ESTIMATION OF INFANT AND CHILDHOOD MORTALITY IN KENYA WHEN MORTALITY CONDITIONS ARE DECLINING: EVIDENCE FROM 1969 AND 1979 CENSUSES.

BY

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DECLARATION

This thesis is my original work and has not been presented for the award of a degree in any other university.

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E.S. ADIENGE.

DEDICATION

In Loving memory to my late father

The Rt. Rev. Walter William Adienge.

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ABSTRACT OF THE THESIS.

This study is concerned with investigating the accuracy of Brass estimates under conditions where mortality schedules are known or suspected to have been declining in the recent past. To achieve this task, three techniques suited for a changing mortality condition have been applied: namely, Additive Hypothetical Synthetic procedure; Kraly-Norris procedure and Palloni's technique. These techniques are applied at National, Provincial and District levels.

The investigation is divided into five chapters. Chapter I deals majorly with historical development of the problem we set out to investigate. Chapter II deals with the intercensal mortality estimation between the period(1969-1979). Additive synthetic technique, a procedure suited for fluctuating mortality schedules is used. Chapter III deals with Kraly-Norris simulation process for a declining mortality conditions. Chapter IV deals with yet another technique suited for a declining condition of mortality:Palloni's model. Chapter V deals with a summary of the findings, conclusions and reccomedations.

The mortality level estimated from Indirect procedure employing Additive hypothetical synthetic procedure behaves exactly the way they would be expected excatly under declining conditions of mortality. The violation of the static assumption of mortality brings inconsistency and unreliability in the estimates. Errors emanating from such a violation showed that

they (the errors) ascended strictly monotonically by childhood age. Kraly-Norris procedure and Palloni's both yielded results which are superior to those obtained form unadjusted values (i.e Using constant assumption of mortality schedules).

CHAPTER 1.

1.0 INTRODUCTION

1.1 STATEMENTS OF THE PROBLEM

Analysis of almost all mortality estimates derived for Kenya, have been based on the indirect techniques of the Brass model and its later modifications by Sullivan and Trussell. These modifications were actually centered on the accuracy of K(i) - which adjusts non-mortality factors that affect proportions of children dead. The assumptions inherent in Brass type models are: that the age specific fertility schedule of a population is assumed to have been approximately constant in the recent past (at least for the younger women) and the approximate form of the schedule should be known; that there is no powerful association between the age of the mother and infant mortality or death rates of the mothers and their children and that infant and child mortality rates should have been approximately constant in the recent years. Undoubtedly these assumptions are difficult to meet in any population under study. Violation of these assumptions as studies carried out by Kraly and Norris(1978) and Palloni (1979) have shown, can lead to a distortion of mortality estimates. In particular Brass technique has its goal,the estimation of mortality values associated with life table prevailing at the time of enquiry. However the values of q(x) actually refers to the cohort mortality. As a result the proportion of children-dead - D(i)'s, measure the past cohort mortality experiences.

Hence, in this study an attempt is made to derive the mortality estimates when some of the above mentioned assumptions do not hold. In particular when the constancy assumptions of mortality is violated - that is mortality conditions are believed to be changing.

1.2 OBJECTIVES OF THE STUDY

The main objective in this study is to estimate infant and child mortality under declining conditions of mortality, at National, Provincial and District levels.

Specifically we shall estimate infant mortality rate (IMR) - 1q0, childhood mortality rate - 4q1, the probability of a live born child dying before attaining 2, 3 and 5 years denoted by q(2), q(3) and q(5) respectively, life expectancy at birth and ages 5 denoted by e(0) and e(5) respectively. Using the additive synthetic adjustment technique, Kraly - Norris technique and Palloni's technique for adjustment of changing mortality conditions.

Comparison then is made of the estimates obtained by the use of those three methods and in the case of Kraly -Norris procedure, errors resulting from violation of the constant assumption of will be computed per district.

Estimating the rate of mortality decline and the level of mortality at census time is also attempted.

1.3 SIGNIFICANCE OF THE STUDY

In the developing nations of the world, deaths to children under five years constitutes a major percentage of all deaths. The childhood mortality statistics are of considerable descriptive value. When known with accuracy, can provide an insight into a population's demographic characteristics facilitating an understanding of the existing fertility, nuptiality and migratory patterns. The measures obtained provides useful index of a society's health status, standard of living, Nuptial behaviour and how the government distributes its resources in relation to its priorities. Infact infant and childhood mortality unearths the society's sufficiency and deprivation.

The life tables used in this study has a measure of mortality which provides a description of the most prominent aspects of the state of human mortality. Essentially they illuminate and summarizes the mortality experience of a population. Application of life table on measuring the capacity for growth of a population has a direct bearing on population policy.

1.4 SOURCES AND QUALITY OF DATA.

The main sources of demographic data arecensusesand surveys. In this study the only source available is the 1969 and 1979 census data. Additive Synthetic method (chapter 2) is applied to data from the aforesaid two census. Age and sex as variables are used since the population data is arranged into sex and age-groups. For the census, the data required is number of children ever borne; children dead and the female population classified by five-year age group.

The Kraly-Norris procedure also needs the use of two censuses to enable us to estimate the rate of annual mortality decline. For Palloni's procedure use is made only of one census - 1979.

The accu.racy of census information has varied from time to time and from region to region all over the world, but some generalizations can be made about the types of errors foud in censuses. Two main types are singled out; errror of coverage (under-enumeration or over-enumeration) and errors of content. The two types are serious where the people are nomadic in their life styles (as in North Eastern Provinces).

Errors of content entails major amongst others, age errors, the age-misreporting which are usually partly systamatic. The main type of age errors are age heaping (digital preference) and age shifting, which often occurs in certain sections of age span, say, in older age groups. The former occurs when the respondents give ages as ending in certain preferred digits (such as 0 and 5) and the latter when the respondents give ages which are systematically younger or older then real or biological age.

Under-reporting or omission of deaths is one of the most difficult error to identify. Older mothers tend to leave out those deaths of their children that occured long ago, normally termed as memory lapse. Cultural proscriptions have also been noted to contribute to this mis-reporting of deaths. Definition of live-births are aslo known to lead to mis-reporting of death of infants. This is the case in equatorial Guinea where deaths within 24 hours of births are termed stillbirths".

1.5.0 LITERATURE REVIEW

A range of demographic techniques has been developed in the last two and a half decades to estimate demographic parameters for countries with limited or inaccurate data sources. Such techniques are often called indirect. The essence of the indirect is that it uses census or survey data.

The procedure for estimating childhood mortality using retrospective data was first developed by William Brass who based his model on the assumptions of unchanging mortality schedules.He also assumed that there is no powerfúl association between the age of the mother and the infant mortality rate.

The assumptions we have outlined are the conditions necessary for the Brass model to be used. Sullivan (1972) proposed ways of estimating the multipliers (i.e adjusting the non-mortality factors which influence mortality). Sullivan's bone of contention hinges upon the structural as well as the functional assumptions inherent in Brass model. Thus he investigated how accurate the Brass functions approximates empirical schedules.

Trussell (1975) later improved on the foregoing works using the functional schedules developed by Coale and McNeil. Trussell used K(i) = G(P1/P2,P2/P3), where K(i) is a function that adjusts for non mortality factors that infuence mortality. P1, P2 and P3 are parity ratios for 1st, 2nd and 3rd age groups He found out that functional relation of the form

$$K(i) = C\ \mathrm{loge}(P1/P2) + D\ \mathrm{loge}(P2/P3) + A(P1/P2) + B(P2/P3) + E$$

fit the observation well. He then concluded that

$$K(i) = a(i) + b(i)*(P1/P2) + c(i)*P(2)/P(3)$$

1.5.1 RECENT STUDIES ON VIOLATION OF THE ASSUMPTION OF UNCHANGING MORTALITY SCHEDULES.

The conversion procedure now available assumes that fertility has remained fairly constant, while mortality has been assumed either to be constant (Brass, 1964; Sullivan, 1972; Trussell, 1975) or to have declined linearly in the past (Brass, 1975; Coale and Trussell, 1978; Kraly and Norris (1978); Sullivan and Udofia, 1979; Feeney, 1980; Palloni, (1980). In cases where the actual experience does not conform to these assumptions, demographic estimates are normally inaccurate. The real demographic situation normally does not conform to those assumed, thus making the estimates highly questionable. Moreover, this may not only mean that they are inadequate for estimating demographic parameters but also that they can prove to be unsuitable for estimating levels when these mortality levels are actually changing.

Feeney (1980) investigated the infant mortality trends from child survivorship data, and indicated several ways in which childhood survivorship estimates may be validly interpreted when mortality is changing. When his procedure was tested for both Costa Rica and Peninsular Malaysia it turned out that the estimates using constant assumption of mortality rather than a linear trend in mortality decline were upwardly biased.

Kraly and Norris' (1978) investigated the effects of declining mortality on the Brass estimates of current mortality as measured by q(2), q(3) and q(5) and found out that the Brass estimates were upwardly biased under declining mortality conditions depending on the pace of mortality decline. The Brass technique was also found faulty with the onset of age at marriage. The result indicated that, the error in estimating current childhood mortality will be largest when childbearing begins at an early age.

These two results - the direct relationship between the accuracy of the Brass estimate - q(x) and the age at which childbearing begins and exact childhood age, x, respectively - are ultimately caused by variation in exposure to mortality. As we have pointed out, under conditions of declining mortality, children of women whose childbearing begun relatively early will have been exposed to mortality schedules and levels divergent from current mortality schedules and levels. Similarly, exposure to divergent mortality conditions increases as childhood age increases.

Zlotnik and Hill (1981) showed that the mortality estimates are likely to be inaccurate when mortality changes do not show a smooth trend or if this smooth trend has not prevailed in the past. The availability of data on children everborn and dead or surviving from census makes it possible to compute proportions of children dead by age group of women during the intercensal period which can then be estimated by Coale-Trussel model. The hypothetical cohort analysis provides childhood mortality level for a well defined period without making assumptions about the nature of mortality and fertility. The general procedure developed makes possible, the estimation of mortality levels for a specified time period despite the confouding influences of trend.

Palloni (1980) noted that Brass's assumption of constant fertility schedules and mortality conditions have become obsolete in many developing coutries. In pursuance of those discovered anomalies, he developed a new technique suited for the estimation of infant and childhood mortality when mortality in a population has been falling. Using the assumption of linear or curvilinear mortality decline he estimated the rate of mortality decline and the level of mortality at the time of census which undoubtedly showed superior estimates. Palloni (1981) tried his procedure in 8 African Countries (census date in Parenthesis) namely Kenya (1969), Liberia (1971), Rwanda (1970), Seychelles (1971), S. Rhodesia (1969), Swaziland (1966) and Tanzania mainland (1967). He found out that in countries where the assumption of constancy in mortality has been more clearly violated (Kenya, Rwanda and Tanzania mainland), Adegbola's (1977) estimates were at least 17 percent higher than those obtained by Palloni.

Ewbank (1982) studying the case of Bangladesh narrated the major sources of errors in mortality estimates. The effect of recent fluctuations in mortality rates was found to be a major contributory factor to the total error. The mortality he maintained is never constant and hence fluctuated from one year to the next. Thus if infant and child mortality rates fluctuates greatly, then the mortality estimates based on the reports of child survival by young women will be heavily affected by recent swings in mortality. If these recent changes in mortality rates are not the result of consistent trends, it then becomes appropriate to adjust these estimates so as to get the mortality rates for the recent years.

1.5.2 SUMMARY

From the foregoing literature review, we can then summarizes that for any population that has been experiencing socio-economic development, naturally, it is naive to assume and use the assumption that the mortality schedules in such a population have remained static in the recent past. The estimates obtained by such an assumption gives estimates that are seriously biased positively and hence does not reflect the true mortality situation in the recent years. Errors resulting from such a situation will be greatest with variation in mortality schedules which did operate in the past.

1.6.0 THEORETICAL FRAMEWORK

From the literature review we have discussed implictly the breakdown of the major cornerstone of which stable and quasi-stable population theories rests on. The idea of stable population theory is not new. It dates back to Euler (1760), who introduced the concept of stable age structure in which proportions in all age categories would remain fixed if mortality were constant and births increased exponentially over time. His paper was similar to Milner (1815), who recognized its theoretical interest but emphasized its restricted applicability in real population under study.

The link between stable theory and real population was very largely uncovered by Alfred Lotka (1907, 1922); F.R.Sharpe and Lotka(1911), in works that form a significant achievement in demography. Lotka's insight expanded from his realization that population could be represented as a renewal process displaying some stability, to his discovery that population would nearly always stabilize, by predictable paths, if fertility and mortality were held costant. Lokta and Sharpe using their mathematical acumen proved that age distribution of any population that is subjet, for sufficiently long period of time to unchanging mortality and fertility schedules becomes fixed. The age distribution of a stable population is jointly determined by the mortality schedules to which the population has been subject and by its annual rate of growth. The use of model stable population in estimating demographic parameters determining the dynamism and structure of actual population derives from three considerations.

(1) It has been found that in a population in which fertility has been approximately static and in which mortality has recently undergone a steady decline, the age distribution closely resemble that of a stable population (quasi-stable) generated by equation of form

$$c(x) = b * \exp(-rx) * l(x)$$

Where c(x) is the infinitestimal proportion of stable population at exact age x; b is the constant birth rate; r is the constant rate of natural increase l(x) is the survival probability from to age x.

(2) These conditions (the recent course of fertility schedules believed to be constant and mortality either approximately static or recently declining) are, or have until recently been, characteristic of the population of many developing countries.

(3) The availability of fairly flexible sets of model populations, such as those generated on the basis of the Coale-Demeny (1966) life tables. This makes it possible to identify a stable age distribution approximating an underlying characteristic of a stable population.

