by the Differential of Marital Status

	T	F	R	
Division	Single	Married.	Widowed	Divorced/ Separated
WESTERN PROVINCE	5.02	8.76	9.25	7.49
BUSIA DISTRICT	4.29	7.96	8.05	5.22
Central Busia	5.04	8.24	10.85	5.03
Hakati	2.86	7.47	7.41	5.01
Busia Township	3.86	7.22	7.02	4.87
Northern Busia	2.89	8.01	7.68	6.49
BUNGOMA DISTRICT	6.16	9.90	8.22	5.87
Tongaren	6.19	7.60	4.94	6.62
Elgon	5.97	9.07	6.81	6.47
Kimilili	4.90	9.06	7.57	5.47
Sirisia	5.76	8.77	8.15	5.29
Kanduyi	5.93	7.15	6.33	5.55
KAKAMEGA DISTRICT	4.81	8.90	8.48	5.72
Kak. Forest/ Lurambi	4.55	8.90	4.79	5.03
Mumias	3.65	8.33	10.20	5.53
Lugari	4.81	8.63	4.98	3.85

Division	T Single	F Married	R Widowed	Divorced/ Separated
Hamisi	3.94	8.92	4.92	5.69
Butere	3.95	8.32	4.76	6.30
Kabras	4.68	8.98	7.54	5.29
Ikolomani	3.78	8.73	8.42	5.10
Vihiga	4.32	8.59	8.53	5.30

It can be seen that fertility rates are lower, on average among women who are single as compared to married women. Secondly, married women exhibit the highest fertility rates followed by the widowed, then the divorced/separated and finally the single coming last in almost all the divisions. It should thus be expected that fertility should be lower the higher the female age at marriage, and the higher the rates of female celibacy, divorce, separation, and widowhood.

Mumias and Central Busia exhibit higher fertility rates for the widowed over the married. The trend in these divisions should be that widowed women tend to re-marry, and the "new" husband wants as many children as possible from his "newly" found wife in order for him to have power in the new home. This tends to raise the TFR. It is also evident that for the divisions in Bungoma district, the fertility for the single is quite significant (at least 5). This high fertility for the single could be attributed to cultural factors, viz: the proof to the society that they are fertile; looking for old age security and the psychological satisfaction that single women derive from their children. Another reason could be due to the educational facilities in the district. Girls secondary schools were quite scarce as per the 1979 year. According to the District Annual Report for 1980, there were only three such Government aided schools in Bungoma by 1979: these were Lugulu, Misikhu and Chwelle.

It would therefore appear sensible to assert that most girls on failing to get a chance in a government boarding school found themselves without anything much to occupy them. The result was to walk around idly, meet boys and sugar daddies and the result was the non-marital pregnancies. In fact the two girls schools - Misikhu and Lugulu both fall under Kimilili division as of that time, the reason why the TFR for the single in Kimilili was the lowest of all the divisions in Bungoma. On the contrary, for Kakamega where many girls schools abound, the TFR for the single is found to be fairly low (less than 5).

It may also be noted that the marital fertility for the married was the highest due to the confinement of fertility within marriages. When the desired family size is well below the "biological" maximum, most women will be able to have the number of children they want more or less independently of the age at which they marry (or begin cohabiting). If, on the other hand, fertility rates are very high (as in Western Kenya) factors which cause fecund women to be out of wedlock should have a negative effect on fertility rates. Even in such cases, however, an additional explanation is necessary, since the actual frequency of factors such as celibacy, divorce, separation and widowhood may not be sufficiently high to have a noticeable effect on the overall fertility rate.

The fertility rate for the divorced/separated is fairly low. During marriage, husbands and wives can be separated for extended periods of time. Sometimes this separation results from cultural practices and other times husbands and wives are separated because the husband migrates in order to increase the family's income. Separation could also result from differences between the spouses. Since it is less likely for conception to occur when spouses are separated, separation/divorce should be negatively related to fertility.

3.3.3 FERTILITY ESTIMATION BY THE DIFFERENTIAL OF RESIDENCE

This section repeats the analysis of fertility rates reported in the previous sections - except that in the present section the analysis is done separately for rural and urban areas in order to observe whether the factors related to fertility rates differ from one area to another.

As in most developing countries, rural and urban areas of Kenya are quite different in their characteristics. In most rural areas of Western province, the economy is based on agriculture with most of the rural households owning land. Most urban households on the other hand obtain their livelihood from wage employment. Urban residents are significantly better educated, have higher incomes and are less traditional (for instance in the length of time they breastfeed their children) than are rural residents.

Consequently, women and children play a much greater role in the rural economy than they do in the urban economy; the opportunity and desire to spend income on modern goods is greater in urban areas than in rural areas; where traditional values tend to be stronger, and it is probably more difficult for urban women to combine work away from home with child care.

Given these significant differences between rural and urban areas of the province under study, the relationships between certain of the explanatory variables and fertility are expected to differ between these areas. The relationship between wife's education and fertility is expected to be stronger in urban as opposed to rural areas, since education should be a more important determinant of the wife's income earning capacity (and thus the opportunity cost of her withdrawing from the labour force) in urban areas, where jobs requiring education are more readily available.

Studies undertaken elsewhere have come up with fascinating results on residential fertility. A particularly interesting finding is that urban fertility is always lower than rural fertility when all women are included, but not when only married women are sampled. In Bangladesh, Indonesia, and Pakistan, the marital fertility of urban women is higher than that of rural women. In Indonesia and Pakistan, this difference is large, one half a child. This implies that, particularly in these two countries, age at marriage is very important in explaining residential differential (Cochrane, 1983).

Multivariate comparisons of urban - rural differences in fertility, similar to those in the table below using the same variables, show that only the degree of urbanization is significant. The higher the level of urbanization in a country, the greater the difference between rural and urban fertility.

Table 3.3.3 Effect of Residence on Predicted Completed Fertility

	Total Fertility (All women)		Marital Duration Adjusted (Ever Married Women)	
Country	Rural	Urban	Rural	Urban
Bangladesh	6.2	6.0	6.3	6.5
Fiji	4.6	3.6	5.2	4.3
Indonesia	4.8	4.6	5.1	5.6
Korea	5.1	3.7	5.9	4.5
Malaysia	---	---	6.1	5.5
Nepal	6.2	---	---	---
Pakistan	6.4	6.2	6.8	7.3
Philippines	6.0	3.9	6.8	5.4
Sri Lanka	3.8	3.2	5.3	4.8
Thailand	4.9	2.9	5.5	4.3
Colomba	6.6	3.5	7.2	4.2
Costa Rica	4.7	2.9	4.8	3.3
Dominican Republic	7.1	4.1	7.6	5.0
Guyana	5.1	4.3	5.1	4.1
Jamaica	5.3	3.9	5.4	4.1
Mexico	7.3	4.8	7.7	5.7
Panama	5.7	3.3	5.9	3.9
Peru	7.0	4.6	7.6	5.8
Jordan	9.8	7.1	9.7	8.5
Kenya	8.4	6.1	8.0	6.5
Total	6.0	4.4	6.4	5.2

Note: Dash indicate Not available

Source: Rodriguez and Cleland (1980)

Findley and Orr (1978) also found the percentage of the population urban significant in explaining urban - rural differentials in fertility. These findings suggest that in countries with greater degrees of urbanization, those classifed as urban are more likely to be from large cities where fertility is in fact lower than in rural areas.

A number of country-specific studies, specifically address or indirectly control for residence in the analysis of fertility. In addition to those studies and the WFS data used by Rodriguez and Cleland, there have been a number of other fairly comprehensive studies of urban and rural differences in fertility.

Kuznets (1974) reviewed data on urban-rural variations in fertility for the late 1950s and early 1960s, and Findley and Orr (1978) reviewed data from the period around 1970. These two studies are different in methodologies, though they share two similarities.

Firstly, they examine the fertility of all, not just married women; and secondly they introduce no controls except for age. Although differences in methodology prevent close comparison, these studies agree on some points that give considerable insight into urban-rural variations.

Findley and Orr found that the average total fertility rate was 4.95 for urban areas and 6.35 for rural areas, yielding a difference of 1.4 and a ratio of 1.28. This absolute difference falls between the two estimates found using data from Rodriguez and Cleland, but the ratio on fertility rates indicates much larger differences than those found by Kuznets. Kuznets found a ratio of 1.09 for developing countries as a whole, this ratio varying from 1.03 for Sub-Saharan Africa to 1.12 for Asia and 1.15 for Latin America. At least some of the contrasts with Findley and Orr is due to differences in methodology. To the extent that Kuznets' results are accurate for the period around 1960, it is also quite possible that urban and rural differences in fertility widened over the decade. Further support for a widening gap is found in the fact that, in Western Europe, residential differences widened during the period of fertility decline and then began to narrow in the Post-World War II period (UN, 1973: 97).

On the other hand, three multivariate studies yield some insight into the channels through which residence operates. A study of Costa Rica by Michielutte et al (1975) shows that adding other variables (education, income, age at first conception, and church attendance) significantly reduces the effect of residence.

Of these variables, the addition of income has the greatest effect on the association, reducing the correlation coefficient from -.32 to -.24; no other variable had an effect even a third this size. Ketkar's (1979) study also shows that fairly large urban-rural differentials in fertility (.85) are reduced to statistical insignificance when income, education, infant mortality, size of extended family, religion and occupation are added to a regression. The Loebner and Driver (1973) Path analysis of fertility in India examines residence as well as education and shows no direct effect of residence. Although residence affects husband's income, family structure, and education, its only indirect effects on fertility are those through education which is itself an indirect effect. Residence's effect is thus much smaller than education's. it is somewhat surprising that residence does not have an effect more directly through age at marriage; however, for this particular sample, no significant effect of this kind exists. On the other hand, this sample is perhaps atypical in that even the zero-order correlations between residence and CEB are very small (.39).

Having now reviewed some work done on the effect of residence on fertility, I now turn attention to the Kenyan case in general and the Western Province case in particular.

The table below gives the TFR for each division in Western Province.