Practically the value of estimates generated by fitting a model stable population is beset by a number of practical demographic considerations.

(1) No actual population is genuinely stable.Fertility may vary as a result of recent trends or past episodes such as wars or epidemics. Age- selectivity and sex-selective migration can affect both the rate of growth and the age distribution of the population, and the recent mortality decline observed in many developing counries produce age distribution that do not conform exactly to those predicted by the equation defining stable population.

(2) The characteristics of the population being studied that are available for identification of a model stable population are often imprecisely record (age distribution is distorted by differential omission by age, or intercensal rate of increase calculated from censuses at two points in time is biased because of differential completeness of coverage between two censuses.

(3) The estimates of certain parameters based on different mortality families of Coale-Demeny set may be quite different. In most cases there is uncertainity about which mortality pattern approximates most closely to that experienced by a given population; and since they are only four families for Coale-Demeny set,there is no quarantee that they cover all possible experience.

The inherent availability of one or more of these practical problem sets in a chain of errors in the estimates.

The estimates obtained from these models are now realized to be only very approximate, except under very artificial conditions such as constant fertility and certain mortality patterns.

In lieu of the foregoing theoretical framework it seems safe to form the following working hypotheses.

1.7 OPERATIONAL HYPOTHESES

From the theoritecal framework one can hypothesize the following

(i) The estimates obtained by using the techniques suited for declining mortality conditions namely: Synthetic; Kraly-Norris; and Palloni's are likely to produce estimates, that are superior to those obtained by techniques that assume a constant mortality schedule if the mortality conditions in those populations have been changing.

(ii) The errors resulting from using static assumption of mortality conditions instead of using the assumption of declining mortality when the latter is the case and will be biased positively and can be substantial, depending on the pace of mortality decline.

(iii) These errors will be greatest with variation in mortality schedules operating in the past. i.e. the magnitude of these errors are likely to increase with childhood age.

(iv) The estimates obtained by using constant assumption when it does not hold refer to past mortality and thus does not refer to current mortality at the time of census.

1.8.0 DEFINATION OF TERMINOLOGIES AND CONCEPTS.

The following terminologies will be used in this study.

Children ever born(e): number of chilren ever born alive by a particular woman.

Cohort: this is groups of persons who experienced the same class of events in the same period.

Age cohort: is a group of people born during a particular period.

Age heaping: a tendency for enumerators or respondents to report certain ages instead of others; aslo known as digit preferences.

Infant mortality rate: number of deaths of children under one year; aslo used in a rigorous sense to mean the number of deaths that would occur under one year of age in a life table per 1000, in which sense it is denoted by the symbol $_1q_0$.

Expectation of life.

Average number of years that a member of a cohort of births would be expected to live if the cohort were subjected to the mortality conditions expressed by aparticular set of age-specific mortality rates. This parameter is denoted by e(0) in life table functions.

Moving averages.

The successive averaging of two or more adjacent values in series to remove fluctations.

Stable population.

A population exposed for a long time to constant fertility and mortality rates, and closed to migration, establishes a fixed age distribution and a constant growth rate.

CHAPTER 11

THE ESTIMATION OF INFANT AND CHILD MORTALITY FOR A HYPOTHETICAL COHORT: ADDITIVE SYNTHETIC-APPROACH.

2.1 INTRODUCTION.

In this chapter we shall consider the use of "Synthetic-Approach" to enable us to estimate intercensal mortlity between 1969 and 1979 for the whole country, and at district level. The method derives mortality measurements from two successive censuses to generate a third data set. The availability of data on children everborn and dead or surviving from two censuses make it possible to compute proportions of children dead by age groups of women during intercensal periods which can be estimated by Coale-Trussell model. The hypothetical cohort analysis does not provide directly the trend curves, but provides child mortality level for a well defined period without making the assumptions about the nature of the trend of mortality and fertility and this is used to remove unwanted variations in mortality and fertility.

2.2 METHOD OF DATA ANALYSIS: ADDITIVE SYNTHETIC APPROACH.

Zlotnik and Hill (1981) described a general procedure that make possible the estimation of mortality levels for a specified time period despite the confounding influences of trends. This method of analysis is applicable in so far as two sets of data from surveys or censuses are available 5 or 10 years apart. These two sets of data are then used to synthetize the third set of data, respresenting the effects on a hypothetical cohort of prolonged exposure to the vital rates in operation during the intersurvey period. This idea is not new, it was first developed independently by Ryder ..., later described by Hajnal (1953), and applied systematically by Agarwala (1962). However, the extension of this method to mortality studies is credited to Zlotnik and Hill. The confounding influences of trend can be resolved using the synthetized set of data from the census. The only assumption needed is that fertility has been constant, however this is not practically necessary, because it seems to work well and more so when data used are of comparable quality.

Child mortality estimates are normally obtained from the proportions of children dead among children ever born by women in a particular age group. Such proportions can increase or decrease depending on the prevailing mortality, thus in the intersurvey approach, the proportion dead D(i) cannot be chained to give the synthetized third set of data. However, the average number of children ever born, and the average number of children dead, are additive as a cohort ages, so that by successive differencing of cohort values at the second and first survey gives the average intersurvey birth and deaths. Thus, by dividing the cummulated average number of intersurvey deaths by the cummulated average number of births. The resultant proportion can then be analysed by the Coale-Trussell technique.

For any possible change in mortality between intercensal period, the additive model for the synthetic (cohort) approach will be applied to the data. The procedure is outlined below:

Table: 2.1. censuses ten years apart.

1st Census	2nd Census	Sythetize set.
S(1,1)	S(1,2)	S(1,3)=S(1,2)
S(2,1)	S(2,2)	S(2,3)=S(2,2)
S(3,1)	S(3,2)	
S(4,1)	S(4,2)	for i $\geqslant$ 3,
S(5,1)	S(5,2)	S(i,3)=S(i,2)-S(i-2,1))
S(6,1)	S(6,2)	+S(i-2,3)
S(7,1)	S(7,2)	

Let the index i represent the ith age group and j represent the jth census, the P(i,j) is the average parity of ith index of jth census, and can be denoted by

P(i,j) = CEB (i,j)/FP(i,j), where CEB(i,j) is the

number of children everborn to women in the ith index of the jth census, FP(i,j) is the number of female population in the ith index of the jth census.

Let also CD(i,j) denote the number of children dead in the ith index of the jth census, then average children dead denoted by ACD(i,j) is given by

ACD(i,j) = CD(i,j)/FP(i,j).

Now if the length of the intercensal period is in five-year intervals, the average number of children everborne by women of age group i in the hypothetical cohort exposed to intersurvey fertility rates and denoted by P(i,s) is

$$P(i,s) = P(i,2)-P(i-n,1)+P(i-n,s) \qquad (1)$$

Similarly, the average number of children dead per woman of age group i in the hypothetical cohort, denoted by ACD(i,s), is

$$ACD(i,s) = ACD(i,2)-ACD(i-n,1)+ACD(i-n,s) \qquad (2)$$

Note that in both equations (1 and 2) above, if i is smaller than or equal to n, the hypothetical-cohoort value is assumed to be equal to the value observed at the second survey.

The hypothetical-cohort proportions dead, D(i,s), are then obtained by dividing equation (2) by equation (1) above. That is,

$$D(i,s) = ACD(i,s)/P(i,s) \qquad (3)$$

Since the calculation uses average numbers per women, it is not important whether the two data sets come both from both censuses or from each type of source.

At this stage, using Coale-Trussell model the estimates of q(x) can be derived from proportions dead D(i,s), and with the help of Trussell multipliers variants.

$$\text{i.e } q(x) = K(i)\ D(i,s) \qquad (4)$$

where K(i) are the multipliers adjusting the non-mortality factors, and are estimated by

$$K(i) = a(i) + b(i)[P(1)/P(2)] + C(i)[P(2)/P(3)]. \quad (5)$$

Once the q(x) is obtained, its compliment l(x), the probability of surviving from birth to exact age x, is readily obtained as l(x) = 1.0 - q(x). Choice is then made of q(2), q(3) and q(5) to estimate the mortality level. q(1) is not considered since the births and deaths are rather small, q(10), q(15), q(20) are not used due to error of mis-reporting of events.

2.3 CALCULATION OF MORTALITY LEVELS

In determining mortality level of a region, use is made of the compliment of q(x), P(x) = 1-q(x), which is the probability of surviving upto age x from birth, where x = 1, 2, 3, 5, 10, 15 and 20. The implied level of mortality is made by considering q(2), q(3), and q(5). This mortality level will lie somewhere between levels derived by Coale-Demeny. To get the needed P(x), we interpolate between the higher and lowers level. 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 proabability of survival. Further (x(2), y(2)) is the upper mortality level with its corresponding probability of survival. Now suppose (x,y) is a point in between, then:

$$(y(2)-y(1))/(x(2)-x(1)) = y-y(1)/x-x(1) \qquad (6)$$

normally x(2)-x(1) = 1 since x(2) and x(1) represent two consective mortality levels. Thus, if y is known then:

$$x = x(1) + (y-y))/(y(2)-y(1) \qquad (7)$$

If however, x is known then, y is easily determined by the formula:

$$y = y(1) + (y(2)-y(1))(x-x(1) \qquad (8)$$

2.4 CONSTRUCTION OF ABRIDGED MODEL LIFE TABLE

The average mortality level so obtained will help us to construct a life table. The calculated probability of surviving y = P(x), using equation (8) . P(x) is then multiplied by the assumed radix l(0) to obtain the number of survivors at age x i.e l(x). Other life table functions can then be calculated as below:

(i) nPx, is the probability of surviving between age x and x+n, and is given by,

$$nPx = l(x+n)/l(x)$$

(ii) nqx, is the probability of dying in the interval (x, x+n), and is given by,

$$nqx = 1-npx$$

(iii) ndx, is the number of persons who die in the interval (x, x+n), and is given by,

$$ndx = l(x)-l(x+n)$$

(iv) nLx is the number of person years lived between the age x and x+n, and is generally denoted by

$$nLx = \frac{n}{2}[l(x) + l(x+n)]$$

where n is the width of the interval. Special formulae are given for those aged (0-1), (1-4), and beyond 75 years:

$$1L0 = 0.3\ l(0) + 0.7l(1)\text{: for ages 0-1}$$

$$4L1 = 1.3l(1) + 2.7l(5)\text{: for ages 1-4}$$

$$\infty L(75) = l(75)\ \log 10\ l(75)$$

(v) T(x), total number of people from age x, and is given by:

T(x) = T(x+n) +nLx, for ages except the last age i.e 75

at age 75, Tx = Lx

(vi) e(x), the expectation of life at age x, is given by:

$$ex = T(x)/l(x).$$

2.5. ESTIMATION OF MORTALITY FOR KENYA AT NATIONAL LEVEL: SYNTHETIC ADDITIVE APPROACH

Mortality estimation using synthetic additive approach involves synthetizing the two sets of data-1969 and 1979 to produce the third data set which then is used as explained below.

The first step involves calculating the parity P(i,j) for each census per age group , which are then additively synthetized. Table 2.2.1 gives an illustration.

Table 2.2.1 Generated synthetic parities from 1969 and 1979 parities

Age group	1969 P(i,1)	1979 P(i,2)	Sythetized set-P(i,s)
15-19	0.35	0.320578	0.320578
20-24	1.88	1.854308	1.854308
25-29	3.65	3.652108	3.622686
30-34	5.11	5.388082	5.362390
35-39	6.00	6.470268	6.442954
40-44	6.44	7.021534	7.273924
45-49	6.69	7.173540	7.616494

Using equation (1) the parities for 1969 and 1979 are calculated. For calculation of the synthetized set-P(i,s) in the 1st and 2nd age group,the value of the third set is assumed to be equal to the value of parity at the second census. Other values are calculated as illustrated below. For the 3rd age group:

$$P(3,s) = P(3,2) - P(1,1) + P(1,s)$$

$$= 3.652108 - .35 + .320578$$

$$= 3.622686$$

In calculating the average children dead, we need the children dead divided by female population. However, the ACD(i)'s for 1969 were generated indirectly from the product of D(i) and P(i) for each age group. Table 2.3 gives the values of average children dead. The synthetized set of ACD(i,s) are generated in a similar manner as was for P(i,s).

Table: 2.3 Generated synthetic Average Children Dead from 1969 and 1979 Average Children Dead

Age group	ACD(i,1) 1969	ACD(i,2) 1979	ACD(i,s) Synthetized set
15-19	0.044695	0.037231	0.037231
20-24	0.275420	0.231301	0.231301
25-29	0.634005	0.515147	0.507683
30-34	1.033755	0.893554	0.849436
35-39	1.385400	1.194057	1.067735
40-44	1.693076	1.526678	1.342362
45-49	2.031084	1.816020	1.498356

The hypothetical-cohort proportions dead-D(i,s) are then obtained by dividing each value of column 4 of table 2.3 by each value of column 4 in table 2.2.1, that is for 3rd age group we have:

$$D(3,s) = ACD(3,s)/P(3,s)$$

$$= .507683/3.622686$$

$$= .140139$$

Table:2.4 Generating the q(1), q(2), q(3), q(5), q(10), q(15) and q(20).