Table 3.3.4 Total Fertility by Differential of Residence

Division	T F R Rural	Urban	Combined	Differe.	Ratio
WESTERN PROVINCE	9.04	7.83	----	1.21	1.16
BUSIA DISTRICT	8.17	7.12	----	1.05	1.15
Central Busia	8.49	6.59	8.49	1.90	1.29
Hakati	7.46	----	7.46	----	----
Busia Township	----	7.04	7.04	----	----
Northern Busia	8.23	----	8.23	----	----
BUNGOMA DISTRICT	9.53	8.34	----	1.19	1.14
Tongaren	10.15	6.69	10.00	3.46	1.52
Elgon	9.26	----	9.26	----	----
Kimilili	9.60	8.03	9.43	1.57	1.20
Sirisia	8.14	7.62	8.98	.52	1.07
Kanduyi	9.19	8.30	9.08	.89	1.11
KAKAMEGA DISTRICT	9.13	7.91	----	1.22	1.15
Kakamega Forest	8.02	----	8.02	----	----
Mumias	8.42	----	8.42	----	----
Lugari	10.69	----	10.69	----	----
Hamisi	8.98	----	8.98	----	----
Butere	8.72	----	8.72	----	----
Lurambi	9.32	7.67	8.87	1.65	1.22
Kabras	9.39	----	9.39	----	----
Ikolomani	8.71	----	8.71	----	----
Vihiga	8.72	8.03	8.72	.69	1.09

From the table above, it is evident that an explicit and exhaustive analysis between rural and urban fertility cannot be undertaken due to lack of urban status in about half the divisions under study. Secondly, as already pointed out earlier, the misclassification errors of whether a certain division contains an urban status or not is bound to give rise to some strange results. However, when all is said and done, it is apparent that some definite trend emerges from the analysis just undertaken. It is with a lot of clarity from the above data that one can confidently observe that rural fertility is higher than urban fertility, at least in all the divisions which had both statuses. There are various reasons for this.

First and foremost, it must be noted that most rural households own land and as has already been pointed out, the rural economy in all the divisions in Western Province is agriculture based. Western Province is well known to be the granary for the country. It is consequently apparent that most households do not have problems of feeding their offsprings as food is available in abundance. This indeed is evidenced in rural Tongaren and Lugari, which are settlement schemes; as well as Kabras, Lurambi, Kanduyi, Kimilili and Elgon where there is still plenty of land, most of which is uncultivated as the need for cultivating all of it has not arisen.

Secondly, the fertility is quite high in all of these rural areas due to the need to utilize child labour in the farmlands to enhance high agricultural yield. It has been well known that hired labour can be expensive and uneconomical. Hence to avoid it, most families prefer producing their own through procreation. As if this is not enough, most families feel, it is necessary and sufficient to create a lineage that can be able to inherit the huge chunks of land available. This is made even more evident in the province where girls do not inherit their parent's land. As a result, in families where only daughters are given birth to, the man must try his best to see to it that he gets sons to do the inheritance. Sons are also important when it comes to farm work. The result is very high fertility rates. Fertility in the urban areas is seen to be not significantly lower as would be expected (there are hardly differences of more than 2) since it is very difficult to differentiate an urban setting from the rural ones, save for Lurambi and Kanduyi, since all the activities going on in the rural settings are the same as those going on in the urban ones, e.g. farming activities.

The main differences could be the provision of clean piped water for drinking, existence of medical facilities, tarmac roads, electricity and the availability of family planning services in the urban areas. Educational facilities are also more abundant in the urban centres than in the rural ones. It is worthy pointing out that the urban areas consist of a heterogeneous people in terms of ethnic configuration due to the job availability in these urban centres.

The fertility rates are nonetheless lower in urban centres because of a number of reasons. In the first place, parents in urban areas would like to take their children to good schools in towns where they pay for their education. This creates an awareness in them that to educate these children in these private good schools costs money, and the more the children the higher the amount of money required. Most of them are thus not willing to sacrifice all earnings on education. This is in contrast to rural areas where such schools do not exist and where not much emphasis is laid to education of children - at least not to the extent of paying for private tuitions, dressing their children elegantly in shoes and buying them more text books and the like. Here it is the labour of the children: looking after cattle, tilling land, etc., that is valued most.

Secondly, under the assumption that coital frequency is inversely related to stress and with the assumption that there is more stress in urban rather than in rural areas, it can be inferred that rural dwellers could be more successful in their efforts to conceive and also more likely to experience unwanted conceptions.

Thirdly, there may be a difference in the timing of pregnancies. Some of these differences in timing can doubtless be attributed to urban-rural differences in the three causally inter-related conditions that define one's ability to control fertility. Knowledge about birth control, skill in its practice and the degree of access to the most effective means. However, these three conditions must play their respective parts within the larger framework of one's willingness to exercise control over fertility - something that will be influenced by the extent to which both the idea of birth control and the various means to its attainment are socially acceptable.

Finally, the possible sources of differences in the number of children people want or are willing to have are numerous and varied. They range from the differences in lifestyles, external living conditions and the costs and benefits thought to be associated with childbearing.

CHAPTER 4

4A. FERTILITY ESTIMATION USING GOMPERTZ RELATIONAL MODEL

4.1 INTRODUCTION

Brass (1978) sought to reduce the number of parameters determining the shape of age specific fertility from the Coale-Trussell model's three to two by postulating a relational scheme and any other schedule.

The Gompertz relational model was designed for the evaluation and adjustment of fertility estimates obtained from retrospective reports of birth histories or features thereof. In the most significant applications the observations are subject to considerable error. The aim, therefore, was to construct a model sufficiently rigid to reveal error deviations but flexible enough to follow the real, significant features of the observations namely to fit good data well, but bad data badly.

A mathematical function is used to express the model linearly in terms of the unkown parameters - which simplifies comparison of models with actual observations. Measures used by the model are calculated from standard values that are linearly related to different populations.

The application of the model may be badly distorted if the mean parities begin to be understated at ages as low as 25 years. Errors for the younger women to age mis-statement may be a further complication.

The modification of the traditional P/F ratio method through the intermediary of the relational Gompertz model has some modest but useful advantages. First, the model is fitted to the rates from the past year using the Z(x) based on the sectional comparisons, rather than the Y(x) which require the insertion of the total fertility. Thus the assumption is that the scale error is the same for the relevant younger women and not necessarily for all ages.

The application of the relational Gompertz system is much facilitated by the use of auxilliary measures calculated from the standard. The model does not necessarily assume that the quality of reporting does not vary with the age of the respondent or that fertility levels have been constant in the recent past (Zaba, 1981).

The model should act as a panacea in detecting types of error present in fertility data with respect to the true trend of fertility levels.

4.2 The Model

The Gompertz Relational model is represented by the formulae;

$$P(i) = T \exp[- \exp(- (a+b\ Y_s(i)))] \ldots\ldots\ 4.2.1$$

where P(i) = the average parity for the i^{th} year age group.

T = the total fertility rate

a, b = unknown parameters determined by the following relation :

$$a + bY_s(i) = -Ln\,[-Ln\,(F_s(x)/T)] \quad \ldots\ldots\ldots\ 4.2.2$$

and

$$Y_s(i) = -Ln[-Ln F_s(x)] \quad \ldots\ldots\ldots\ 4.2.3$$

$F_s(x)$ = standard cumulated fertility up to age x with T = 1.0

Similarly,

$$F(x) = T\,\exp[-\exp\{-(a + bY_s(x))\}] \quad \ldots\ldots\ 4.2.4$$

where F(x) = cumulated fertility up to age x.

Total fertility can be found directly from data if a and b are estimated by relating average parity, P(i) and cumulated fertility, F(x).

Namely, -Ln(-Ln P(i)/T) and -Ln(-Ln F(x)/T) and the corresponding $Y_s(x)$ and $Y_s(i)$ values respectively.

Accurate estimation of T (Total fertility) is often difficult with retrospective data from developing countries. However, T can be estimated indirectly by relating the ratios of successive P(i) and F(x) values and the parameters a and b. Zaba (1981) separates the examination of fertility pattern from the examination of fertility level.

$$\text{If } Z(i) = -Ln[-Ln\,P(i)/P(i + 1)] \quad \ldots\ldots\ldots\ 4.2.5$$

$$\text{or } Z(i) = -Ln\left[-Ln\,\frac{T\exp(-\exp(-(a+bY_s(i))))}{T\exp(-\exp(-(a+bY_s(i+1))))}\right] \quad \ldots\ 4.2.6$$

and $Q_x(b) = -Ln[\exp -(bY_s(i)) - \exp(-bY_s(i+1)]$ 4.2.7

The term $Q_x(b)$ can be expanded by Taylor's approximation and substituted into Z(i).

It can indeed be shown that

$$Z(i) - e(i) = a + bg(i) - \frac{(b-1)^2}{2!} . Q''_x(1) + \ldots \quad 4.2.8$$

where $e(i) = Q'_x(1) - Q_x(1)$ 4.2.9

and $g(i) = - Q''x(1)$ 4.2.10

It is also possible to show that

$$Z(i) - e(i) = a + bg(i) - \frac{(b-1)^2}{2!} C \quad \ldots\ldots\ldots \quad 4.2.11$$

where C is a constant approximated by $Q''_x(1)$ for $15<X<35$;

i.e. Z(i) - e(i) and g(i) are linearly related, having the gradient b and intercept

$$a - \frac{c(b-1)^2}{2!}.$$

This relationship could easily be directly extended to cumulated fertilities F(x):

$$Z(x) = -Ln\left[-Ln \frac{F(x)}{F(x+5)}\right] \quad \ldots\ldots\ldots \quad 4.2.12$$

$$Z(x) = -Ln\left[-Ln \frac{T \exp(-\exp(-(a+bY_s(x))))}{T \exp(-\exp(-(a+bY_s(x+5))}\right] \quad \ldots \quad 4.2.13$$

and consequently

$$Z(x) - e(x) = a + bg(x) - \frac{(b-1)^2}{2} C \quad \ldots\ldots\ldots\ldots \quad 4.2.14$$

Total fertility, T, is estimated from reliable P(i) and F(x) values as under:

$$T(i) = \frac{P(i)}{\exp(-\exp(-(a+bY_s(i)))} \quad \ldots\ldots\ldots \quad 4.2.15$$

or

$$T(x) = \frac{F(x)}{\exp(-\exp(-(a+bY_s(x)))} \quad \ldots\ldots \quad 4.2.16$$

4.3 Computational Procedure

Values for P(i) and F(x) are obtained directly from average parities and cumulated fertilities, respectively in this case, using Kenya National 1979 census (in the manner described in chapter 3).

The cumulated fertility schedule, F(x) = Q(i)

where

$$Q(i) = 5\sum_{j=1}^{i} f(j).$$

The following steps are adopted:

Step 1: The ratios of consecutive average parities P(i) and P(i+1) and cumulated fertilities F(x) and F(x+5) are first calculated, namely P(i)/P(i+1) and F(x)/F(x+5).

Step 2: $Z(i) = -\text{Ln}\,[-\,\text{Ln}\{P(i)/P(i+1)\}]$ and

$$Z(x) = -\text{Ln}\,[-\,\text{Ln}\{F(x)/F(x+5)\}]$$

Step 3: For $Z(i) - e(i)$ and $Z(x) - e(x)$, $e(i)$ values are obtained from table 4.3(b), while $e(x)$ values are obtained from table 4.3(a). It can also be estimated from:

Step 4: $\hat{Y}(i) = a_1 + b_1 Y_s(i)$, and

$$\hat{Y}(x) = a_2 + b_2 Y_s(x),$$

The values of a_1 and b_1 are estimated by using the least squares method on the values of $Z(i) - e(i)$ and $g(i)$. In other words, the $Z(i) - e(i)$ are the Y-values while $g(i)$ are x-values. The $g(i)$ are given in table 4.3(b) and $g(x)$ values are given in table 4.3(a).

Table 4.3(a): Standard Values for cumulated fertilities and their ratios with half year shifts

Age X	Fs(X)/F	Ys(X)	e(X)	g(X)
14.5	.0018	-1.8444	.9760	-2.4020
19.5	.1151	-.7712	1.3364	-1.4501
24.5	.3528	-.0410	1.4184	-.7430
29.5	.5869	.6294	1.2978	-.0382
34.5	.7795	1.3897	.9670	.8356
39.5	.9192	2.4736	.4509	2.1649
44.5	.9889	4.4984	.0462	2.4564
49.5	.9999	9.3416	-	-

Source : International Population Conference, Manila, 1981, P.360

Table 4.3(b) : Standard Values for mean parities and their ratios

Age	i	P(i)/F	Ys(i)	e(i)	g(i)
15 - 19	1	.0528	-1.0787	1.2897	-1.7438
20 - 24	2	.2551	-0.3119	1.4252	-1.0157
25 - 29	3	.4956	.3538	1.3725	-0.3353
30 - 34	4	.7064	1.0569	1.1421	.4391
35 - 39	5	.8678	1.9534	.7061	1.5117
40 - 44	6	.9676	3.4130	.2763	3.2105
45 - 49	7	.9977	6.0557	-	-

Source: International Pop. Conference, Manila 1981, p360.

step 5

$$\hat{P}(i) = e^{-e^{-\hat{Y}(i)}} \quad \text{and} \quad \hat{F}(x) = e^{-e^{-\hat{Y}(x)}}$$

where

$$\hat{Y}(i) = a + bY_s(i) \text{ and}$$

$$\hat{Y}(x) = a + bY_s(x)$$

step 6: Estimation of a and b

$$b = \frac{\sum[(Z(i) - e(i) * (g(i)^2] - [(Z(i) - e(i)\sum g(i)]/5}{[\sum(g(i))^2 - (\sum g(i)^2]/5}$$

$$a = [\sum(Z(i) - e(i) - b(\sum g(i)]/5$$

step 7:

$$T(i) = P(i)/\hat{P}(i)$$

$$\text{or} \quad T(x) = F(x)/\hat{F}(x)$$

Total fertility rate for various age groups T(i) are averaged to obtain estimates for all age groups.

Table 4.2(c) : Measures for the Gompertz Model

$Y_s(1)$	$e(1)$	$g(1)$	$g(1)$sqd	$Y_s(x)$	$e(x)$	$g(x)$	$g(x)$sqd
1.0787	1.2097	1.7438	3.040838	0.7712	1.3364	1.4501	2.102790
0.3119	1.4757	1.0157	1.031646	0.041	1.4184	0.743	0.552049
0.3538	1.3725	0.3353	0.112426	0.4224	1.2974	0.0382	0.001459
1.0569	1.1421	0.4391	0.192808	1.3897	0.967	0.8356	0.698227
1.9534	0.7061	1.5117	2.285236	2.4774	0.4509	2.1649	4.686792
3.413	0.2763	3.2105	—	4.4704	0.0442	4.4564	—
6.0557	—	1.144	6.662956	9.3414		0.7492	0.841317

Source: International Population Conference, Manila 1981, p340

Table 4.3(d): Estimation of Total Fertility by Fitting the Relational Gompertz Model to P(i) values:Central Busia Combined, 1979

Age(x)	P(i)	P(i)/P(i+1)	Z(i)	Z(i) e(i)	Y
15 19	.385477	.176253	0.55140	1.84118	3.71066
20 24	2.187035	.543195	.493027	0.93137	.945995
25 29	4.031290	.658047	.874071	0.49047	.167139
30 34	6.110499	.842772	1.7653	.473653	.273046
35 39	7.254376	.937449	2.739650	2.03355	3.074110
40 44	7.739138	.971235	3.534067	—	—
45 49	7.966451	—	—	0.61383	7.471763

Age(x)	b	$\hat{Y}(i)$	$\hat{P}(i)$	$P(i)/\hat{P}(i)$
15 - 19	1.176546	-1.12271	.046273	8.330264
20 - 24	a	-0.22053	.287438	7.608712
25 - 29	.146426	.562688	.565709	7.117155
30 - 34		1.389918	.779505	7.839686
35 - 39		2.444691	.916903	7.908308
40 -44		4.161978	.984543	7.856416
45 - 49		7.271236	.999304	7.969606

Mean Estimate of Total Fertility 7.804307

The procedure is illustrated by obtaining the total fertility for the first age group, T(1). The ratio P(i)/P(i+1) for i = 1 is first calculated i.e.

$$P(1)/P(2) = .385472/2.187035 = 1.76253$$

$$Z(i) = -\ln[-\ln(P(i)/P(i+1))]$$

For i = 1, we have

$$Z(1) = -\ln[-\ln(P(1)/P(2))]$$

$$= -\ln[-\ln(1.76253)] = -0.55148$$

Values of e(i) are then obtained from table 4.3(c) and used in the expression Z(i) - e(i), and for i = 1, we have Z(1) - e(1) = -.55148 - 1.2897 = -1.84118. Next the constants a and b are calculated. We have seen that

$$b = \frac{\sum[(Z(i) - e(i))(g(i))^2] - [(Z(i) - e(i))\sum g(i)]/5}{[\sum(g(i)^2 - (\sum g(i)^2]/5}$$

Hence

$$b = \frac{7.671763 - [(-0.61383)(-1.144)]/5}{[6.662956 - (1.144)^2]/5}$$

$$= 1.176546$$

Consequently

$$a = [\sum(Z(i) - e(i) - b\sum g(i)]/5$$

$$= -0.61383 - 1.176546(-1.144)]/5$$

$$= .146426$$

Thus

$$\hat{Y}(i) = a + bY_s(i)$$

$$\Rightarrow \hat{Y}(1) = a + bY_s(1)$$

$$= .146426 + 1.176546(-1.0787)$$

$$= -1.12271$$

and

$$\hat{P}(i) = e^{-e^{-\hat{Y}(i)}}$$

$$=> \hat{P}(1) = e^{-e^{-\hat{Y}(1)}}$$

$$= e^{-e^{-(-1.12271)}} = .046273$$

Hence

$$T(i) = P(i)/\hat{P}(i), \text{ and for } i = 1$$

$$T(1) = P(1)/\hat{P}(1)$$

$$= .385472/.046273$$

$$= 8.330264$$

All T(i)'s for i = 2 through 7 were computed in this manner. The mean estimate of total fertility for Central Busia Combined from mean parities was 7.804307, and 6.378835 from current births, giving a mean TF of 7.090571.

Table 4.3(e): <u>Estimation of Total Fertility by Fitting the Relational Gompertz Model to F(x) values, Central Busia Combined, 1979</u>

Age(x)	F(x)	F(x)/F(x+5)	Z(x)	Z(x)-e(x)	Y
15 - 19	.659817	.297198	-0.19338	-1.52978	2.218347
20 - 24	2.220122	.588303	.633910	-0.78448	.582875
25 - 29	3.773773	.759240	1.289399	-0.00840	.000320
30 - 34	4.970455	.850628	1.821519	.854519	.714036
35 - 39	5.843273	.928172	2.59645	2.14555	4.644903
40 - 44	6.29546	.970439	3.506359	-	-
45 - 49	6.487224	-	-	.677391	8.160483

Age(x)	b	$\hat{Y}(x)$	$\hat{F}(x)$	$F(x)/\hat{F}(x)$
15 - 19	1.016823	-.80512	.106781	6.179149
20 - 24	a	-.06263	.34485	6.437917
25 - 29	-0.02094	.619038	.593645	6.465866
30 - 34	-	1.392129	.779934	6.372914
35 - 39	-	2.494264	.920758	6.346149
40 - 44	-	4.553127	.989521	6.362128
45 - 49	-	9.477805	.999923	6.378835

Mean Estimate of Total Fertility; 6.378835

4.4 FITTING THE RELATIONAL GOMPERTZ MODEL TO 1979 WESTERN PROVINCE DATA

In practical application, a chosen set of Standard fertility rates, $Y_s(x)$, should be an average which minimises deviation from linearity for individual sets of Y(x) values in their relation to the standard. Booth (1979) used a selection of Coale - Trussel models that seemed most appropriate for high fertility populations to derive such a standard set of rates shown in table 4.3(c).

The model has been fitted to both P(i) and F(x) data for divisions to estimate total fertility rates where three differential variables: marital status, education and residence were considered. The results for the total fertilities have been displayed in tables 4.4.1(a), 4.4.1(b), 4.4.1(c), all the way upto 4.4.3.