Index (i)	a(i)	b(i)	c(i)	k(i)	D(i,s)	q(x)	l(x)
1	1.1119	-2.9287	0.08507	1.172557	0.116137	0.136177	0.863822
2	1.2390	-0.6865	-0.27545	1.036828	0.124737	0.129330	0.870669
3	1.1884	0.0421	-0.51560	0.958144	0.140139	0.134273	0.865726
4	1.2046	0.3037	-0.56560	0.980768	0.158406	0.155359	0.844640
5	1.2586	0.4236	-0.58980	1.037128	0.165721	0.171873	0.828126
6	1.2240	0.4222	-0.54560	1.022513	0.184544	0.188698	0.811301
7	1.1772	0.3486	-0.46240	1.005409	0.196725	0.197789	0.802210

Now with the help of K(i)'s and D(i,s)'s from the table in the opposite page, the q(x) values can be generated using the relation- q(x) =K(i)D(i,s). K(i) values are obtained by the use of equation (5). l(x) values are then generated from q(x), which are then used in locating the implied levels for each l(x). Use is then made of the levels resulting from q(2), q(3), q(5) to locate the implied level by averaging them. The table below illustrates.

Table:2.5.4 Calculation of implied level.

l(x)	Lower level	Upper level	Lower p(x)	Upper p(x)	Implied levels	Implied level (Average)
l(2)	14	15	0.86841	0.88329	14.21201	
l(3)	14	15	0.85139	0.8686	14.83298	14.60898
l(5)	14	15	0.82886	0.84904	14.78196	

The implied level-14.6 falls in between level 14 and 15. The p(x) values for the two afore-said levels are obtained from Coale-Demeny life tables. Linear interpolation is used to generate the survival probabilities for the implied level.

The survival probabilities so obtained (see table 2.6.5) are used to calculate the number of survivors-l(x). By assuming a radix of 100,000 and multiplying each value of the said table column 4, column 4 of the next table -2.^.6 is generated. e.g. l(1) is obtained by:

l(1) = 100,000*.902646

=.902646

Table: 2.6 Calculation of the the survival probabilities

Ages	14	15	p(x)
1	0.89613	0.90699	0.902646
5	0.82886	0.84904	0.840968
10	0.80185	0.82527	0.815902
15	0.78736	0.81221	0.80227
20	0.77059	0.79668	0.786244
25	0.74896	0.77646	0.76546
30	0.72599	0.75495	0.743366
35	0.70143	0.73191	0.719718
40	0.67449	0.70651	0.693702
45	0.64404	0.67745	0.664086
50	0.61014	0.64466	0.630852
55	0.56857	0.60373	0.589666
60	0.51779	0.55332	0.539108
65	0.45153	0.48651	0.472518
70	0.36666	0.39967	0.386466
75+	0.26441	0.29308	0.281612

Table: 2.7

LIFE TABLE FOR KENYA SYNTHETIC-APPROACH

GROUP	nPx	nQx	l(x)	nDx	nLx	Tx	ex
0-1	0.902646	0.097354	100000	9735.4	93477.28	5148838.	51.48838
1-4	0.931669	0.068330	90264.6	6167.8	344726.0	5055360.	56.00601
5-9	0.970193	0.029806	84096.8	2506.6	414217.5	4710634.	56.01443
10-14	0.983293	0.016706	81590.2	1363.1	404543.2	4296417.	52.65849
15-19	0.980022	0.019977	80227.1	1602.7	397128.7	3891874.	48.51071
20-24	0.973568	0.026431	78624.4	2078.2	387926.5	3494745.	44.44861
25-29	0.971133	0.028866	76546.2	2209.6	377207.4	3106818.	40.58749
30-34	0.968187	0.031812	74336.6	2364.8	365771.2	2729611.	36.71961
35-39	0.963852	0.036147	71971.8	2601.6	353355.2	2363840.	32.84397
40-44	0.957307	0.042692	69370.2	2961.6	339447.3	2010485.	28.98196
45-49	0.949955	0.050044	66408.6	3323.4	323734.5	1671037.	25.16297
50-54	0.934713	0.065286	63085.2	4118.6	305129.5	1347303.	21.35688
55-59	0.914261	0.085738	58966.6	5055.7	282193.7	1042173.	17.67396
60-64	0.876479	0.123520	53910.9	6659.1	252906.7	759979.9	14.09696
65-69	0.817886	0.182113	47251.8	8605.2	214746.2	507073.2	10.73129
70-74	0.728685	0.271314	38646.6	10485.4	167019.5	292327.0	7.564106
75+	0	1	28161.2	28161.2	125307.5	125307.5	4.449651

Once l(x) in column 4 have been calculated, they are used to calculate (nPx), which is the probability of surviving between age x and x+n and is denoted by:-

nPx = l(x+n)/l(x)

Example:

5P10 = l(15)/l(10)

=81589/80226

=.983299

The 3rd column is obtained from the compliments of each 2nd column. By succesive differencing the l(x)'s in column 4 we obtain nDx in column 5.

To obtain nLx- the person years lived between ages x and x+n, four expressions are used depending on the age group being considered.

1L0 =.310*l(o) + .71*l(1)   0 < x < 1

=.31*100,000 +.71*902646

=934777

4L1 = 1.33*90264 + 2.7*84096   1 < x < 4

=344726

For each age group in the interval 5 < x < 75 , the general formular:-

nLx = n(l(x)+l(x+n))/2.

And lastly for 75+ we use:

L75+ =l(75)ln(75)

=28161*ln(28161)

=125307

To obtain column 7, we add the succesive age groups from bottom of column 6, except for age 75+ where nLx=Tx.

e(x)-the expectation of life at birth is obtained by dividing column 7 by column4.

2.5 RESULTS AND DISCUSSIONS:

In the intercensal period under consideration, the whole country experienced a high mortality schedule (see table 2.8s). The infants had a higher risk of dying when compared to children, for all types of data set. Clearly one can say with certainity that in the ten-year period mortality schedules became more favourable for the survival of infants and children.

ble 2.8 : Summary of the estimates; Probabilities of a born child ying before ages 2,3 and 5; infant and child mortality rate; and life pectancies at birth and at age five at National level.

ype of ata set.	q(2)	q(3)	q(5)	IMR	4q1	e(0)	e(5)
969	0.151895	0.166429	0.198409	112	84	48.2	53.3
ynthe- ized	0.129331	0.134273	0.155359	97.3	68	51.5	56.0
979	0.129331	0.132241	0.148900	97.5	68	51.8	56.4

The high mortality schedules as portrayed in the table could partially be explained when attention is focused on the epideomological structure which prevailed in the intercencal period and before in the country. The prevalence of the diseases such as tetanus and respiratory tract infections in the neonatal stage claimed a big percentage of deaths. Respiratory tract infections, Gastroenteritis, malaria and malnutrition are known causes which plague infants and children. Infact among infants and children in Kenya at ages 0-4 years, 28% of the registered deaths in 1977 were ascribed to Respiratory tract infection and between 1977-1978 this cause contributed 30-55% of all infant and children deaths (Ewbank, et.al, 1986). However, this cause is more pronounced in cooler parts of the country,wetter areas of Central, Eastern and Rift-valley province than in Nyanza, Coast, and Western provinces. Gastro-enteritis and dysentry accounted for 10% of all infant deaths between (0-4) years, and in 1978, these diseases were found to be more pronouced in Coast,Western,and Nyanza regions. Measles,another known severe public health problem claimed a big proportion of infant and children, 20% of deaths in (0-4) years were ascribed to this cause (Ewbank,et.al. 1986). Other researchers had earlier shown the importance of measle morbidi ties on infant and child mortality-(Hendricks,1975;Hayden,1972; Muller, et. al.;1977). The registra's general office record (1977-78), showed that this rate was 0.9per 1000. A large pro-portion of whose death is associated with measles do die after such acute phase of the disease from such complications such as respiratory infection and gastro-enteritis.

Other variables which could possibly be adduced are : availability of clean water; level of literacy and probably the distribution of health facilities in the country. Infact in 1979-1981 water related childhood diseases accounted for nearly 30% of morbidities reported in rural Health Centers. Water availability by percentages shows a very grim picture, only 14%

of the total population have piped water within their reach.

2.7.0: RESULTS AND DISCUSSIONS FOR PROVINCES AND DISTRICTS.

When constructing the synthetized set of third data from those of 1969 and those of 1979 censuses, assumption was made such that the first and second age group average parities of 1979 data be equal to those of the synthetic values. Thus the synthetic values of q(1) and q(2) are the same as those of 1979. Presentation is made of the values of q(2) for 1969 and synthetic/1979 (see table 2.9.1).

The probabilityes of a child born in those regions dying before attaining the second birth day reveals two major categories of mortality behaviour. The mortality has either declined in the intercensal (1969-1979) or has increased. Each of these two can be categories into three major phases of decline. The three phases are :(1) the mortality has declined or(ii) increased which ever is the case by between (1.0%-2.0%); (2.1%-4.0%); and (iii) above 4.0% for those children of 2 years and below.

Out of the total regions considered, there are 36 regions which actually experienced mortality decline. A further 13 had experieced a rise in mortality risks for those children aged 2 years. For those regions experiencing the decline, 12 regions had a pace of decline between 1% to 2%. Put differently the mortality conditons improved such that between 10 to 20 deaths in 1000 children aged 2 years in were averted. In 16 other regions between 21 to 40 deaths were averted, where as in 7 regions over 40 deaths were averted. If quality of 1969

Table 2.9 :The probabilities of a child dying before year 2.

Province/Districts.	1969	Synthetic/1979	% decline
Nairobi	0.091643	0.087937	-0.3706
Central Province	0.085754	0.064686	-2.1068
Nyeri	0.053669	0.047555	-0.6114
Murang'a	0.109063	0.066964	-4.2099
Kiambu	0.091992	0.058208	-3.3784
Nyandarua *	0.060841	0.066314	0.5473
Kirinyaga	0.105325	0.079861	-2.5464
Western Province	0.165543	0.145059	-2.0484
Busia	0.222624	0.200513	-2.2111
Bungoma	0.146172	0.140712	-0.546
Kakamega	0.159006	0.143253	-1.5753
Nyanza Province	0.203166	0.163007	-4.0159
Kisii	0.127674	0.101967	-2.5707
Kisumu	0.220852	0.182999	-3.7853
Siaya	0.243596	0.214713	-2.8883
South-Nyanza	0.230464	0.223945	-0.6519
Rift-Valley	0.101464	0.101399	-0.0065
Kericho *	0.078116	0.093068	1.4952
Kajiado *	0.081864	0.090071	0.8207
Samburu	0.084962	0.076636	-0.8326
Nandi *	0.096049	0.112158	1.6109
Turkana *	0.094697	0.133649	3.8952
Nakuru	0.123595	0.063934	-5.9661
Narok *	0.095261	0.100116	0.4855
Elgeyo-Marakwet *	0.095272	0.125588	3.0316
West-Pokot *	0.140759	0.192135	5.1376
Laikipia	0.096916	0.077563	-1.9353
Baringo *	0.131512	0.189691	5.8179
Uasin-Gishu *	0.082551	0.092366	0.9815
Trans-Nzoia	0.119526	0.115347	-0.4179
Eastern-Province	0.132049	0.095197	-3.6852
Machakos	0.128226	0.095801	-3.2425
Marsabit	0.188896	0.129368	-5.9528
Meru	0.114421	0.076541	-3.788
Embu	0.118679	0.081392	-3.7287
Isiolo	0.217082	0.127521	-8.9561
Kitui	0.160304	0.141212	-1.9092
North-Eastern	0.158914	0.132054	-2.686
Wajir	0.178248	0.126919	-5.1329
Mandera *	0.136899	0.142365	0.5466
Garissa	0.160721	0.128012	-3.2709
Coast-Province	0.168314	0.114368	-5.3946
Kilifi	0.228891	0.218345	-1.0546
Mombasa	0.130945	0.114368	-1.6577
Taita-Taveta	0.177177	0.112035	-6.5142
Kwale *	0.169549	0.175971	0.6422
Tana-River	0.189316	0.182133	-0.7183
Lamu *	0.129401	0.202819	7.3418

* Those districts which show the post 1969 mortality conditions to be much more harsher than those operating in 1969.

data is anything to go by, then the greatest improvement in child survival occured in Isiolo, where there was 8.9% of mortality decline. There are 8 regions which are believed to have experienced a mortality rise of between 1% to 2%, whereas there are 2 in this category which experienced 2% to 4% of the rise, a further 3 regions experienced unprecendented mortality rise above 4%. These are Lamu (7.3%); Baringo (5.8%); and West-Pokot (5.1%). Certain possible reasons can be adduced to explain these situations. West-Pokot for instance experiences periodic famines which weakens the body's resistance against diseases. This facilitates the spread of epidemic diseases and encourages endemic. The manace caused by cattle rustlers slowed down efforts to improve the lives of the people. Poor distribution of medical facilities and their inaccessibility as a result of poor road network makes the control of diseases of diseases a very difficult process.

In Baringo, one factor which could possibly explain the rise in mortality is the uneven distribution of health facilities. By 1979, 80% of all health units were concentrated in the high and medium potential areas of Kabartojo, Kabarnet, and Eldama Ravine. The facilities in the remaining parts of the district are thinly scattered and hence patients have to walk long distances to reach health facilities. The road network in most cases are inaccessible, making the supply of medical facilities a protracted effort(DDC. Report 1979).

Lamu which experienced the highest increase is known to be plagued by water related diseases and in particular diarrhoeal diseases. In fact by 1977, according to Registrar

General's report, 25% of deaths in 0-4 years were ascribed to diarrhoea,while only 18% were ascribed to respiratory diseases. The muslim culture has influenced their socio-cultural values and their lives-early and polygamous marriages, high rate of illiteracy among women. Factors known to influence mortality.