The TFR obtained by fitting the model to p(i) refers to lifetime fertility whereas that obtained by fitting the model to F(x) refers to current fertility.

The results in tables 4.4.1(a) - 4.4.3 all show that the values based on F(x) are too low as compared to those based on P(i). This is possibly due to under - reporting of births. Consequently, total fertility rates based on P(i) are preferred.

4.5 GENERAL OBSERVATIONS FROM THE TABLES

4.5.1 DIFFERENTIAL BY EDUCATION.

Women with Primary education have higher fertility than those with no education. Primary education makes it possible for women to be more conscious of the importance of hygiene and all other basic health requirements which help prevent pregnancy or foetal wastage. Women with at least

Secondary education have the lowest level of fertility. Hence secondary education is probably a pre-requisite for change of a woman's attitude to family size.

4.5.2 DIFFERENTIAL BY MARITAL STATUS:-

Both non - marital and marital fertility are significant in contributing to the increment of fertility in the province under study. The TFR of 3 and above for the single is quite predominant. But while this figure may be giving the true picture of the situation in most divisions, there's likely to be some mis - interpretation of the word single. Some divorced, separated and widowed women might have considered themselves single.

4.5.3 DIFFERENTIAL BY RESIDENCE

Generally urban fertility is lower than rural fertility. This may be explained in terms of the constraints imposed by urban living, which place greater strains on parents in their efforts to provide food, health-care, housing, clothing and education for their children. The urban woman has the advantage of greater knowledge, accessibility, availability and use of contracaptives.

Table 4.4.1(a) TFR by Gompertz Relational Model

Education: None

	P(i)	F(x)	Mean
Busia	7.471311	5.514186	6.86137
Central Busia	7.778709	5.944031	6.86137
Hakati	7.154789	5.634232	6.394511
Busia Township	6.724692	5.915649	6.320171
Northern Busia	7.516668	6.152936	6.834802
Bungoma	8.905371	7.437982	8.171677
Tongaren	9.014850	8.334216	8.674533
Elgon	8.117141	7.353153	7.735147
Kimilili	9.254402	7.653110	8.453756
Sirisia	7.531857	7.166540	7.349199
Kanduyi	8.732479	7.186646	7.959563
Kakamega	8.441632	6.729012	7.585322
Kakamega Forest/ Lurambi	8.394548	7.028283	7.711416
Mumias	8.121040	6.822610	7.471825
Lugari	8.968301	7.860510	8.414406
Hamisi	8.728243	7.063850	7.896047
Butere	7.797330	5.406679	6.602005
Kabras	9.242837	7.299608	8.271223
Ikolomani	8.508121	6.357387	7.432754
Vihiga	7.648418	6.869763	7.259091
Western	8.335956	6.780579	7.558268

Table 4.4.1(b) TFR by Gompertz Relational model

Education: Primary

	P(i)	F(x)	Mean
Busia	8.001033	6.326717	7.163875
Central Busia	8.120136	60685741	7.402939
Hakati	7.791819	6.087721	6.943451
Busia Township	7.593798	5.830842	6.71232
Northern Busia	8.058491	5.872468	6.965480
Bungoma	9.289287	8.700293	8.99479
Tongaren	9.938478	8.131003	9.034741
Elgon	8.767805	7.889761	8.328783
Kimilili	9.599023	7.785205	8.692114
Sirisia	8.643368	7.781922	8.212645
Kanduyi	8.446128	7.551256	8.998692
Kakamega	9.22536	7.157910	8.155868
Kakamega Forest/ Lurambi	8.133328	7.157910	7.645619
Mumias	7.992790	6.793996	7.393393
Lugari	9.711235	7.577431	8.644333
Hamisi	9.125879	7.108114	8.116997
Butere	8.430871	5.680830	7.055851
Kabras	9.404067	7.219482	8.311775
Ikolomani	8.779786	6.378704	7.579245
Vihiga	8.681564	6.735559	6.798562
Western	8.316881	7.332775	7.824828

Table 4.4.1(c) TFR by Gompertz Relational Model

Education: Secondary+

	P(i)	F(x)	Mean
Busia	5.832511	5.428939	5.630725
Central Busia	6.458737	6.533576	6.496157
Hakati	6.366722	4.514575	5.440649
Busia Township	6.766970	4.535496	5.651233
Northern Busia	5.895666	6.639399	6.267533
Bungoma	7.861366	7.246564	7.553965
Tongaren	10.85658	8.968079	9.9123295
Elgon	5.277556	6.716911	5.9972335
Kimilili	7.497493	7.290806	7.364150
Sirisia	8.866524	7.156817	8.011671
Kanduyi	6.752118	5.985348	6.368733
Kakamega	7.464253	5.717693	6.590973
Kakamega Forest/ Lurambi	7.022029	4.794301	5.908165
Mumias	5.157870	4.911700	5.034785
Lugari	6.418681	5.736343	6.077512
Hamisi	8.609519	4.943359	6.776439
Butere	7.026978	5.604208	6.315593
Kabras	8.832319	6.862268	7.847294
Ikolomani	7.065876	5.131406	6.098641
Vihiga	7.607857	5.677568	6.642713
Western	5.942513	5.666377	5.804445

Table 4.4.2(a) TFR by Gompertz Relational Model

Single

	P(i)	F(x)	Mean
Busia	2.884894	2.305132	2.595013
Central Busia	3.571557	2.740164	3.155861
Hakati	3.509948	1.945153	2.727551
Busia Township	6.268956	2.430527	4.349742
Northern Busia	3.904099	2.329737	3.116918
Bungoma	7.212326	6.205468	6.708897
Tongaren	7.928849	4.478417	6.203633
Elgon	5.160578	3.803823	4.482201
Kimilili	4.137794	3.177971	3.657883
Sirisia	6.108367	3.450841	4.779604
Kanduyi	4.799302	3.778577	4.288940
Kakamega	3.883514	3.555323	3.719419
Kakamega Forest/ Lurambi	3.882020	2.925773	3.403897
Mumias	2.953905	2.656529	2.805217
Lugari	3.633394	2.986092	3.309743
Hamisi	2.971254	3.208609	3.089932
Butere	3.492804	2.163113	2.827959
Kabras	3.839496	2.317089	3.078293
Ikolomani	3.804549	2.359215	3.081882
Vihiga	4.992039	2.979341	3.98569
Western	4.402314	3.314601	3.858458

Table 4.4.2(b) TFR by Gompertz Relational Model

Married

	P(i)	F(x)	Mean
Busia	7.377613	7.105997	7.241805
Central Busia	8.002504	7.448121	7.725313
Hakati	7.391124	6.653236	7.02218
Busia Township	6.917160	5.851481	6.384321
Northern Busia	7.764288	5.839001	6.801645
Bungoma	9.725904	9.069777	0.007841
Tongaren	9.846147	9.410067	9.6281075
Elgon	8.802147	8.539834	8.670991
Kimilili	9.605484	9.100813	9.353149
Sirisia	8.757361	8.741794	8.749578
Kanduyi	8.729853	7.440474	8.085164
Kakamega	-	7.903599	7.910973
Kakamega Forest/ Lurambi	8.183405	8.142828	8.163117
Mumias	8.151040	7.606868	7.878954
Lugari	9.409476	8.932567	9.171022
Hamisi	9.120070	8.387200	8.753635
Butere	7.232626	6.557796	6.895211
Kabras	8.134924	8.284663	8.209794
Ikolomani	8.770328	7.537213	8.153771
Vihiga	8.801957	8.064653	8.433305
Western	6.867569	8.497892	7.682731

Table 4.4.2(c) <u>TFR by Gompertz Relational Model</u>

<u>Widowed</u>

	P(i)	F(x)	Mean
Busia	7.617145	4.691519	6.154332
Central Busia	7.327974	5.285680	6.306827
Hakati	8.303333	3.353980	5.828657
Busia Township	5.952930	6.628878	6.290904
Northern Busia	6.939389	4.102075	5.520732
Bungoma	8.211721	5.679671	6.945696
Tongaren	8.869082	5.243656	7.0563695
Elgon	6.877084	4.067259	5.472172
Kimilili	7.526402	7.143390	7.334896
Sirisia	7.653618	6.032761	6.843190
Kanduyi	7.788520	3.879406	5.833963
Kakamega	7.922804	4.513341	6.218073
Kakamega Forest/ Lurambi	4.552680	3.570574	4.061627
Mumias	7.342960	4.747994	6.045477
Lugari	4.502101	6.683909	5.593005
Hamisi	3.313724	3.738828	3.526276
Butere	3.284018	3.344541	3.314280
Kabras	6.680316	6.150985	6.415651
Ikolomani	7.426887	4.514686	5.970787
Vihiga	7.927939	4.469565	6.198752
Western	-	5.747953	6.32

Table 4.4.2(d) TFR by Gompertz Relational Model

Divorced/Separated

	P(i)	F(x)	Mean
Busia	6.149021	3.865233	5.007127
Central Busia	5.587930	4.680612	5.134271
Hakati	4.011590	2.947890	3.47974
Busia Township	4.843742	2.399766	3.621754
Northern Busia	5.214642	2.399766	4.183034
Bungoma	6.943738	5.829523	6.386631
Tongaren	6.878537	7.676428	7.277483
Elgon	5.950527	5.841933	5.89623
Kimilili	5.502776	5.262693	5.382735
Sirisia	6.560250	5.466822	6.013536
Kanduyi	6.686948	4.504520	5.595734
Kakamega	6.288701	5.993361	6.141031
Kakamega forest/ Lurambi	3.076112	3.499811	3.2879615
Mumias	5.066761	4.001318	4.534040
Lugari	3.225284	3.835040	3.530162
Hamisi	5.711360	5.897311	5.804336
Butere	7.671018	5.379094	5.525056
Kabras	4.382663	4.609091	4.495877
Ikolomani	4.707619	4.616379	4.661999
Vihiga	5.461644	5.751259	5.606452
Western	-	6.221039	5.28

Table 4.4.3 TFR by Gompertz Relational Model

Residence :Rural & Urban

	Rural			Urban		
	P(i)	F(x)	Mean	P(i)	F(x)	Mean
Busia	7.56	5.97	6.77	6.82	5.71	6.27
Central Busia	7.81	6.36	7.09	5.61	7.24	6.43
Hakati	7.24	5.57	6.41	--	--	--
Busia Township	--	--	--	6.84	5.61	6.23
Northern Busia	7.55	5.84	6.70	--	--	--
Bungoma	9.05	7.40	8.23	7.72	6.81	7.27
Tongaren	9.63	7.90	8.77	6.10	6.26	6.18
Elgon	8.48	7.32	7.90	--	--	--
Kimilili	9.49	7.57	8.53	7.75	6.78	7.27
Sirisia	7.48	5.46	6.47	8.65	5.12	6.89
Kanduyi	8.82	7.10	7.96	7.71	6.64	7.18
Kakamega	8.53	6.46	7.50	6.31	5.13	5.72
Kak.forest	7.36	6.87	7.128165	--	--	--
Mumias	8.08	6.57	7.33	--	--	--
Lugari	9.12	6.20	7.66	--	--	--
Hamisi	8.84	6.69	7.77	--	--	--
Butere	7.83	5.33	6.58	--	--	--
Kabras	9.26	7.02	8.14	--	--	--
Ikolomani	7.73	5.93	6.83	--	--	--
Vihiga	8.61	6.48	7.55	7.87	6.20	7.04
Lurambi	8.59	7.15	7.87	7.21	5.64	6.43
Western	8.46	6.61	7.54	8.13	6.60	7.37

4B. FERTILITY ESTIMATION BASED ON REPORTED LIFETIME FERTILITY

4.6 INTRODUCTION

The analysis of the Coale - Trussel and Gompertz Relational Models have portrayed disparities between current fertility data and information on CEB reported by the same women. In this section, we examine Coale - Dememy's P_3^2/P_2 formula which will further assist in highlighting the nature of errors that may afflict Kenya's census data. However, this method will only be applied in the estimation of total fertility for comparison with those obtained with the other two methods. The procedure will be found to be relatively simple and only relies on lifetime fertility data which will be assumed to be more accurately reported. The method estimates TFR from the average parities of younger women and compares it with the average parities of women aged 40 years and over.

4.7 THE PROCEDURE

The census and survey data are normally classified by the number of CEB, tabulated by the age of the mother. If fertility rates have been approximately constant in the recent history of the population in question, if the reported fertility histories have not been substantially affected by migration and if substantial mortality according to the prolificacy of the woman has not had an important effect on the survival of mothers, then the average number of CEB to women past age forty-five or fifty equals total fertility. More precisely, the average number of CEB per woman aged 45 - 49 equals the total fertility of this cohort of women which in turn is about the same as the total fertility of the population at the time of the census or survey, provided fertility rates in the population have been approximately constant. If we take the assumptions stated above to be valid, then it's possible to estimate the age of specific fertility rate for each five year age interval within the child-bearing span by fitting the polynomial to the reported number of CEB by age of mother.

The uncritical use of the reported average number of CEB as a means of estimating the fertility of a population is risky, however, because of widespread tendency for the number of CEB to be under-reported, espacially by older women. In most cases, the average number of CEB increases too gradually with age, more so at ages above thirty, and indeed a very common feature of many censuses is reported average number of CEB that decline with age above age forty-five or fifty. This apparent under-reporting could be precipitated by several factors among them;

(1) Some women who tend to omit children that have grown up or have left home.

(2) The inability of some illiterate respondents to report large numbers accurately.

(3) Older women who tend to omit offsprings who died especially many years earlier, although there are many instances in which the proportion reported as dead rises with the age of the woman in a consistent fashion.

Results have shown that the average number of CEB is very frequently a downward biased estimate of the cumulative fertility experience of women over thirty or thirty five, and the average parity of women past age forty five or fifty, being typically under-stated, would usually provide an under-estimate of total fertility.

On the other hand, younger women presumably report the number of CEB to them with much better accuracy. Such women are not asked to recall events from the remote past or to count accurately to a large number; secondly a higher proportion of the CEB have survived to the time of the interview, and few, if any have left the household. If age mis-reporting does not cause excessive distortion, the sequence of average numbers of CEB by age of woman duplicates closely the curve of cumulative age specific fertility rates, until an age is reached where the proportion of CEB that are omitted by the respondents becomes significant.

The other potential source of information about the age pattern of fertility is survey data on births occurring during some preceding period, typically a year before a census or a demographic survey. The number of births reported in response to such questions has not proven accurate. Experience seems to indicate that the source of the inaccuracy is not a systematic tendency for women to fail to report births that have occurred or to exaggerate the number of these births but rather the difficulty that the respondents have in identifying properly the length of the interval for which births should be reported. In some surveys, there's a net tendency for women to report births that occurred in a period that's less than a year and in other surveys to report on the average events that occurred during more than the preceding year. The factors causing this referance error seem likely to depend on general cultural conditions, the circumstances of the particular survey, including the wording of the questions, the instructions to enumerators and the like. There seems to be no reason to expect an association between the errors in reference period and age of respondents. Furthermore, the population covered by questions on births during the preceding interval is the same as that covered by questions about CEB so that inconsistencies caused by differences in coverage or in forms of age-misreporting are avoided - differences that may exist between a population included in a register and a population covered by a survey.

There are some censuses and surveys that have included a question on CEB, with the responses tabulated by age of mother, but that have failed to include a question on current fertility. In such a case, it can be hypothesised that the ratio of the average parity of women at the end of childbearing to the average parity of a younger group (say women aged 25 - 29) is closely related to the relative parity of women early and late in their twenties. The reasoning behind this hypothesis is as follows:

(1) The average parity of women aged 25 - 29 is an unusually large multiple of the average parity of women 20 - 24, chilbearing does not begin early in this population since the high ratio implies that fertility is unusually high at ages 22.5 to 27.5 compared to before 22.5. It therefore implies that in this population an unusually large fraction of total fertility occurs in the later years of childbearing, and the ratio of final average parity to the average at ages 25 to 29 is therefore unusually large.

(2) On the other hand, an unusually low ratio of parity at 25 - 29 to parity at 20 - 24 indicates that the high rates of childbearing began early, that an unusually small fraction of total fertility occurs in the later years of childbearing, and that the ratio of final average parity to the average at 25 - 29 is unusually low (Manual IV).

Suppose that the average number of CEB (average parity) to women 15 - 19 age group is designated by P_1 to women aged 20 - 24 P_2, and so on, until P_7, designates the average parity of women aged 45 - 49. Further, suppose the average parity of women reaching age 50 - assumed to be the upper limit of childbearing, is designated TF (for total fertility).

We hypothesise, then that

$TF/P_3 \simeq P_3/P_2$ .... (4.7.1)

The usefulness of this hypothetical relationship, should it prove valid, is that it provides a possible method of estimating total fertility when older women under-report the number of children they have borne, and younger women report parity accurately.

It can thus be deduced that

$TF = (P3)^2/(P2)$ .... (4.7.2).

The formula provides an estimate of total fertility under the following conditions:

(i) Fertility at ages 15 - 29 has been constant in the recent past.

(ii) The age pattern of fertility conforms to the typical age relationships found in populations practising little birth control implying

(a) that the age pattern of declining fecundity is typical; and

(b) that widowhood, divorce, and other forms of dissolutions of sexual unions do not have an unusual age incidance from age 30 - 45 in the population under consideration.

The value of $(P3)^2/(P2)$ can be compared with the average parity reported by women over 50, and 45 - 49. Lower parity reported by women over 50 than at 45 - 49 is an indication of likely ommission of CEB by older women. If under these circumstances $(P3)^2/(P2)$ exceeds P_7, the estimate gains in credibility and is to be preferred to the numbers supplied by the older women. Approximate equality of P_7, the average parity reported by women over 50, and $(P3)^2/(P2)$ indicates that any of the figures is an acceptable estimate of total fertility. But if $(P3)^2/(P2)$ is substantially less than P_7, or if the average parity reported by women over 50 is much greater than P_7, the wisest course is not to attempt an estimate of current fertility by manipulation of the data on CEB.

The results in tables 4.7.1 to 4.7.3 give the total fertility rate values for each variable under consideration per each division. It should be observed that

(i) The Coale-Demeny procedure generates acceptable estimates of total fertility. These rates, are, for most divisions lower than those obtained by C-T method. When TFR was approximated by P(7) the mean parity of women aged 44 - 49, the ratio TF/P(3) was found to approximate P(3)/P(2) - suggesting consistency in parity data. The procedure was proven credible as P(3)/P(2) obtained total fertility rates that are close to P(7).

(ii) The procedure does not reveal much in terms of types of errors that the data may suffer from. But it should be noted that the trend is that the ratio P(7)/P(3) is consistently higher than P(3)/P(2) albeit by small margins. This would mean that either P(7) values are over-estimated or P(2) underestimated. The former is likely to be more plausible, implying that older women over-report the number of CEB. Cases of women reporting grand-children as their own are not uncommon (Anker, 1979). Another implied error would be exaggeration of age by older women, which inflates P(7). These observations, based on less sophisticated tests, seem to contradict the view that older women under-report CEB. They are consistent with those inferred from the behaviour of P(i)/F(i).