In table 2.10 , next page, presentation is made of values of q(3) and q(5) for 1969, Synthetic, and 1979 data. The majority of these values for most regions shows that the mortality pattern took a downward trend. Those 1969 values are higher than the synthetic values-which actually represent the average mortality in the intercensal period (1969-1979), these synthetic values in turn are higher than the 1979 values. They indicate that mortality had actually declined in the period under consideration. Some of these values are quite close as in the case of Kericho, Samburu and Nandi districts. Infact in general the values of Synthetic data are very close to 1979 values, and thus it can be construed that the unadjusted values of 1979 refer to mortality pattern prior to census time.Of course it true to say that the synthetic values are baised towards the 1979 values.

For some regions the q(3) values for synthetic are unexpectedly higher than those of 1969 and 1979, these could be due to poor coverage of census in 1969 for Nandi, Narok and Elgeyo-Marakwet. In some regions these values are higher for both children aged 3 and 5 years. These areas includes Elgeyo-marakwet, West-pokot, Baringo, and Uasin-Gishu. Thus it can be concluded either that the two data sets were not of comparable quality or that the synthetic approach actually

Table 2.10): The probabilities of a child dying before age 3 and 5

Region:Province/ Districts.	q(3) 1969	q(3) Synthetic	q(3) 1979	q(5) 1969	q(5) Synthetic	q(5) 1979
Nairobi	0.105133	0.090379	0.087994	0.125496	0.09853	0.099685
Central Province	0.203156	0.06589	0.072666	0.135661	0.096452	0.092706
Nyeri	0.080661	0.052857	0.050415	0.101162	0.067517	0.061345
Murang'a	0.119801	0.076788	0.071903	0.148087	0.085345	0.087906
Kiambu	0.094915	0.087258	0.069945	0.130212	0.115688	0.078594
Nyandarua *	0.092489	0.071219	0.068676	0.112973	0.094921	0.082686
Kirinyaga	0.132129	0.100775	0.090042	0.18504	0.121848	0.11465
Western Province	0.192534	0.160153	0.152606	0.218597	0.190695	0.175424
Busia	0.248412	0.212071	0.207255	0.283647	0.252458	0.23882
Bungoma	0.159256	0.148625	0.150233	0.194786	0.167267	0.170455
Kakamega	0.188657	0.158646	0.150019	0.207775	0.175224	0.169434
Nyanza Province	0.229448	0.186669	0.174848	0.273021	0.229714	0.205202
Kisii	0.159837	0.11986	0.109217	0.183889	0.12145	0.131332
Kisumu	0.24595	0.20165	0.19611	0.288394	0.22156	0.231368
Siaya	0.253672	0.22662	0.221621	0.31043	0.256901	0.251453
South-Nyanza	0.263726	0.233882	0.231044	0.318939	0.266704	0.257265
Rift-Valley	0.123669	0.108456	0.107144	0.147811	0.13985	0.122448
Kericho	0.144181	0.10046	0.097466	0.122022	0.121509	0.110907
Kajiado *	0.078893	0.082589	0.086963	0.115499	0.093652	0.089227
Samburu **	0.080641	0.082689	0.081348	0.090037	0.095968	0.092738
Nandi *	0.107653	0.116916	0.114591	0.151775	0.142617	0.129106
Turkana	0.156486	0.141827	0.137149	0.142815	0.182364	0.159236
Nakuru	0.153216	0.105423	0.102219	0.175031	0.097313	0.116715
Narok * *	0.106072	0.107812	0.104336	0.115457	0.127034	0.119829
Elgeyo-Marakwet *	0.106771	0.133863	0.129143	0.160582	0.152864	0.143098
West-Pokot * *	0.161812	0.216946	0.200125	0.20504	0.252309	0.224602
Laikipia	0.108659	0.090717	0.082012	0.133866	0.089692	0.093392
Baringo * *	0.161175	0.200868	0.170072	0.200518	0.208626	0.182964
Uasin-Gishu * *	0.087362	0.102226	0.096983	0.123098	0.124189	0.11235
Trans-Nzoia	0.145514	0.113309	0.119352	0.193219	0.140956	0.13375
Eastern-Province	0.145062	0.107105	0.101151	0.173014	0.139214	0.123159
Machakos	0.154219	0.102083	0.099487	0.165469	0.120328	0.11762
Marsabit	0.159716	0.07895	0.128649	0.153545	0.116548	0.135601
Meru	0.11253	0.088111	0.083608	0.149237	0.106325	0.105468
Embu	0.135452	0.091125	0.088192	0.166853	0.110568	0.109346
Isiolo	0.191634	0.13195	0.128783	0.231456	0.138033	0.144209
Kitui	0.177949	0.15684	0.142343	0.222671	0.15694	0.168901
North-Eastern	0.147597	0.132456	0.131187	0.188808	0.150231	0.147317
Wajir	0.170001	0.126486	0.131482	0.222587	0.151644	0.164068
Mandera *	0.132121	0.134913	0.135755	0.163327	0.165286	0.163293
Garissa	0.135505	0.130061	0.130202	0.176736	0.154456	0.164900
Coast-Province	0.17854	0.146125	0.143199	0.223486	0.13589	0.14522
Kilifi	0.268298	0.240832	0.217492	0.346876	0.205882	0.236481
Mombasa	0.147587	0.124697	0.128783	0.176638	0.138451	0.144209
Taita-Taveta	0.167429	0.116425	0.117218	0.230076	0.12564	0.134992
Kwale	0.19596	0.185126	0.184263	0.231174	0.210325	0.207705
Tana-River	0.147972	0.176524	0.17585	0.180689	0.18736	0.186564
Lamu *	0.169691	0.175448	0.190139	0.163143	0.218068	0.196179

* The synthetic values for age 3 were both higher for 1969 and 1979.

** The synthetic values for both ages were higher than the 1969 and 1979 removed the unwanted variations and showed that in fact in the intercensal period the mortality risks increased. The latter seems to be the case as the technique is devised to give clear indication as to whether mortality did decline.

On the whole the variation in the probability of a new born child dying before attaining age 3 is so vast, ranging from as low as 52 deaths per 1000 (Nyeri) to as high as 240 deaths in 1000 births (Kilifi), South Nyanza is also close to Kilif's value with 233 per 1000.

For all regions considered, variation of mortality by region and age of the children is confirmed, and results showed that risks of death were higher as the child's age increased, a function of harsher mortality risks experienced by older children in the past.

The infant and childhood mortality rates for the regions are tabulated for 1969 data, synthetized data set, and 1979 data (see table 2.11C). As is expected the infant mortality rates for 1969 are higher than those of synthetic, but synthetic values are not necessarily higher than 1979. Some synthetic values are lower than 1979 estimates, as in the case of Trans-Nzoia, Muranga, Nakuru, Meru e.t.c. While others gave estimates that were same as in the case of Nandi, Kericho, and Nyeri. It is not easy to say with certianity whether the kind of results obtained are due to technique used or actual the mortality fluctuation from one region to the next

Nyeri has the most favourable mortality condition in the whole country experiencing an IMR of 57/1000 in 1969 which dropped to 43/1000 in 1979, this shows that mortality did

Table 2.11 :The estimates of infant and childhood mortality rates.

Region:Province/ Districts.	IMR-1q0 1969	Synthetic	1979	:	4q1 1969	Synthetic	1979
Nairobi	75	69	67	:	47	42	40
Central Province	76	60	56	:	47	33	31
Nyeri	57	43	43	:	31	20	20
Murang'a	85	56	59	:	30	31	33
Kiambu	74	62	56	:	46	35	31
Nyandarua	65	57	56	:	34	31	31
Kirinyaga	95	78	73	:	66	69	44
Western Province	131	119	115	:	102	91	86
Busia	178	150	135	:	130	121	107
Bungoma	121	105	103	:	94	76	74
Kakamega	123	109	120	:	96	81	94
Nyanza Province	165	133	131	:	119	104	102
Kisii	104	83	80	:	75	54	52
Kisumu	176	164	144	:	129	118	116
Siaya	185	158	162	:	136	129	133
South-Nyanza	192	164	166	:	148	134	137
Rift-Valley	115	84	82	:	86	52	34
Kericho	77	75	75	:	48	47	47
Kajiado	72	65	65	:	44	34	34
Samburu	81	62	63	:	52	35	37
Nandi	88	87	87	:	58	58	58
Turkana	113	105	104	:	84	76	75
Nakuru	103	65	78	:	74	33	53
Narok	103	79	80	:	51	51	51
Elgeyo-Marakwet	79	96	95	:	51	66	66
West-Pokot	113	156	151	:	84	127	123
Laikipia	82	63	64	:	53	31	32
Baringo	115	136	122	:	86	108	95
Uasin-Gishu	77	75	75	:	48	47	47
Trans-Nzoia	124	87	90	:	97	58	60
Eastern-Province	105	84	80	:	76	52	49
Machakos	104	76	78	:	75	47	50
Marsabit	130	78	95	:	102	49	64
Meru	93	65	68	:	64	38	41
Embu	96	70	71	:	65	40	40
Isiolo	154	93	93	:	125	125	64
Kitui	124	116	111	:	97	87	79
North-Eastern	132	105	103	:	106	76	74
Wajir	156	94	97	:	127	65	68
Mandera	114	102	102	:	85	73	73
Garissa	116	96	98	:	87	67	68
Coast-Province	133	100	93	:	107	72	64
Kilifi	154	119	153	:	125	91	130
Mombasa	105	92	93	:	76	63	64
Taita-Taveta	142	99	89	:	114	70	59
Kwale	132	138	134	:	106	110	108
Tana-River	144	128	127	:	116	101	100
Lamu	105	135	133	:	76	107	109

actually decline by 14 per 1000 over a period of 10 years representing an annual mortality decline of 1.4. Thus Nyeri in the intercensal period experienced relative mortality decline of 25%.

The harshest mortality conditions were experienced in South Nyanza, which by 1969 had an IMR of 192 which by the intercensal period dropped to 164 representing 28 per 1000 decline in infant mortality rate. This represented 15% decline in mortality. The IMR of this district by 1969 was 3.4 times as high as that of Nyeri, whereas in the intercensal it was 3.8 times as high.

Siaya which is also in the same province as South Nyanza also experienced an IMR of 185 (1969), 158 (1969-1979), 162 (1979). These are by any standards, representative of high mortality. The fact that IMR was lower in the intercensal period than at 1979 stems from the techniques used. Variations in mortality and fertility schedules could have easily affected the estimate - a complication that is adjusted for in the intercensal period.

For regions like Lamu, Kwale, and Elgeyo-Marakwet the infant mortality rose (see table 2.11). The greatest rise occured in Lamu with a relative rise of 29%.

The closeness of Synthetic estimtes and 1979 estimates can be explained in two ways: on one hand it involves the technique (synthetic) which for the first two age groups uses the 1979 proportions dead without adjustment. The synthetized sets begun at 3rd age group, which was then used to locate the level of mortality in that period. On the other hand the use of q(2), q(3), and q(5) strictly speaking does not refer to mortality levels at census time, rather it refers to past mortality , slightly a few years preccedinq the census.

Table 2.124 gives for the three type of data sets, life expectancies at birth and at age 5. Again variatoin exists from one region to the next. Higher life expectancies are concentrated in central, Rift-Valley, and Eastern provinces, where as low life expectancies are foud in Western, Nyanza, and Coastal regions. Some possible explanations have been adduced.

For Western province, the high mortality shedules are influenced by conditions prevailing in the three regions,namely Busia, Bungoma, and Kakamega. Briefly, Busia's promixity to water surfaces such as lake Victoria, river Yala, and river Nzioa have normally caused serious flooding during rainy season The direct and indirect effects of these floods are many,amongs them are malnutrition, malaria, diarrhoeal,loss of property and lives, destruction of crops and livestock. The stagnant water surface is an enviromental hazard as this is a habitat for breeding of mosquitos and bilharzia. Due to this, 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. While in Kakamega, DDC report (1978-79) showed that malaria and helmenthology are quite common,infectious diseases are major sourge namely measles, diphtheria, whooping cough,tuberclosis and tetanus. In Bungoma 28% and 19% of all infant and childrens' deaths were ascribed to respiratory

Table 2.12.: Estimated life expectancies at birth and age 5.