Table 4.7.1: Coale - Demeny's TFR by Education

Division	No Ed.	Primary Ed.	Sec. Ed+
BUSIA DISTRICT	6.62	6.76	6.15
Central Busia	7.26	7.09	6.62
Hakati	6.11	6.56	6.12
Busia Township	6.57	6.68	5.66
Northern Busia	6.25	6.64	6.12
BUNGOMA DISTRICT	7.25	7.88	7.08
Tongaren	4.58	8.98	8.05
Elgon	4.75	7.83	6.34
Kimilili	7.39	7.77	6.77
Sirisia	7.16	7.55	6.34
Kanduyi	7.09	7.73	6.50
KAKAMEGA DISTRICT	6.88	7.61	5.78
Lurambi	6.90	6.61	6.37
Mumias	7.04	6.91	5.13
Lugari	7.35	8.69	5.60
Hamisi	6.84	7.98	5.89
Butere	6.37	7.07	5.94
Kabras	7.15	8.07	7.65
Ikolomani	6.91	7.98	6.47
Vihiga	6.87	7.57	6.73
WESTERN PROVINCE	6.89	6.91	6.45

Table 4.7.2: Coale - Demeny's TFR by Residence

Division	Rural	Urban
BUSIA DISTRICT	6.89	6.65
Central Busia	7.43	3.14
Hakati	6.41	----
Busia Township	----	6.71
Northern Busia	6.65	----
BUNGOMA DISTRICT	8.06	7.21
Tongaren	9.02	7.62
Elgon	7.85	----
Kimilili	8.23	7.26
Sirisia	7.78	6.00
Kanduyi	7.84	7.22
KAKAMEGA DISTRICT	7.48	6.56
Lurambi	8.14	6.63
Mumias	7.25	----
Lugari	8.72	----
Hamisi	7.98	----
Butere	6.88	----
Kabras	8.19	----
Ikolomani	6.71	----
Vihiga	8.15	8.55
WESTERN PROVINCE	7.69	6.85

Table 4.7.3: Coale - Demeny's TFR by Marital Status

Division	Single	Married	Widowed	Divorced/ Separated
BUSIA DISTRICT	3.77	8.45	6.96	4.56
Central Busia	4.90	7.08	7.60	4.76
Hakati	2.21	6.15	5.43	4.24
Busia Township	4.77	6.34	6.32	4.37
Northern Busia	2.44	6.45	5.38	4.03
BUNGOMA DISTRICT	5.30	8.54	5.35	5.28
Tongaren	5.40	8.16	5.34	5.66
Elgon	5.57	7.50	5.33	5.37
Kimilili	4.69	8.51	5.55	5.52
Sirisia	4.57	7.51	5.28	4.78
Kanduyi	6.04	7.26	5.79	4.57
KAKAMEGA DISTRICT	3.08	7.77	6.33	4.78
Lurambi	3.09	7.20	4.18	3.79
Mumias	2.88	7.03	5.74	4.69
Lugari	3.91	8.04	4.99	3.99
Hamisi	3.14	7.38	3.73	5.19
Butere	2.06	7.40	3.02	4.99
Kabras	3.39	7.83	4.53	4.15
Ikolomani	3.56	7.04	5.92	4.74
Vihiga	3.70	7.42	5.98	4.42
WESTERN PROVINCE	4.35	7.99	5.45	5.45

4.8 Comparison of Results Obtained by Coale-Trussell (C-T) Coale-Demeny (C-D) and Gompertz Relational (GRM) Models

Tables 4.8.1 to 4.8.3 give the levels of fertility as estimated, using the 1979 census at the divisional level of Western Province.

For Coale-Trussell model, the total fertility rates are based on

$$TFR = [P(1)/F(1) + P(2)/F(2) + \ldots + P(7)/F(7)]/7.$$

and for the Coale-Demeny, TFR as already seen is computed from $TFR = P3^2/P_2$, while for the Gompertz relational model the total fertility rates are given based on the mean parities P(i) and their equivalents F(x). The TFR given in the tables is the mean of the two values, i.e.

$$TFR = \frac{P(i) + F(x)}{2}.$$

From the tables, it is clearly evident that the Gompertz relational model gives lower values than the Coale-Trussell model. This is because the latter assumes under-reporting of the fertility events and hence tends to raise the values whereas the Gompertz relational model gives better results as it takes into account both under-reporting and over-reporting.

Further, apart from isolated cases here and there, the values obtained by Coale-Demeny are consistently the lowest, as compared to those of Coale-Trussell and Gompertz model.

Exceptions to this trend exist when the differential by residence is considered. But this could be mainly due to the classification errors. This is particularly so when the divisions in Kakamega are considered. Here it can be observed that in all the divisions except Mumias and Ikolomani, the Coale-Trussell TFR values are the highest followed by the Coale-Demeny with the values obtained by Gompertz model being the least. It should be noted that the Coale-Demeny procedure draws data from a very small age range as a basis for extrapolation to all reproductive years. Consequently, if there is any anomaly in the data obtained from women in these age ranges the TFR values so obtained are likely to be spurious. The model assumes that the lifetime fertility of women in these age groups under consideration is both reliable and dependable, and that it can be used to forecast the lifetime fertility in the succeeding age groups. However, from all the above discussions, it can be logical to conclude that the Coale-Demeny's procedure is less affected by reporting errors, since it uses more reliable average parities. Furthermore, the Coale-Demeny procedure has, in most cases, lower estimates. It also seems to have a sound demographic basis that is relevant to Kenya's communities (Pitchar, 1987).

The use of this technique required that

(i) the age pattern of declining fecundability was typical, and that

(ii) widowhood, divorce and other forms of disolution of sexual unions did not have an unusual age incidence from age thirty to forty (UN Manual IV, 1967.

Table 4.8.1 <u>TFR Values by Education: A Comparison</u>

Division	No Education			Primary Education			Secondary Ed. +		
	C-T	C-D	GRM	C-T	C-D	GRM	C-T	C-D	GRM
BUSIA	8.02	6.62	6.49	8.54	6.76	7.16	6.66	6.15	5.63
Central Busia	8.58	7.26	6.86	8.88	7.09	7.43	7.26	6.62	6.50
Hakati	7.38	6.11	6.40	8.00	6.56	6.94	6.61	6.12	5.44
Busia Township	7.01	6.57	6.32	7.57	6.68	6.71	7.28	5.66	5.65
Northern Busia	8.16	6.25	6.84	9.30	6.64	6.97	4.82	6.12	6.27
BUNGOMA	9.41	7.25	8.17	9.94	7.88	8.99	7.87	7.08	7.55
Tongaren	10.03	4.58	8.68	10.62	8.98	9.04	8.07	8.05	9.91
Elgon	9.16	4.75	7.74	7.73	7.83	8.33	6.46	6.34	6.00
Kimilili	9.39	7.39	8.45	9.93	7.77	8.69	7.88	6.77	7.34
Sirisia	9.19	7.16	7.35	9.33	7.55	8.21	8.22	6.34	8.01
Kanduyi	9.10	7.09	7.96	9.53	7.73	8.00	6.98	6.50	6.37
KAKAMEGA	9.08	6.88	7.59	9.28	7.61	8.16	7.34	5.78	6.59
Lurambi	10.20	6.90	7.71	8.99	6.61	7.65	6.50	6.37	5.91
Mumias	8.46	7.04	7.47	8.62	6.91	7.39	5.39	5.13	5.04
Lugari	9.38	7.35	8.41	10.38	8.69	8.64	7.81	5.60	6.08
Hamisi	8.89	6.84	7.90	9.27	7.98	8.12	7.10	5.89	6.78
Butere	8.76	6.37	6.60	9.98	7.07	7.06	7.84	5.94	6.32
Kabras	9.42	7.15	8.27	9.39	8.07	8.31	8.56	7.65	7.85
Ikolomani	8.64	6.91	7.43	9.49	7.97	7.58	7.19	6.47	6.10
Vihiga	7.90	6.87	8.26	8.87	7.57	6.80	7.06	6.73	6.64
WESTERN	8.91	6.89	7.56	9.37	6.91	7.83	7.41	6.45	5.80

Table 4.8.2 TFR Values by Marital Status: A Comparison

	Single			Married			Widowed			Divorced/Separated		
Division	C-T	C-D	GRM	C-T	C-D	GRM	C-T	C-D	GRM	C-T	C-D	GRM
BUSIA	4.29	3.77	2.60	7.96	8.45	7.24	8.05	6.96	6.15	5.22	4.56	5.01
Central Busia	5.04	4.90	3.16	8.24	7.08	7.73	10.85	7.60	6.31	5.03	4.76	5.13
Hakati	2.86	2.21	2.73	7.47	6.15	7.02	7.41	5.43	5.83	5.01	4.24	3.48
Busia Township	3.86	4.77	4.35	7.22	6.24	6.28	7.02	6.32	6.29	4.87	4.37	3.62
Northern Busia	2.89	2.44	3.12	8.01	6.45	6.81	7.68	5.38	5.52	6.49	4.03	4.18
BUNGOMA	6.16	5.30	6.71	9.90	8.54	9.40	8.22	5.25	6.95	5.87	5.28	6.39
Tongaren	6.19	5.40	6.20	7.60	8.16	9.63	4.94	5.34	7.06	6.62	5.66	7.28
Elgon	5.97	5.57	4.48	9.07	7.50	8.67	6.81	5.33	5.47	6.47	5.37	5.90
Kimilili	4.90	4.69	3.66	9.06	8.51	9.35	7.57	5.55	7.33	5.47	5.52	5.38
Sirisia	5.76	4.57	4.78	8.77	7.51	8.75	8.15	5.28	6.84	5.29	4.78	6.01
Kanduyi	5.93	6.04	4.29	7.15	7.26	8.09	6.33	5.79	5.83	5.55	4.57	5.60
KAKAMEGA	4.81	3.08	3.72	8.90	7.77	7.91	8.48	6.33	6.22	5.72	4.78	6.14
Lurambi	4.55	3.09	3.40	8.90	7.20	8.16	4.79	4.18	4.06	5.03	3.79	3.29
Mumias	3.65	2.98	2.81	8.33	7.03	7.87	7.20	5.74	6.05	5.53	4.69	4.53
Lugari	4.81	3.91	3.31	8.63	8.04	9.17	4.98	4.99	5.59	3.85	3.99	3.53
Hamisi	3.94	3.14	3.09	8.92	7.28	8.75	4.92	3.73	3.53	5.69	5.19	5.80
Butere	3.95	2.06	2.83	8.32	7.40	6.90	4.76	3.02	3.31	6.30	4.99	5.53
Kabras	4.68	3.39	3.08	8.98	7.83	8.21	7.54	4.53	6.42	5.29	4.15	4.49
Ikolomani	3.78	3.56	3.08	8.73	7.04	8.15	8.42	5.92	5.97	5.10	4.74	4.66
Vihiga	4.32	3.70	3.99	8.59	7.42	8.43	8.53	5.98	6.20	5.30	4.42	5.61
WESTERN	5.02	4.35	3.86	8.76	7.99	7.68	7.25	5.45	6.22	6.49	5.45	5.28