Region:Province/ Districts.	e(0) 1969	e(0) Synthetic	e(0) 1979	:	e(5) 1969	e(5) Synthetic	e(5) 1979
Nairobi	54.85	57.8	57.13		59.35	59.7	60.08
Central Province	56.26	60	59.82		60.88	61.5	61.3
Nyeri	60.68	64.3	64.3		63.44	66.2	66.2
Murang'a	54.13	61.1	60.9		60.61	63.7	63.2
Kiambu	56.6	59.7	61.1		60.26	62.6	63.7
Nyandarua	58.77	60.9	59.82		60.13	63.6	62.4
Kirinyaga	52.06	51.1	56.5		58.72	56.1	58.8
Western Province	44.8	46.9	46.8		53.36	53.5	53.38
Busia	37	41.4	41.09		49.87	47.6	47.2
Bungoma	46.67	48.7	49.14		54.66	54.6	54.86
Kakamega	46.16	49.9	47.96		53.98	53.9	53.6
Nyanza Province	38.98	41.8	44.4		51.84	51.9	50
Kisii	50.03	45.7	55.1		58.02	57.9	58.9
Kisumu	37.24	40.4	43.3		50.1	50.6	49.5
Siaya	35.95	40.1	39.4		49.36	49.2	45.9
South-Nyanza	34.92	39.1	38.6		48.86	48.6	45.3
Rift-Valley	53.35	54.4	54.6		57.56	57.82	58.3
Kericho	56.06	56.4	56.7		59.17	59.9	59.9
Kajiado	57.17	58.7	58.62		60.14	61.9	61.8
Samburu	55.17	59.6	59.3		60.05	62.6	62.2
Nandi	51.87	53.5	53.6		57.49	57.8	57.7
Turkana	48.1	51.5	51.8		54.94	56.6	56.9
Nakuru	48.1	58.8	55.6		58.4	61.9	59.3
Narok	50.2	55.4	55.2		59.16	59.2	59
Elgeyo-Marakwet	55.4	51.8	51.8		55.47	57.2	56.3
West-Pokot	45.95	40.4	41.1		50.59	46.8	47.4
Laikipia	54.79	59.3	58.8		60.36	62.3	62
Baringo	47.68	43.8	46.3		52.34	49.6	51.7
Uasin-Gishu	56.07	56.2	56.2		59.04	59.7	59.8
Trans-Nzoia	46.09	53.8	52		57.29	57.8	56.6
Eastern-Province	49.91	54.4	55.1		57.97	57.7	58.8
Machakos	50.01	56.2	55.7		58.01	59.8	59.4
Marsabit	44.92	55.8	50.2		56.03	59.5	54.5
Meru	52.5	58.7	57.92		60.01	61.8	61.1
Embu	51.71	57.2	56.9		59.17	59.3	60.3
Isiolo	40.75	52.4	52.2		55.02	56.7	56.6
Kitui	46.08	47.7	45.6		53.49	53.6	50.3
North-Eastern	44.46	49.7	51		54.87	54.9	55.3
Wajir	40.39	52.1	51.4		54.99	56.5	55.9
Mandera	47.86	50.4	50.4		54.33	55.1	55.1
Garissa	47.86	51.8	51.3		55.12	56.2	55.8
Coast-Province	44.43	50.4	52.2		55.56	55.7	56.6
Kilifi	40.64	48.1	47.1		50.04	52.3	52.5
Mombasa	49.88	52.9	52.6		56.66	57.1	56.9
Taita-Taveta	42.77	46.1	45.6		55.79	52.2	51.3
Kwale	44.38	43.5	45.12		51.14	51.3	50.2
Tana-River	42.34	45.6	45.03		51.27	51.3	50.3
Lamu	49.78	44.8	44.2		51.37	49.1	50.1

and diarrhoeal diseases respectively (Registrar Generals'report 1977). Thus the complexity and diversity of these morbidity structures in these regions makes the control of these diseases a difficult process.

Nyanza province, is seriously afflicted with high mortality rates. All its three disricts are malarial zones, the sugar belts of miwani, muhuroni, chemelil in Kisumu district and the rice shemes coupled with floods of Kano plains makes the survival rates for infants very low. Malnutrition, gastro-enteritis, respiratory related diseases have been suggested as major killers. Infact gastroenteritis instead of malaria has been suggested as the major scourge of infant (Grounds 1964). In Kisumu district diarrhoeal related diseases accouted for 10% of the deaths while 20% is contributed by respiratory diseases Registrars' general report 1977). Coastal province shares most most of these reasons, in addition to thier the coastal culture as influenced by muslim ways of life and customary beliefs.

SUMMARY

In summary it is worth noting the consistency therein in between the values obtained by the two methods used for 1979 data. I have already cited concrete reasons which explia-ns this closeness. Technically these two methods are the same only that synthetic is meant to adjust for any variation in mortality. The application of these these techniques has augured well for Kenyan data.

What now remians is the improvement of mortality conditions in high mortality regions. To do this, strongest measures must be chartered out to encampass the policies concerning health facilities, with a view to alleviating the deficiencies therein, so as to improve promotive, preventive, curative and rehabilitative health services. Efforts must be continued on the immunisation campaigns of infants and pregnant mothers against T.B, measles, diphtheria and tetanus.

In the foregoing chapter we only adjusted for envisaged mortality variation which could have been operative in the past. In the next chapter we shall look again at the mortality structures when taking consideration that mortality has been declining in the recent past - a violation of the e major assumptions on which Brass technique hinges on.

CHAPTER III

3.0 ESTIMATION OF INFANT AND CHILD MORTALITY: KRALY-NORRIS MODEL FOR DECLINING MORTALITY.

3.1.0 INTRODUCTION

In this chapter, attention is focused on a model which envisages to estimate the infant and childhood mortality estimates at the time of the census. This model yields only estimates which can be termed as "current" since they are actually adjusted to refer to mortality schedules as at the time of census. Thus use will only be made of 1979 census data. However, before obtaining the q(x) values needed for the said adjustments, the 1979 data are smoothened by using moving averages which have a property that tend to remove unwanted fluctuations in the data.

3.2 KRALY-NORRIS CORRECTIVE TECHNIQUES

Kraly-Norris (1978) modification of Brass q(x)'s uses a computer simulation to investigate the effects of declining mortality on the Brass estimates of current mortality as measured by q(2), q(3) and q(5).

The simulation process obtained by Kraly-Norris found that the difference between the "true" value q(x) and the estimated q*(x) could be approximated by the equation below

$$q(x) - q^*(x) = A[dq(x)/dt] + B\,[dq(x)/dt]\,[P2/P3] \qquad (1)$$

$$\therefore\; q(x) = q^*(x) + A[dq(x)/dt] + B[p(2)/p(3)]*[dq(x)/dt] \qquad (2)$$

Where q(x) is the adjusted probability of dying at age x.
q*(x) is the unadjusted value.
A and B are Kraly-Norris Coefficients developed in a simulation process by using 3168 observations which yielded 396 mortality declines, and are selected according to childhood age and mortality pattern. p(2) and p(3) are parities for age groups 20-24 and 25-29 respectively. dq(x)/dt is the annual mortality rate of decline , which is normally assumed positive.

The expression (2) then gives the adjusted new value of q(x). When the accuracy of this method was checked and percentage errors calculated, Brass estimates under West-Mortality yielded errors of 7% for q(2), 14.8% for q(3) and 21.6% for q(5). The percentage errors for Kraly-Norris estimates were found to be 0.0%, 1.1% and 2.6% respectively.

In practice, the annual mortality decline dq(x)dt is difficult to estimate, so with the help of two censuses a rough estimate of dq(x)/dt was found - the expectancy at birth - de(o)/dt. In this situation the expression (2) may be used with slight modification to yeild a model which can then be used to adjust the unadjusted estimate for declining mortality.

$$q(x)-q^*(x) = Ade(o)/dt + Bde(o)/dt\ (P2/P3 \qquad (3)$$

3.3 PROCEDURE FOR USE OF CORRECTION TECHNIQUE.

The correction technique outlined above required an estimate of the rate of mortality decline as measured by dq(x)/dt or as in this case de0/dt, as well as information on the fertility schedule as reflected in the ratio of the average parity of women aged 20 - 24 to women aged 25 - 29.

Step 1. We calculate the deO/dt from two census separated by t years, and in this case by 10 years.

Step 2. To find the fertility schedule we shall calculate the P2/P3 for the last census.

Step 3. Calculation is made of the value of q*(x)-the smoothene but still unadjusted value.

Step 4. From table 3.3.1 values of A and B are selected depending on the age being considered and underlying mortality pattern. In this case North parttern is seleted

Table 3.3.1

Results of Regressions as obtianed by Kraly and Norris.

Childhood age	Mortality Patterns	Regression Coefficients A	B
2	West	0.009	-0.054
	North	0.015	-0.078
	East	0.003	-0.04
	South	0.017	-0.063
3	West	-0.003	-0.069
	North	0.002	-0.096
	East	-0.008	-0.058
	South	0.004	-0.067
5	West	-0.0019	-0.076
	North	-0.011	-0.096
	East	-0.027	-0.067
	South	-0.015	-0.071

Each regression is based on 3168 observation on data

Source: Demography vol. 15(4), Nov (1978).pp.555

Step 5. Using equation (2) the "true" value of q*(x) are obtained, then using normal procedure of estimating mortality the needed estimates are obtained .

Step 6. Error analysis is then made of the q*(x) values in relation to the corrected q(x) values.

3.4.0 MORTALITY ESTIMATION FOR KENYA AT NATIONAL LEVEL: KRALLY-NORRIS SIMULATION.

From the literature review, we have shown clearly that when mortality conditions have been declining, there will be biases when the constancy assumption is used, Thus to avoid this neccitates the use of Kraly-Norris model- a model used when mortality conditions are suspected or are known to have been changing in the recent past.

Using the 1979 census arranged by 5-Year age group with their corresponding children everborn and children dead as shown in table 3.2.1, the proportion dead D(i) are easily obtained i.e D(i) = CD(i)/CEB(i).

Table 3.2.1 Calculation of the proportions dead.

Age group	Female Population	Children Everborn CEB(i)	Children Dead CD(i)	Proportion Dead D(i)
15-19	887722	284585	33051	0.116137
20-24	886003	1272061	158674	0.124737
25-29	541261	1976744	278829	0.141054
30-34	412691	2223613	368762	0.165839
35-39	325367	2105212	388507	0.184545
40-44	275367	1921808	417855	0.217428
45-49	221965	1592275	403093	0.253155

Then using Coale-Trussell multiplies, the q(x) values are obtained (see table 3.3.2) below. These q(x) values are what we have termed Brass q(x) values - q*(x). The q*(x) is what will be termed as the unadjusted values. The 8 th column are the smoothened values of q*(x).

Table 3.3. Calculation of the smoothened q*(x) values.

a(i)	b(i)	c(i)	D(i)	k(i)	q*(x)	smoothened q*(x)
1.1119	-2.9287	0.8507	0.116137	1.172557	0.136177	
1.239	-0.6865	-0.27545	0.124737	1.036828	0.129330	0.132754
1.1884	0.0421	-0.5156	0.141054	0.958144	0.135150	0.132240
1.2046	0.3037	0.5656	0.165839	0.980768	0.162649	0.148899
1.2586	0.4236	-0.5898	0.184545	1.037128	0.191396	0.177023
1.224	0.4222	-0.5456	0.217428	1.022513	0.222322	0.206859
1.1772	0.3486	-0.4624	0.253155	1.005409	0.254524	0.238423

Using equation (2), that is

q(x) - q*(x) = A(de0/dt) + B[de0/dt)(P2/P3)

the values of q*(x), namely q*(2), q*(3) and q*(5) are slotted in the above expression. e.g for age 2, we have,

q(2) - q*(2) = 0.015*0.37744380 - (0.078)*(3744380)*(0.517489).

Where the values of A and B are selected from table 3.2.1 depending on the mortality pattern and childhood age. The value of A and B in this illustration are obtained from the said table, North pattern age 2. Where as 0.3744380 is the average annual decline in mortality rate, and is calculated from the life expectancies at birth in 1979 and 1969 divided by time interval. The value 0.5177489 is the fertility schedule which is the P2/P3 ratio.Normally the value of q(x)-q*(x) is negative showing that q*(x)'s are normaly upwardly biased. By adding the value so obtained to q*(x) we obtain the new q(x)'s, which we shall term, the "Current Mortality". For example, q(2)=

0.132754-0.0151897 which is the Current Mortality Probability of a child dying before reaching the 2nd birth-day in Kenya as a whole in 1979. The survival probabilities are then obtained from their compliments.

Ages	q(x)	l(x)
2	0.123257	0.876742
3	0.115357	0.884642
5	0.126179	0.87382

Then from Coale-Demeny Regional life tables we obtain the level in which l(2), l(3) and l(5) falls as shown

Table 3.4.3 Calculating the implied mortality level.

	lower level	upper level	lower	upper	
l(2)	14	15	0.86841	0.88329	14.0
l(3)	15	16	0.8686	0.88536	15.96294
l(5)	16	17	0.8618	0.88633	16.31073

Implied level 15.42456

Table 3.5.4

Calculation of the survival probabilities.

	15	16	p(x)
1	0.90699	0.91675	0.911133
5	0.84904	0.868818	0.857437
10	0.82525	0.84751	0.8347
15	0.8122	0.83592	0.82227
20	0.79668	0.82169	0.807298
25	0.77646	0.80298	0.787719
30	0.75495	0.78306	0.766884
35	0.73191	0.76166	0.74454
40	0.70651	0.738	0.719879
45	0.67745	0.71053	0.691494
50	0.64466	0.67915	0.659303
55	0.60372	0.63915	0.618762
60	0.55332	0.58955	0.568702
65	0.48651	0.52279	0.501913
70	0.39967	0.43442	0.414423
75+	0.29308	0.32398	0.306199

Table: 3.6

LIFE TABLE FOR KENYA (K-N) SIMMULATION

GROUP	nPx	nQx	l(x)	nDx	nLx	Tx	ex
0-1	0.911133	0.088867	100000	8886.7	94045.91	5341493.	53.41493
1-4	0.941066	0.058933	91113.3	5369.6	350234.4	5247447.	57.59255
5-9	0.973482	0.026517	85743.7	2273.7	423034.2	4897213.	57.11455
10-14	0.985108	0.014891	83470	1243	414242.5	4474179.	53.60224
15-19	0.981791	0.018208	82227	1497.2	407392	4059936.	49.37473
20-24	0.975747	0.024252	80729.8	1957.9	398754.2	3652544.	45.24407
25-29	0.973550	0.026449	78771.9	2083.5	388650.7	3253790.	41.30648
30-34	0.970863	0.029136	76688.4	2234.4	377856	2865139.	37.36079
35-39	0.966877	0.033122	74454	2466.1	366104.7	2487283.	33.40698
40-44	0.960569	0.039430	71987.9	2838.5	352843.2	2121178.	29.46577
45-49	0.953447	0.046552	69149.4	3219.1	337699.2	1768335.	25.57268
50-54	0.938509	0.061490	65930.3	4054.1	319516.2	1430636.	21.69922
55-59	0.919096	0.080903	61876.2	5006	296866	1111120.	17.95715
60-64	0.882558	0.117441	56870.2	6678.9	267653.7	814254.2	14.31776
65-69	0.825686	0.174313	50191.3	8749	229084	546600.4	10.89034
70-74	0.738856	0.261143	41442.3	10822.4	180155.5	317516.4	7.661652
75+	1	0	30619.9	30619.9	137360.9	137360.9	4.486003

Table:3.7 The probalities of all children aged 2, 3 and 5 dying in Kenya.

Ages	Unadju-sted q (x)	Adjusted q(x)	Error in absolute differenc	Error in %age difference	Relative Error in %
2	0.132754	0.123257	0.009497	0.9497	7.153833
3	0.132241	0.115357	0.016884	1.6884	12.76759
5	0.1489	0.126179	0.022721	2.2721	15.25923

Table:3.8 The estimated values for Kenya-1979 census.

	Adjusted	Unadjusted
Infant mortality rate-IMR	88	98
Childhood mortality rate-4q1	59	70
Life expectancy at birth-e(0).	53.42	51.02
Life expectancy at age 5-e(5).	57.56	55.6

In the table 3.7 , Summary is made of estimates obtaianed from Brass model using constant assumption of mortality-unadjusted, and Kraly-Norris adjustment for changing mortality schedules-adjusted. Relative errors obtained for using the constancy assumption instead of the latter are also calculated.

The contention that constancy assumption leads to upwardly biased estimates under declining mortality is confirmed in the Kenya case at national level. By using the assumption unchanging mortality schedules for age 2, the Brass model exaggerates the error in relative terms by 7.2% .That is by using q*(2) instead of q(2), relative error of 7.2% will have been made in the estimates. The older children are confirmed to have been subjected to variant mortality schedules which are quite different from those operating currently. The difference in using unadjusted values shows life expectancy of 51.8, where as the adjusted shows e(0) as 53.4 years(see table 3.8.7)

Using the values of e(0)-48.076 for 1969 and 53.42 for 1979 shows an increase in life expectancy of 5.35 years as opposed to only 3.75 years if no corrective procedure is used. In terms of IMR, the unadjusted values gives the estimate as 98 whereas the adjusted shows the estimate as 88, an error of 10 deaths in every 1000 live births.

3.5.0 ESTIMATION OF MORTALITY FOR NAIROBI.

The probabilities of dying before reaching the indicated ages for a child born in Nairobi are displayed in table

3.9 . Clearly one would have expected a wide variation between the two types of estimates, since Nairobi being the capital is endowed with most indicators of social and economic developments. However, mortality conditions in Nairobi are influenced

Table 3.9.1: Probablity estimates and errors for Nairobi.

Childhood Ages	Unadjusted. q*(x)	Adjusted. q(x)	Absolute % error	Relative % error
2	0.087937	0.085635	0.2302	2.6
3	0.088236	0.084299	0.3941	4.4
5	0.093839	0.088622	0.5217	5.6

by many factors, amongst them are: the mushrooming of slums has tended to encourage poor sanitation which is a health risk; the in-migration from the malarial zones of Nyanza, Western and coast regions has tended to increase the malarial cases in Nairobi. Nairobi hosptitals are also referal centres and hence have the more serious cases to deal with.

Thus the errors resulting from use of q*(x) instead of q(x) increases with childhood ages, but their magnitudes are not large enough to warrant conclusion of a fast declining mortality. Although there is evidence of a mortality decline the pace of decline is not very impressive.

The derived estimates shows an IMR of 64 per 1000 and for children it is 37 per 1000. The life expectancies are 59.2 and 62.2 years respectively.

3.6.0 MORTALITY ESTIMATION FOR CENTRAL PROVINCE

Central province is composed of 5 districts. Table 3.10 shows these districts with their respective values for q(x) both adjusted and unadjusted. The adjusted values shows low values for all regions considered when compared with the unadjusted values-q*(x). Clearly this shows that for all districts in this province, the values obtained using the constancy assumption are upwardly biased. The errors resulting are presented in the table 3.112.

The errors resulting from using the unadjusted values instead of the adjusted, reveals that the magnitude of those errors increase with childhood age. This indicates that children at different ages were exposed to divergent mortality schedules.

Table 3.104: The adjusted and unadjusted values for districts in Central province for 1979.

Districts	q*(2)	q(2)	q*(3)	q(3)	q*(5)	q(5)
Central	0.06486	0.059302	0.072666	0.054365	0.092706	0.062922
Nyeri	0.049437	0.042308	0.050415	0.036719	0.061345	0.042348
Muranga	0.07372	0.065047	0.071903	0.055874	0.087906	0.065752
Kiambu	0.072843	0.068153	0.069945	0.061141	0.078594	0.066488
Nyandarua	0.066838	0.064548	0.068676	0.064376	0.082686	0.076773
Kirinyaga	0.076511	0.067924	0.090042	0.0737	0.11465	0.092062

However,these variations differ from one district to next, depending of course on the pace of mortality decline. From table 3.112 it is evident that Nyeri experienced a very fast mortality decline as evidenced by high magnitudes of errors resulting from assuming constancy instead of changing mortality conditions. Nyandarua on the other hand seemed to have had a low pace of decline.

The estimated values of infant mortality rate (1q0), childhood mortality rates(4q1),the life expectancy at birth [e(0)] and the life expectancy at age 5 [e(5)] are tabulated (see table 3.12).

Table 3.11 :Relative errors of using unadjusted instead of adjusted probabilities in percentages for districts in Central province.

Province/districts.	q(2)	q(3)	q(5)
Central Province	8.3	25.2	33.2
Nyeri	14.4	27.2	30.9
Muranga	11.5	22.3	25.2
Kiambu	6.4	12.6	15.4
Nyandarua	3.5	6.7	7.7
Kirinyaga	11.2	18.1	19.7

Table 3.12: Estimates obtained by using adjusted value for for districts in Central province.

Province/districts.	1q0	4q1	e(0)	e(5)
Central Province	51	25	62.5	64.8
Nyeri	33	12	67	68.8
Muranga	47	23	63.3	65.4
Kiambu	51	26	62.4	64.8
Nyandarua	56	25	62.5	64.7
Kirinyaga	58	32	60.7	63.4

As can be inferred from the above table the whole of Central Province enjoys very favourable mortality conditions when compared to other regions of Kenya. Nyeri seems to experience the most favuorable mortality shedules than any other region in the whole Republic as is exemplified by its low infant and child mortality rates and high life expectancies.

3.7.0: MORTALITY ESTIMATION FOR WESTERN PROVINCE.

Table 3.13 gives the summary of results obtained when mortality condition are believed to have been changing in the past . For all regions studied adjusted values for changing mortality conditions show a somewhat lower probabilities of dying before attaining those indicated ages.Nonetheless the differences between these two values of q(x) do not show a very impressive mortality decline as is indicated by the magnitude of errors therin(see table 3.14.).

Table 3.13.: The unadjusted and adjusted values for districts in Western province (1979).

Regions:Province/ Districts	q*(2)	q(2)	q*(3)	q(3)	q*(5)	q(5)
Western-Province	0.14311	0.13813	0.152606	0.143185	0.175424	0.163914
Busia	0.19782	0.187527	0.207255	0.187784	0.23882	0.21918
Bungoma	0.140712	0.131753	0.150233	0.135025	0.170455	0.146163
Kakamega	0.146985	0.142585	0.150019	0.142095	0.169434	0.158716

Table 3.14.:Relative errors of using unadjusted instead of the adjusted probabilities in percentages for districts in Western province.

Regions:Province/ Districts.	q(2)	q(3)	q(5)
Western- Province	3.5	6.2	6.6
Busia	5.7	9.4	10.9
Bungoma	6.4	10.2	14.3
Kakamega	2.99	5.3	6.3

This slow rate of mortality decline could be ascribed to slow progress being witnesed in areas of preventive and curative measures in controlling the diseases such as whooping cough, diphtheria, diarrhoeal related infections and malaria.

Because of the aforesaid probable reasons, morbidity in this province is high and hence the estimates derived indicate a harsher mortality conditions. Table 3.15 throws light on this situation. In general, Busia experiences the highest mortality rates and the lowest life expectancies.

Table 3.15: Estimates obtained by using adjusted values for districts in Western province.

Regions:	1q0	4q1	e(0)	e(5)
Western- Province	103	74	50.3	54.9
Busia	133	106	44.3	50.1
Bungoma	96	67	51.6	56.2
Kakamega	102	74	50.2	55.0

3.8.0: MORTALITY ESTIMATION FOR NYANZA PROVINCE.

Nyanza province is situated between the lake region and the Rift Valley. It is comprised of 4 districts. The probabilities for dying in Nyanza and its districts are displayed in table 3.16.

Table 3.16: The unadjusted and adjusted values for districts in Nyanza province.

Regions:Province/ Districts	q*(2)	q(2)	q*(3)	q(3)	q*(5)	q(5)
Nyanza- Province	0.153073	0.139414	0.174848	0.149313	0.208202	0.177161
Kisii	0.096133	0.085419	0.109217	0.08906	0.131332	0.103591
Kisumu	0.173011	0.161171	0.19611	0.175755	0.231368	0.204362
Siaya	0.208174	0.196099	0.221621	0.200807	0.251453	0.223805
South- Nyanza	0.226035	0.21074	0.231044	0.204582	0.257265	0.22206

The probabilitys of dying before reaching the indicated ages for those selected districts are quite high irrespective of the assumption used. Nonetheless the unadjusted values gives high values when compared to the adjusted ones. For instance in South-Nyanza, the static assumption leds us to believe that 226 deaths in 1000 birth did occur for those aged 2 years.While the non-static assumption gives this value as 210 in 1000, resulting in an error of 16 deaths in every 1000 births. When relative percentage was considered they were found to be a function of childhood age and pace of mortality decline. In all regions errors increased when the past mortality was taken into account confirming the contention that there existed variation of mortality conditions in this province(see table 3.17).

The application of Kraly-Norris corrective procedure on data derived from these districts produced estimates in table 3.18 . Indeed these estimates shows that the

Table3.17 :Relative errors of using unadjusted instead of adjusted probabilities in percentages for districts in Nyanza provin

Regions:Province/ Districts.	q(2)	q(3)	q(5)
Nyanza- Province	8.9	14.6	14.9
Kisii	11.2	18.5	21.2
Kisumu	6.8	10.4	11.7
Siaya	5.8	9.4	10.99
South-Nyanza.	6.8	11.5	13.7

Table 3.18 : Estimates obtained by using adjusted values for districts in Nyanza province .

Regions:	1q0	4q1	e(0)	e(5)
Nyanza- Province	107	78	49.4	54.3
Kisii	66	39	58.4	61.6
Kisumu	124	97	46.3	51.8
Siaya	140	112	42.7	48.7
South-Nyanza.	145	117	42.2	48.3

the province experiences harsh morbidity. The socio-economic structure of the province makes it susceptible to high risks of dying. For example the rice irrigation schemes in Kano accompained by the incessant yearly floods have made the elimination of malaria and those other water related diseases a protracted effort.South-Nyanza stands out as the most affected area with high infant and child mortality and low life expectancy (see table 3.18).

Socio-cultural as well as Socio-economic practices are believed to influence the infant and child mortality.

3.9.0: MORTALITY ESTIMATION FOR RIFT VALLEY PROVINCE.

There exists diverse variations in the probabilities of dying before attaining ages 2,3 and 5 for adjusted as well unadjusted .This depends on geographical location of the region being studied. The table below gives the summary of those risks. High morbidities are found in West-Pokot district, Turkana, Elgeyo-Marakwet and Baringo district. The low mortali-

Table 3.19:The unadjusted and adjusted values for districts in Rift- Valley province

Districts	q*(2)	q(2)	q*(3)	q(3)	q*(5)	q(5)
Rift Valley	.097205	0.095091	0.107144	0.103241	0.124485	0.119766
Kericho	0.092085	0.089871	0.097466	0.093551	0.110907	0.105649
Kajiado	0.081734	0.079562	0.086963	0.083112	0.089227	0.084048
Samburu	0.077323	0.069659	0.081348	0.067401	0.092738	0.074592
Nandi	0.111568	0.102525	0.114591	0.099142	0.129106	0.108666
Turkana	0.137613	0.135979	0.137149	0.134204	0.159236	0.155251
Nakuru	0.099303	0.083045	0.102219	0.074896	0.116715	0.082386
Narok	0.096786	0.093299	0.104336	0.098461	0.119829	0.111883
Elgeyo	0.128689	0.141663	0.129143	0.142085	0.143098	0.156039
W.Pokot	0.200099	0.210722	0.200125	0.218237	0.224604	0.248549
Laikipia	0.078497	0.069043	0.082012	0.065495	0.093392	0.071327
Baringo	0.178538	0.185451	0.170072	0.185135	0.182964	0.199072
Uasin-Gishu	.089947	0.087718	0.096983	0.094754	0.112351	0.110121
Trans-Nzoia	.11107	0.092315	0.119352	0.087257	0.133751	0.091253

ty regions are Samburu, Laikipia and Kajiado district. The remaining other districts are somewhat in between the low and the high mortality regions. For all regions,as expected, shows low probability for the adjusted than the unadjusted and these shows a positive bias in the static assumption. However, West-Pokot reveals unexpected results,that is, the adjusted values shows high probabilities than the unadjusted values for all childhood ages. This uniqueness stems from the fact that when annual rate of mortality decline was calculated it revealed that mortality was increasing. This is not hard to believe as their has been severe famine,prolonged drought and internal strife caused by cattle rustlers(Ngorokos).

The calculated relative errors resulting from misrepresentation of the true mortality situation is tabled below(see table 3.202). Then clearly the pace of decline can be inferred from the magnitude of the errors. For all cases they show a positive bias, the degree of bias depends on the pace of decline. Nakuru, Laikipia, Samburu, Trans-Nzoia and Elgeyo-Marakwet seemed to have experienced a rapid pace of decline. whereas Turkana, Narok, Kajiado and Kericho seemingly did experience a rather low pace of mortality decline.