Table 4.8.3 TFR Values by Residence: A Comparison

Division	Rural C-T	Rural C-D	Rural Gompertz	Urban C-T	Urban C-D	Urban Gompertz
BUSIA	8.17	6.89	6.77	7.12	6.65	6.27
Central Busia	8.49	7.43	7.09	6.59	3.14	6.43
Hakati	7.46	6.41	6.41	--	--	--
Busia Township	--	--	--	7.04	6.71	6.23
Northern Busia	8.23	6.65	6.70	--	--	--
BUNGOMA	9.53	8.06	8.23	8.34	7.21	7.27
Tongaren	10.15	9.02	8.77	6.69	7.62	6.18
Elgon	9.23	7.85	7.90	--	--	--
Kimilili	9.60	8.23	8.53	8.03	7.26	7.27
Sirisia	8.14	7.78	6.47	7.62	6.00	6.89
Kanduyi	9.19	7.84	7.96	8.30	7.22	7.18
KAKAMEGA	9.13	7.48	7.50	7.91	6.56	5.72
Lurambi	9.32	8.14	7.87	7.62	6.63	6.43
Mumias	8.42	7.25	7.33	--	--	--
Lugari	10.69	8.72	7.66	--	--	--
Hamisi	8.98	7.98	7.77	--	--	--
Butere	8.72	6.88	6.58	--	--	--
Kabras	7.39	8.19	8.14	--	--	--
Ikolomani	8.71	6.71	6.83	--	--	--
Vihiga	8.72	8.15	7.55	8.03	8.55	7.04
WESTERN	9.04	7.69	7.54	7.83	6.85	7.37

CHAPTER 5

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The main objectives of this thesis were

(i) to show that infant and child mortality rates in Western Province differ by region and by the differentials of education, marital status and residence, using the Coale-Trussell model.

(ii) to show that the expectation of life at birth in Western Province is influenced by the level of education, type of marital union and type of residence.

(iii) to estimate the fertility rates in Western Province at divisional level using the Coale-Trussell, Gompertz and Coale-Demeny models.

These models highlight the difficulties which demographers encounter when estimating fertility rates and their determinants. As has already been seen, different models provide different estimates even when the same sets of data are used. This is mainly so, given that different models have different underlying assumptions. When all is said and done, however, it can be observed that the estimates so obtained are not far from each other.

5.2 SUMMARY OF RESULTS

5.2.1 INFANT/CHILD MORTALITY

The study has unearthed a lot of findings on infant/child mortality in the divisions of Western Province, although the said findings do not differ greatly from what has been found to exist at the national, provincial and district levels.

The major findings are:-

(i) Infant and child mortality rates vary with geographic regions. That the mortality rates are highest in the divisions of Busia district, and that apart from Sirisa and Kanduyi divisions the mortality rates are quite low in the divisions of Bungoma (less than 140 per 1000) and that Mumias division in Kakamega exhibits the highest infant mortality rate in Kakamega district (a rate of 198 per 1000 live births). It should further be noted that Kanduyi, Sirisia and Mumias all border Busia district implying that the whole region from these three divisions towards Busia district, is a high mortality region in the province.

(ii) That the place of residence has a great influence on infant and childhood mortality. Although not showing wide differences, this study confirms that both the divisions and the province generally conform to the national experience of infant and child mortality being higher in the rural areas where medical facilities are found to be much scarcer, as opposed to the urban areas. Further, it is clearly evident that the expectation of life at birth for the urban dwellers is comparatively higher than that of the rural inhabitants.

(iii) That the level of mother's education has great influence on the infant and child mortality in the divisions of the province, showing a marked inverse relationship and a considerable gain in life expectancy with the rising in the level of education. Thus, the children of the mothers with at least secondary education live for the longest period followed by those whose mothers have primary education and that the children of the women with no education live for the shortest duration of life (as low as 42.6 years in Hakati as compared to 48.9 years for primary education and 54.8 years for holders of at least secondary education.)

(iv) That although marital status does not seem to have a definite pattern, the overall contention is that the single and married women do, on the average, experience low infant and child mortality estimates while the widowed and divorced/separated have higher values. This could be explained by saying that most of the single mothers re-direct all the love and care to their children as they see old age security in them. Consequently, all the resources are pumped to the offspring with the result that there are diminishing chances of infant/child mortality. In the case of married women, the marriage stability contributes a great deal to the low infant/child deaths.

In so far as expectation of life at birth is concerned, it is generally apparent that children of the married live for the longest period and that those of the widowed are the most disadvantaged.

5.2.2 FERTILITY RATES

In estimation of fertility rates by the differentials of education, marital status and residence, three models were employed: Coale-Trussell, Gompertz and Coale-Demeny models. From the findings, it is generally observed that the Gompertz relational model gives lower values than the coale-Trussell model. The Coale-Trussell model always assumes under-reporting of the fertility events and hence tends to raise the values whereas the Gompertz relational model adjusts for both under and over-reporting. In this sense, the Gompertz technique gives more reliable results. In the Gompertz model the F(x) values are generally low due to under-reporting of the births 12 months before the census. Hence, the total fertility values based on the P(i) are to be preferred. The Coale-Demeny procedure, on the other hand drew data from a very small age range as a basis for extra-polation to all reproductive years. The procedure produces values which are lower than the Coale-Trussell and the Gompertz models. It may be logical to infer that the Coale-Demeny's procedure is less affected by reporting errors since it uses more reliable average parities. Further, the procedure seems to have a sound demographic basis that is relevant to Kenya's communities.

The use of this technique required that:-

(i) the age pattern of declining fecundity was typical and that

(ii) widowhood, divorce and other forms of dissolution of sexual unions did not have an un-usual age incidence from age thirty to forty (UN Manual IV, 1967).

If "Natural" describes fertility in populations which exhibit no deliberate control of births (Henry, 1961) then Kenya's fertility pattern could reasonably be considered close to a typical "natural" pattern.

The Coale-Demeny's $P(3)^2/P(2)$ was found to be acceptable as an estimate of total fertility since for nearly all the divisions under consideration, it is approximately equal to P(7). For some divisions, however, P(7) was found to exceed $P(3)^2/P(2)$, while for a few others the reverse is true, but the difference lacks substantiality.

When the Coale-Demeny procedure is used, it does not reveal the type of errors that the data may suffer from. But one interesting trend is that the ratio P(7)/P(3) is consistently higher than P(3)/P(2) albeit by small margins. This would mean that either P(7) values are over-estimated or P(2) under-estimated. The former is more plausible, implying that older women over-report the number of children ever born.

5.2.2.1 DISCUSSION:

(a) BY EDUCATION

Looking at the tables in chapters 3 and 4, it can be noted that women with primary education have higher fertility than those with no education. This may be because the primary education makes it possible for a woman to be more conscious of the importance of hygiene and all other basic health requirements, which help prevent pregnancy (foetal) wastage. Further, the women with primary education may not be following strictly the cultural norms of say birth spacing. They would like to follow both the cultural and modern modes of life. The women with at least secondary education have the lowest level of fertility. Hence secondary education is possibly a pre-requisite for a woman to change her attitude.

The argument here is that formal schooling is likely to be associated with differences in knowledge about modern techniques of birth control, access to these techniques and willingness to use them together with the presence of those conditions of life, levels of aspirations, and the like that determine the interest in controlling in the first place, and late marriages as a result of many years having been spent at school.

(b) BY RESIDENCE

There are two important limitations on the analysis of any association between human behaviour and urban-rural residence: the necessary arbitrariness in the definition of urban and rural, and the possibility that - so far as human behaviour is concerned, the meaning of these residential categories will change without there being any change in the way they are defined. At the very least, such limitation would seem to counsel caution in reaching conclusions concerning observed differences in urban-rural patterns of behaviour.

The fundamental behaviour of distinguishing urban from non-urban relate simultaneously to human members and density: below some minimum of both these attributes, urban or metropolitan or other urban may no longer be said to exist. But the delineation of positions along an urban - rural dimension of residence is unavoidably arbitrary.

Yet, differences in fertility and mortality associated with the urban-rural classification used in this study do exist, however arbitrary and uncertain a classification it may be; and these differences are pervasive, consistent and for the most part notably stable in extent between cohorts. Moreover, because of the masking effect of internal geographic mobility, the actual differences may be somewhat greater than those calculated. Certainly, those who move can be expected to differ in some respects from those who do not, but whether in ways that would relate to fertility is a moot point. We cannot rule out the possibility of selective movement, either of lower fertility wives to urban areas or of higher fertility wives to rural, nor can we rule out the possibility of a kind of anticipatory socialisation among these wives to the respectively lower or higher fertility norms associatied with the areas to which they eventually moved. But if the fertility of wives who changed their categories of residence after completion of childbearing is at all comparable with the fertility of wives who did not - and this seems a reasonable assumption - the full extent of fertility differences associated with patterns of urban-rural residence will have been to some degree obscured. The point at issue here is whether there is anything affecting the desired (or tolerated) number of children that can be singled out as likely to be particularly related to the maintenance of specifically urban-rural fertility differential. There appears to be several, of which the more important are:

(i) The relatively greater difficulty of caring for children in an urban setting where daily access to the out-doors is more likely to depend on the availability of public land, like parks and playgrouds and private land in the relatively expensive form of one's own garden.

(ii) The relatively greater costs - whether in terms of money, psychic energy or time - of rearing children in an urban setting; this originating, in part, in the greater fixed costs in urban areas of things like housing, food, transportation and entertainment, and, in part, in tha frequently higher levels of aspiration among urban dwellers with respect to standards of comfort, convenience, self-fulfilment and the case and training of children.

(iii) The relatively greater economic returns that rural dwellers, and to a lesser extent other dwellers, can reasonably expect from children - this in consequence not only of the greater possibilities in these areas for children to work or perform chores in the household or family enterprise, but also of the relative absence of parental participation in work - connected retirement schemes.

(iv) The relatively greater psychic returns from child bearing that rural dwellers (particularly women) may anticipate because of their greater residential isolation.

(v) The relatively greater availability in urban areas of alternatives on which to expend one's money, time, physical and psychic energy: alternative goods and services, and also alternative activities of a sort likely to conflict with the demands of children and child rearing.