Table3.202:Relative errors of using unadjusted instead of adjusted probabilities in percentages for districts in Rift Valley

Regions:Province/ Districts.	q(2)	q(3)	q(5)
Rift Valley	2.2	3.6	3.8
Kericho	2.4	4.0	4.7
Kajiado	2.7	4.5	5.8
Samburu	9.9	17.1	19.6
Nandi	8.1	13.5	15.8
Turkana	1.2	2.2	2.5
Nakuru	16.4	27.5	34.6
Narok	3.6	5.7	6.6
Elgeyo	10.1	17.6	21.2
W.Pokot	5.3	9.1	10.7
Laikipia	12.0	20.1	23.6
Baringo	3.9	7.1	8.8
Uasin-Gishu	2.5	3.6	5.4
Trans-Nzoia	16.8	26.9	31.8

The regions considered showed that there did exist a mortality variation which operated in the recent past. This variation differs from one region to the next, with those experiencing fast decline showing a great mortality divergence than those under a relatively low pace of decline.

The estimates obtained under changing conditions of mortality for Rift Valley Province are in table 3.21.

The table reveals that regions like Laikipia, Samburu and

Table 3.21: Estimates obtained by using adjusted values for districts in Rift valley province.

Regions:Province/ Districts.	1q0	4q1	e(0)	e(5)
Rift Valley	75	33	56.1	59.7
Kericho	70	42	57.61	60.9
Kajiado	61	30	59.6	62.5
Samburu	53	28	61.8	64.4
Nandi	74	46	56.5	60.1
Turkana	101	72	51.6	56.4
Nakuru	59	33	59.7	62.6
Narok	73	45	56.9	60.4
Elgeyo	107	78	49.3	54.2
W.Pokot	141	120	42.8	49.5
Laikipia	51	14	62	64.5
Baringo	128	102	45.1	50.7
Uasin-Gishu	70	41	57	60
Trans-Nzoia	78	49	58.5	55.6

Kajiado are low mortality areas with IMR of 51, 53 and 61 all per 1000 live births respectively. Regions such as Turkana, Elgeyo, West-Pokot and Baringo have IMR high than 100 per 1000. Hence, can be construed as high mortality regions.

3.10.0: MORTALITY ESTIMATION FOR EASTERN PROVINCE.

The probabilities of a child risking death before reaching the ages 2, 3 and 5 are given in Table 3.22.1. These range from as high as .142507 for Kitui to as low as .05991 for Marsabit (adjusted). For Kitui the difference between the two values are quite minimal. Nonetheless, for all values those adjusted for variation in mortality are relatively lower than the other set. Of course, these depends on the behaviour of the mortality schedules.

Table 3.22 : The unadjusted and adjusted values for districts in Eastern province.

Regions: Province/ Districts	q*(2)	q(2)	q*(3)	q(3)	q*(5)	q(5)
Eastern	0.095568	0.085099	0.101151	0.082173	0.123159	0.092984
Machakos	0.096744	0.085852	0.099487	0.079263	0.11762	0.089926
Marsabit	0.07061	0.052991	0.128649	0.097878	0.135601	0.094501
Meru	0.077896	0.064408	0.083608	0.058835	0.105468	0.071691
Embu	0.079729	0.069025	0.088192	0.06766	0.109346	0.080881
Isiolo	0.119108	0.093609	0.128783	0.084557	0.144209	0.085308
Kitui	0.145065	0.142507	0.146908	0.142343	0.168901	0.162747

The errors are tabulated below and again follows the same trend as already been discussed for other districts.

Table3.23.2: Relative errors of using unadjusted instead of adjusted probabilities in percentages for districts in Eastern prov

Regions: Province/ Districts.	q(2)	q(3)	q(5)
Eastern province	10.9	18.9	24.5
Machakos	11.3	20.3	23.5
Marsabit	24.9	23.9	30.31
Meru	17.3	29.6	32.1
Embu	13.4	23.3	26.1
Isiolo	21.4	34.3	40.8
Kitui	1.7	3.1	3.6

The case of Marsabit differs from all the rest in that the errors do increase with childhood age rather it decreased slightly at age 2 and then rises steeply at age 5. The probable reason is that those children who by 1979 were aged 5 years had experienced very fast changing mortality. For those aged 2 seemed to have experienced slightly the same risks as those aged 3 years, only that the pace seems to be faster in the 2nd or so years preceding the 1979 census.

Conditions of mortality seems not to be very favourable for the children born in Kitui, since the result shows that the mortality condition have not been changing impressively. IMR was 105 and e(0) was 47.3. The reason for this sad state of affair are not difficult to find. In the period 1978-1979 alone, malaria accouted for 43.7% of all deaths in Kitui plaguing infants, whereas 16.4% were due to acute respiratory diseases (Ewbank, 1986).

Table: 3.24.3: Estimates obtained by using adjusted values for districts in Eastern province.

Districts.	1q0	4q1	e(0)	e(5)
Eastern Province	61	30	59.03	61.8
Machakos	63	36	59.2	62.2
Marsabit	59	33	60.3	63.1
Meru	50	24	62	64.5
Embu	53	23	60.5	62.9
Isiolo	64	33	58.4	61.3
Kitui	105	74	47.3	51.8

Among these districts, Meru seems to have a more favourably mortality schedules, it has the lowest IMR(50) and a high e(0)- 62.

3.11.0 MORTALITY ESTIMATION FOR NORTH EASTERN PROVINCE

The province is situated on the North Eastern frontier of Kenya. Geographicaly it occupies a semi-arid area. The three districts comprising North Eastern (Garissa, Mandera and Wajir) has a very similar socio-cultural as well as socio-economic backgrouds. When analysis is made of these regions, one feature is common-that is, they seem to have very similar mortality characteristic. However, the adjusted values are better than the unadjusted, but the difference in them seems to be quite small. It is only for the whole province that the magnitude is high(see Table 3.25.1).

Table 3.25.1:The unadjusted and adjusted values for districts in North Eastern province

Regions:Province/ Districts	q*(2)	q(2)	q*(3)	q(3)	q*(5)	q(5)
N.E.Prov.	0.132054	0.118738	0.131187	0.105437	0.147317	0.111513
Wajir	0.127494	0.125465	0.1292	0.125147	0.147775	0.142072
Garissa	0.128959	0.123534	0.129109	0.119166	0.147552	0.13401
Mandera.	0.142185	0.140806	0.13906	0.136351	0.149524	0.145892

The closness of adjusted and unadjusted values generates relative errors which are low in magnitude (table 3.26). Seemingly the whole province did not experience a rapid mortality change. There is only slight variations in the values this shows that constant mortality assumption can do as well as the changing mortality assumption.

Table3.26.2:Relative errors of using unadjusted instead of adjusted probabilities in percentages for districts in N.Eastern

Districts.	q(2)	q(3)	q(5)
N.E.Prov.	10.1	19.6	24.3
Wajir	1.6	3.1	3.9
Garissa	4.2	7.7	9.2
Mandera.	0.9	1.9	2.4

Table: 3.27.3: Estimates obtained by using adjusted values for districts in North Eastern province.

Regions:Province/ Districts.	1q0	4q1	e(0)	e(5)
N.E.Prov.	81	52	54	57.8
Wajir	92	64	52.6	56.7
Garissa	88	59	53.3	57.5
Mandera.	98	69	51.15	55.7

The derived estimates are shown on table 3.27 , and portrays the mortality behaviour in these districts as very close. The lowest e(0) being 51.2 where as the highest is 53.3 years.

3.12.0: ESTIMATION OF MORTALITY FOR COAST PROVINCE.

The two techniques gives different values of q(x) for various ages as is indicated in table 3.28.1. As is expected the static assumption gives values that are biased positively. In some regions the difference is quite large as in the case of Taita-Taveta, and in others this so small (Kwale).

Table 3.28.1: The unadjusted and adjusted values for districts in Coast province.

Regions	q*(2)	q(2)	q*(3)	q(3)	q*(5)	q(5)
Coast	0.1191	0.0997	0.128783	0.095936	0.144209	0.105794
Kilifi	0.22344	0.221186	0.217492	0.213728	0.236481	0.231552
Mombasa	0.119108	0.11753	0.128783	0.12609	0.144209	0.140647
Taita	0.121775	0.102648	0.117218	0.082007	0.134992	0.086933
Kwale	0.167794	0.168149	0.184266	0.184869	0.207705	0.208508
Tana	0.200217	0.197338	0.175855	0.170915	0.186564	0.180016
Lamu	0.197345	0.216623	0.190139	0.222922	0.192179	0.235468

In Lamu and Kwale the adjusted values give higher values than the unadjusted ones. This stems from the fact that either mortality did increase or the quality of data in 1979

Table3.29.2: Relative errors of using unadjusted instead of adjusted probabilties in percentages for districts in Coast provinc

Regions	q(2)	q(3)	q(5)
Coast	15.1	24.5	28.4
Kilifi	1.01	1.7	2.1
Mombasa	1.32	2.09	2.5
Taita	15.7	30	35.6
Kwale	0.02	0.3	0.4
Tana	1.4	2.8	3.5
Lamu	9.8	17.2	22.5

were more accurate and reliable than 1969.Thus when the annual mortality rate was calculated, it was found to be positive.

From table 3.29.2 it can be concluded that the pace of mortality was fastest in Taita-Taveta. On the other hand

Table: 3.30.3: Estimates obtained by using adjusted values districts in Coast province.

Regions:Province/ Districts.	1q0	4q1	e(0)	e(5)
Coast	72	41	56.7	60
Kilifi	149	125	42.6	48.9
Mombasa	89	60	53	57.2
Taita	66	35	57.94	61.04
Kwale	128	101	45.7	51.4
Tana	126	99	46	51.6
Lamu	150	126	42	48.76

mortality decline was slowest in Kwale District. Hence, it is safe to assume that variation in mortality schedules in past was almost negligible.

The estimates obtained are listed above in Table 3.30.3 and indicates that Taita has the most favourable mortality schedules in the whole province, where as Lamu lags behind with a harsh mortality condition. Mombasa being the second largest town in the Republic would have been expected to show a favourable condition. Nevertherless, this kind of situation could be understood when one looks at the fact that it handles all cases of diseases from the province.

3.13.0 SUMMARY

In this chapter concerted efforts were aimed at estimating infant and childhood mortality under violation of stable population theory which stipulates that mortality schedules should remain static. Consequently an evaluation of Brass estimates using Coale-Trussell multipliers under conditions of declining mortality were investigated. This revealed an overestimation of current mortality . Errors increased as the rate of mortality declined. This was true for almost all districts.

Inherently implicit in this technique was the assumption of a linear decline in mortality as represented in the expression used in adjusting the q(x) values. In the next chapter, another technique (Palloni's) which yields the rate of mortality decline at census time, the level of mortality and of course the mortality estimates at census time under the assumption of a linear decline of mortality is attempted.

CHAPTER 4

4.00. ESTIMATING INFANT AND CHILDHOOD MORTALITY UNDER CONDITIONS OF CHANGING MORTALITY: PALLONI'S TECHNIQUE.

4.1.0 INTRODUCTION.

In this chapter attention is focused on a procedure developed by Palloni (1979), using indirect techniques of estimating infant and childhood mortality under changing mortality conditions, to investigate mortality patterns and trends. More specifically, investigation is made of mortality levels as at the time of census or survey, whichever is the case.

This technique was developed in response to the violation of two important basic assumptions used in Brass type of models: the static mortality and fertility in the population under investigation. In general, the survivorship statistic is inflated (deflated) by a multiplier which, in turn, is estimated from known values of statistics which describe the fertility pattern. In brief, this technique allows the estimation of multipliers independent of any knowledge of or assumptions about the fertility pattern. Instead, the conversion of the survivorship statistic into probabilities of dying depends on parameters describing the age structure of surviving children.

Although the assumption of constant mortality cannot be avoided in the formulation of the technique, it is altogether unrealistic in view of the remarkable mortality reductions that have been experienced in the developing world since world war II.

By introducing some reasonable modification, a simple technique is developed for estimating mortality in infancy and childhood when mortality in a population has been falling.

4.2.0 BASIC DEFINITIONS.

In defining "changing conditions of mortality", certain basic assumptions must be made. Assume that m morta-lity in a population can be adequately described by a mortality function contained in one of the 4 model pattern of Coale-Demeny system. Assume, further, that throughout the period of interest - usually 20-25 years - the model best describing mortality conditions remains the same in that group. Then "changing conditions of mortality" are understood to mean variation in the probability of dying before any fixed age x attributable only to shifts in mortality functions pertaining to the same model. Declining mortality in this chapter will be construeded to mean a continous reduction in the probability of dying before any age x as the time of census is approached. Thus the term "changing mortality" will be used in this chapter to be synonymous with "declining mortality".

4.2.1 COHORT VARIATIONS.

Naturally mortality reduction can be understood to imply the improvement in mortality conditions under which the infants and children are exposed. In other words an improvement in mortality conditions automatically means a gain in life expectancy. The survivorship probabilities to certain ages for members of various cohorts will be regarded as a non-intersecting network. Clearly the successive curves of survivorship functions will be ordered by their date of the cohort birth. Indeed cohorts born earlier have a unique function from the rest and thus each cohort will be represented uniquely.