(vi) The relatively greater availability in urban areas of alternative sources of satisfactions (e.g. response, intellectual interest, personal fulfilment, creativity, companionship) presumably associated with the bearing and rearing of children - something particularly important with women because of the expectation that mothers will play the major role in child care and also derive the greater benefit from association with children.

(vii) The relatively greater likelihood in rural areas of having higher fertility role models - either one's own parents or one's friends and associates.

The importance of any one of these in determining urban-rural fertility differences is unlikely to have remained the same over successive cohorts. The urban-rural difference in the specifically economic value of children, for example, may have been diminishing - response to the relative decline in the family farm and small enterprise while that in the availability of alternative sources of satisfaction may have been increasing - as employment opportunities for women expanded in the metropolitan areas. Moreover, the effect of these on fertility is necessarily through the medium of what people think during the period surrounding conception and early pregnancy (Day, 1984).

Turning to our results, we observe that the general pattern is that the rural women have higher fertility than the urban women. The lower urban fertility may be explained in terms of the constraints imposed by urban life, which places greater strains on parents in their efforts to provide food, health care, housing and education for their children. The urban women have greater availability and use of contraceptives and marry late. One may explain this in terms of a higher degree of urbanization with all that it implies for changes in custom and improved health. This argument stresses only those aspects of cultural drift resulting from urbanisation that are likely to promote fertility but excludes other counter-vailing influences that may operate to inhibit high fertility in the urban centres (e.g. greater availability and use of contraceptives, higher costs of living in urban places etc.

(c) BY MARITAL STATUS

Generally both marital and non-marital fertility are seen to have a significant contribution to the rise in fertility in the province. The high marital fertility rate is due to the early and stable marriages within the reproductive period. The non-marital fertility is significant because of the old age security and the love the parents gain from their children. The general pattern is that the fertility of the married is highest followed by the widowed (most of these are remarried on the death of their husbands - a common feature in the province), then followed by the divorced/separated and finally the single.

5.2.3 RECOMMENDATIONS

5.2.3.1 POLICY RECOMMENDATIONS

(i) Given that the measures of infant and child mortality provides a useful index of a society's health status, standards of living, nuptial behaviour and the manner in which the government ditributes its resources, it is our contention that such an index should be accurately measured, depending on the real demographic situation in the province under study in particular and in the country in general. In this connection, therefore, indirect techniques suited for the stable and quasi-stable population theory need to be adjusted since these etimates provide planners with a vital opportunity for effective planning.

(ii) Infant and child mortality rates are influenced by many factors, among them the effect of birth orders, sex ratio, recent fluctuation in mortality schedules and age of mother. If accuracy and consistency of mortality estimates are to be achieved, then planners of demographic and census surveys need to obtain data that enables a researcher to adjust for these factors affecting the estimates. In this connection, the quality of data generated from respondents should be gauged in such a way that it is accorded utmost priority.

(iii) Hygiene in every homestead, provision of clean piped water and mass education on matters pertaining to the upbringing and rearing of children are some major issues that the government needs to attach greater premium to if a reduction in infant/child mortality is to be realised. Vaccinations of infants against the killer diseases are not only to be said to be necessary but must be strongly enforced in order to reduce infant deaths.

(iv) As a measure for the reduction of fertility, it is highly recommended that there should be universal and compulsory secondary education for girls.

(v) To reduce non-marital fertility, sex education should be introduced in all schools and moral education given support by all. Girls falling pregnant either in school or before marriage should be sued by the state and fined heavily.

(vi) The old and archaic adage that every family should have the number of children they can effectively shelter, clothe, feed, educate and care for should be discouraged because the parents who have the means will have high fertility and yet this high fertility will definitely drain the national resources.

5.2.3.2 FURTHER RESEARCH RECOMMENDATION

I recommend further research in the following areas:

(i) The effect of in-migrations on the infant/child mortality and fertility in settlement schemes.

(ii) The effect of cash crops to infant/child mortality and fertility at divisional level.

(iii) The effect of bride price on fertility in Kenya.

BIBLIOGRAPHY

1. Adienge, S.E. (1987): Estimation of Infant and Childhood Mortality Conditions are Declining: Evidence from 1969 and 1979 Census, Msc. Thesis, PSRI, University of Nairobi.

2. Anker , R. and Knowles, J. (1982): An Empirical Analysis of Fertility Differentials in Kenya at the Macro and Micro levels, ILO, Geneva.

3. Anker, R. et al (1979): Mortality Differentials in Kenya at the Macro and Micro Level, an Occasional Paper, University of Nairobi.

4. Bogue , D.J. (1969): Principles of Demography: New York, John Wiley and Sons Inc.

5. Bongaarts, J. (1978): A Framework for Analysing the Proximate determinants of Fertility. In Population and Development Review, Vol. 4 N. II.

6. Brass, W. (1959): "Differentials in Child Mortality by the Marriage Experience of Mothers in Six African Communities". In International Population Conference, Viena, Liege IUSSP.

7. Caldwell, J.G. (1980): "Mass Education as a Determinant of the Timing of Fertility Decline". In Population and Development Review, Vol. 6 No. 2.

8. Cochrane, S.H. (1979): Fertility and Education: What do we Really Know? Baltimore, Md: The Johns Hopkins University Press.

9. Coale, A.J. and Demeny, P. (1966): Regional Model Life Tables and Stable Populations. Princeton, N.J: Princeton University Press.

10. Coale, A.J. and Trussell, T.J. (1974): Model Fertility Schedules: Variations in the Age Structure of Childbearing in Human Populations. Pop. Index 40 (2).

11. CBS (1969) Population census Analytical Report, Vol.4 Ministry of Finance and Planning, Kenya.

12. CBS (1979) Population census Analytical Report, Vol.2. Ministry of Finance and Planning, Kenya.

13. Day, L.H. Analysing Population trends: St. Martins Press New York (1984).

14. District Development Committee Report for Kakamega (1979).

15. DDC Report for Bungoma (1979).

16. DDC Report for Busia (1979).

17. Ewbank, D., Henin, R.,Kekovole,J. (1986): An integration of Demographic and Epidemiologic Research on Mortality in Kenya. In Determinants of Mortality Change and Differentials in Developing Countries, UN, 1986.

18. Farah, A.A., Preston, S.H. (1982): Child Mortality Differentials in the Sudan. In Population and Development Review, Vol. 8 No. 2.

19. Findley, S.E. and Orr A.C. (1978): Patterns of Urban-Rural Fertility Differentials in Developing Countries. A Suggested Framework. Washington D.C. office of Urban Development, Development Support Bureau, Agency for International Development.

20. Gasana, G.R."Some Aspects of Fertility in Nairobi. In CDC Research Monograph, series No. 15 (1985).

21. Hamed, M.E. (1988): Levels Trends and Differentials of Infact and child mortality in Egypt. In CDC Research Monography series No. 17.

22. Hamed, A.G. (1982): Fertility levels and Differentials by Mother's Education in some countries of the ECWA Region. In CDC Research Monograph series No. 10 tia.

23. Hazayyin, S.A.: Mortality situation in some Arab and African countires. In CDC Research Monograph series No.8 1982.

24. Henry, L. (1961) Some data on National fertility. Eugenies quarterly 8(2).

25. Kuznets, S (1974). Rural urban differences in fertility. An International Comparison: Proceedings of the American Philosophical Society 118:1-29.

26. Ketkar, S.L. (1979) Female education and fertility. Some evidence from Sierra Leone. Journal of Developing Areas 13: 23 - 33

27. Loebner, H and E.D. Driver (1973) Differential fertility in central India. A path Analysis. Demography 10.

28. Michielutte, R.C.A. Haney, Cochrane C.M. et al (1975). Residence and Fertility in Costa Rica. Rural Sociology 40.

29. Munala, A.J. Infant and child mortality differntials in Kakamega District by Division, PGD in PSR J (1988).

30. Mosley, H.W. Chen, L.C. An analytical Framework for study of child survival in Developing countries. In Pop. and Development Review, A suplement to vol. 10, 1984.

31. Mott, F.L. (1979): Infant Mortality. In Kenya, Evidence from KFS, Nairobi.

32. Mutai, E.K.J: Infant/Child Mortality Differentials in Kericho at Locational Level. PGD in PSRI (1987).

33. Mwobobia, I.K. (1982): Fertility Differentials in Kenya; A Cross-Regional Study - An Msc. Thesis, University of Nairobi.

34. Kichamu, G.A. (1986): Mortality Estimation in Kenya with Special Case Study on Vital Registration in Central Province - An Msc. Thesis in the PSRI, University of Nairobi.

35. Omer, M.A.J. (1985): Infant Mortality in the Sudan: Levels and Differentials. CDC Research Monograph Series No. 15.

36. Osiemo, A.J.O. (1986): Estimation of Fertility Levels and Differentials in Kenya: An Application of Relational Gompertz and Coale-Trussell Models. An Msc. Thesis in the PSRI, University of Nairobi.

37. Pittcher, J.O: Intercensal Fertility Estimation in Kenya (1987). Msc. Thesis in the PSRI, University of Nairobi.

38. Rodgriguez, G. and Cleland, J. (1980). Socio-economic Determinants of Marital Fertility in Twenty Countries. A Multivariate Analysis. WFS Conference Substantive Findings Session No. 5, London.

39. Sivamurthy, M., Ma'ayta, A.R. (1982). A Study of Mortality in Jordan with Special Reference to Infant Mortality in COC Research Monograph Series No. 8.

40. U.N: Department of Economic and Social Affairs (1967) Manual IV: Methods of Estimating Basic Demographic Measures from Incompele Data, New York.

41. U.N. (1973): The Determinants and Consequences of Population Trends, Vol. I, Dept. of Economic and Social Affairs. Pop. Studies, No. 50. New York.

42. U.N. (1977): Levels and Trends of Fertility throughout the World 1950 - 1970. Dept. of Economic and Social Affairs. Pop. Studies No. 59.

43. U.N. Manual X: Indirect Techniques for Demographic Estimation. New York 1983. .

44. Zaba, B. (1981): Use of the Relational Gompertz Model in Analysing Fertility Data Collected in Retrospective Surveys. CPS Working Paper 81 - 82. London School of Hygiene and Tropical Medicine.