4.30. REPRESENTATION OF MODELS TO STUDY MORTALITY DECLINE AND DERIVATION OF TECHNIQUE.

In order to formulate the function describing the probability that an individual born y years previously would have died before x^{th} birth day, we let y be the number of years elapsed since the birth of the cohort and the time of a census. The probability of dying in the interval $(x, x+\Delta x)$, y.x years before the census is given by:-

$$P_y(x)U_y(x) = k(y) \frac{d}{dx} q_s(x) \quad , \quad y > x \qquad (1)$$

Where, $P_y(x)$ denotes the probability of surviving upto age x for those birth cohorts born y years ago, $U_y(x)$ is the force of mortality at age x for those born y years ago, $q_s(x)$ is the probability of dying before age x in a standard mortality function and k(y) is a proportionality factor. By integrating equation (1) we have,

$$\int_0^x Py(x)Uy(x)dx = \int_0^x k(y) \frac{d}{dx} q_s(x)dx, \quad y > x$$

But the force of mortality - Uy(x) can be expressed as,

$$Uy(x) = \lim_{\Delta x \to 0} \left[\frac{ly(x) - ly(x+\Delta x)}{ly(x)\Delta x}\right] = - \frac{dvl_y(x)}{ly(x)dx} \qquad (2)$$

with slight modification of py(x) the expression (2) becomes

$$\int_0^x \frac{ly(x) * (-dvl_y(x))dx}{ly(0) * (ly(x))} = k(y) \int_0^x \left[\frac{d}{dx} qs(x)\right]dx$$

$$\int_0^x - \frac{dvl_y(x)}{ly(o)} dx = k(y) \left[q_s(x)\right]_o^x$$

Therefore,

$$\left[-Py(x)\right]_o^x = k(y)\left[q_s(x)\right]_o^x$$

By substitution we have

$$\Longrightarrow \quad Py(o) - Py(x) = k(y)[q_s(x) - q_s(o)]$$

But $Py(o) = 1$ and $q_s(o) = 0$

$$\Longrightarrow \quad 1 - Py(x) = k(y) q_s(x)$$

$$qy(x) = 1-py(x)$$
$$qy(x) = k(y)\ q_s(x) \qquad (3)$$

The expression in (3) shows that the probability of dying before age x for the cohort born y years before can be decomposed into two parts: One part expresses the effects of the level of mortality - K(y), which depends only on y - the number of years elapsed since the birth of the cohort; the other part expresses the effects of age pattern of mortality - $q_s(x)$, which of course depends on the age x. Naturally mortality can either be linear or quadratic, but we opt to consider the case of a linear decline. Under such constraint, k(y) which is a parameter representing the level of mortality can be expressed in a linear function

$$k(y) = k(o) + k(o).r.y$$

where k(o) is the level of mortality at the time of census, r is the rate of decline in k per unit of y. Expression (3) then has the form

$$qy(x) = ko(1 + ry)\ q_s(x);\ r > o \qquad (4)$$

The parameter ko and r represents levels of mortality at the time of the census and the rate of increase of this parameter as one moves away from the time of the census into the past.

By assigning a set of values to the parameters r and k the model defined above yields a range of mortality histories.

When these are combined with a set of fertility patterns it becomes possible to assess the amount of bias associated with current estimates calculated by using Brass type of technique. Palloni found out that in developing countries the proportionate errors vary from an average of 2.5% for women aged 15-19 to an average of 27% for those age group 35-39.

We have pointed out that cohort variation link each birth cohort to a unique mortality function or sequences of values $\{q(x)\}$ corresponding to a life table in the Coale-Demeny system. By selecting appropriate values for each birth cohort it is possible to form sequences $\{q_x(x)\}$ $x = [0,1 \cdot 30]$ of multi-cohort probabilities of dying for individuals born $x = 1, 2, \ldots,$ years before the census . Using equation (4) each value of x can be obtained. The proportion of children born to mothers aged-a- who have died can now be expressed as

$$D_a(ko,r) = \int_0^{a-ba} C_a(a-x)\ q_s(x)dx = \int_0^{a-ba} C_a(a-x)\ ko(1 + rx)\ q_s(x)dx \qquad (5)$$

Where $C_a(a-x)$ is the proportion of all children born x years earlier to mothers aged now,a,and,ba,is the earliest age at which childbearing was possible for those mothers. The above expression can be satisfied by different values of ko and r, one such set of values is when ko = ke and r = o, meaning the mortality has remained constant and easily we obtain

$$D_a(ko,r) = \int_{o}^{a-ba} C_a(a-x)\ q(x)dx. \qquad (6)$$

Comparing (5) and (6) and of course bearing in mind that $r > o$, it becomes evident why the assumption of constant mortality leads to upward biases when there has been a decline: Setting $r = o$ requires an upward adjustment in other parameters to maintain the equality. Those magnitudes will depend on $C_a(a-x)$, increasing with an increase in $C_a(a-x)$. Consequently, the upward baises in the estimates of mortality are large for populations with an early pattern of childbearing and for older women. The consistent mortality function for the cohort born at the time of the census while at the same time being appropriate for a cohort born say A_D years earlier. Similarly, the sequence of probability of dying $\{q_E(x)\}$ is the same as that characterizing the mortality experience for the cohort born A_D years earlier. If such a value A_D exists then

$$\int_{o}^{a-ba} C_a(a-x)\ ko(1 + rx)\ q_s(x)dx = \int_{o}^{a-ba} C_a(a-x)\ ko(1 + rA_D)\ q_s(x)dx \qquad (7)$$

Expansion of both sides we obtain

$$\int_0^{a-ba} C_a(a-x)\, q_s(x)dx + \int_0^{a-ba} C_a(a-x)\, rx.\, q_s(x)dx$$

$$= \int_0^{a-ba} C_a(a-x)\, q_s(x)dx + \int_0^{a-ba} C_a(a-x)\, rA_D\, q_s(x)dx$$

common terms on both sides cancels out and we have

$$\int_0^{a-ba} C_a(a-x)\, rA_D\, q_s(x)dx = \int_0^{a-ba} C_a(a-x)\, rx\, q_s(x)dx$$

note also that ko and r cancels out since they are independent of age x. Rearranging we have

Therefore,

$$A_D = \frac{\int_0^{a-ba} C_a(a-x)\, x\, q_s(x)dx}{\int_0^{a-ba} C_a(a-x)\, q_s(x)dx}$$

$$\text{Thus, } A_D = \frac{\int_0^{a-ba} xC_a(a-x)\, q_s(x)dx}{\int_0^{a-ba} C_a(a-x)\, q_s(x)dx} \qquad (7)$$

The expression (7) can be considered as a probability density function. This expression can also be interpreted as the mean age since birth for those individuals who have died before census, if they had been exposed to the standard mortality function and their births been distributed according to C_a (a-x). A_D also denotes the number of years elapsed since the birth of cohort. A notable property of A_D is that it is independent of the parameters of mortality decline - ko and r. It is only a function of the fertility pattern. This value of C_a (y) and and the standard mortality pattern. This value of A_D will increase, the greater the weights given to large values of x. This is consistent with the contention that the upward biases in Brass's types of estimates will be higher the earlier the onset of childbearing age. Similarly the A_D will increase with the age of the mother. Finally, A_D possesses the additional property that it corresponds to the age of intersection between the consistent mortality function and a multi-cohort mortality function, {q_s (x)} x = o, 30. Clearly, knowledge of A_D is indespensible to determine the parameters of the mortality trend and, as a consequence, to adjust the estimates obtained on the assumption of constant mortality. The next section concentrates on a method of estimating the indespensible value of A_D. Infact various techniques are available , but we shall concentrate on only one.

4.40. TECHNIQUE OF ESTIMATING THE VALUE OF AD.

4.41. USE OF THE FERTILITY FUNCTION OF ITS INDICES.

If we have our data on children arranged by single age of their mothers, the whole distribution $C_a(y)$ can be calculated, provided one resorts to the assumption of unchanged fertility. If the model of mortality pattern were known even suspected, A_D could be determined for each age group of mothers. A cohort procedure is resorted to if some relationship can be adduced between A_D and some selected parameters of the fertility function. The conditions are that those parameters should be easily obtainable from information on children ever born and that the assumption of unchanged fertility holds true. Thus Palloni concluded that the expression below would adequately relate A_D and the suspected fertility function.

$$A_D = a + b1(P1/P2) + b2\,(P2/P3) + b3\,\log e(P1/P2) + b4\,\log e(P2/P3) \qquad (8)$$

Where P1, P2, and P3 are the average parities of women in the age groups 15-19, 20-24, and 25-29. The values of a ; b1, b2, b3, and b4 are obtained from Table 4.1 1, and are selected depending on age group. These parities presented above only approximate the fertility pattern and performs better for early ages and deteriorates with older ages.

4.5.0. OPTIMUM STRATEGIES OF PARAMETER ESTIMATION.

Before the final estimates are arrived at, selection of a mortality model is made, of course, if this is misidentified, this will lead to errors. Once this decision is made, application of Brass-type technique is made resulting in a sequence of probabilities of dying before predetermined ages. Using Trussell's regression equations estimates of dying before ages 1, 2, 3, 5, 10, 15 and 20 were generated.

Table 4...1.
Regression equation of the form: AD = a+ b1(P1) + b2(P2) + b3LNP(1) +b4LN(P(2)) For North model, for linear decline.

Age Group	a	b1	b2	b3	b4	Standard Erro	Relative Error**
15-19	4.105	4.691	-4.041	0.3131	0.815	0.973	0.0476
20-24	3.372	5.511	0.435	0.215	0.322	0.999	0.0071
25-29	3.075	4.747	4.339	-0.153	0.560	0.999	0.0055
30-34	3.441	3.139	9.1610	-0.811	1.498	0.989	0.1196
35-39	4.571	1.337	13.552	-1.640	2.872	0.945	0.3611
40-44	6.899	-0.104	16.736	-2.439	4.379	0.889	0.6446
45-49	10.972	-0.0573	17.767	-2.439	5.446	0.857	0.8006

* All coefficient except those starred are signigicant at P < 0.01
** The ratio of the standard error to the average value of A
Source: Palloni, A. Population Studies Vol.35.No.1, Page 104.

4.5.1 RECOVERING THE PARAMETERS OF THE MORTALITY DECLINE FROM ESTIMATES AD.

This section deals with strategies of estimating r and parameters describing the true mortality function. The strategy used here is one that assumes the existence of mortality decline.

If it is reasonably certain that mortality has declined and if the underlying model mortality pattern is known or suspected. One way of arriving at estimates, r, and, l_0, the level of mortality at the time of census requires the estimation of A_D and $q(x)$ - the consistent mortality function, for any two age groups of women. The consistent mortality function, however, needs to be estimated with a full knowledge of the underlying mortality pattern. Thus, information will be available on the level of mortality prevailing at two points in time, A_1 and A_2, corresponding to the first and second age group. Since by assumption, the mortality has declined linearly, we can generate two - equation with two unknowns.

$$\hat{l}_1 = l_0(1+rA_1)$$

$$\hat{l}_2 = l_0(1+rA_2) \qquad (9)$$

Where $\hat{l}_1$ and $\hat{l}_2$ respectively represent the levels of mortality of the consistent mortality functions for the first and second age group of women. An estimate $\hat{r}$ of r can easily be obtainable.

$$\hat{r} = \frac{\hat{l}_1 - \hat{l}_2}{\hat{l}_2 A_1 - \hat{l}_1 A_2} \qquad (10)$$

A solution for $\hat{l}_0$, the estimated level of mortality at the time of the census, can be obtained by substituting $\hat{r}$ of r in any of the equations (9).

Alternatively the level at census time can be estimated by fitting the best line passing through the ordered pairs (A_D, l_i) for all the age groups.

The advantage of using this alternative method is that when the level does not show a uniform pattern which can enable one to estimate l(o) then we resort to it by drawing the best line connecting the majority of the levels. Another advantage is that it uses majority of the information available, rather than selectively disregarding parts of it.

It is not an easy task to say which one apply where, rather, when the level does not conform to a uniform pattern and more so when the much needed l(1) and l(2) does not show a mortality decline, all the levels are used to predict the level at census time. However, r, can estimated by any of the expressions in (9).

4.60. SUMMARY OF THE PROCEDURE.

Step 1. Using data distributed by age of the mother, the number of births and deaths arranged by age groups, calculation is made of q(x) values.

Step 2. The mortality levels l_1 and l_2 are estimated from Coale-Demeny life table system.

Step 3. Using parities - P1, P2 and P3 the value of AD is obtained using equation (8), based on North pattern of mortality.

Step 4. Substituting $\hat{l}_1$, $\hat{l}_2$ and A_1, and A_2, in expression (10), the value of $\hat{r}$ of r is estimated.

Step 5. Substituting $\hat{r}$ in equation (9), the needed level of mortality at census time - $\hat{lo}$ is obtained. Hence life table is generated.

OR Judging from the level, make a straght best line of the ordered pairs and estimate the mortality level at census time.

4.70. CONCLUSION.

Application of the new technique would yield estimates of infant and childhood mortality. It will also permit the estimation of the much needed pace of mortality decline in the districts that will be considered. The level of mortality as at the time of census is a vital parameter in as at the time of census is a vital parameter in construction of the life table.

The estimation of A_D - the mean number of year s elapsed since the birth of a cohort shows clearly when the q(x) values refers as they refer to past mortality schedules.

4.8.0: APPLICATION OF THE MODEL TO THE WHOLE COUNTRY.

Using the Kenya population census data of 1979 distributed by age group of the mothers, the birth and children dead , calculation is made of the values of D(i)'s- the proportions of children dead in the ith age group. The P(i)'s -the average parity by age group is also calculated. These values together with the use of table (4.5.1) are used together with equation (8) in calculating A_D - the number of years elapsed since the birth of the cohort (see table 4.2.)

Table 4.2. Calculation of AD values.

Age Group	Female Pop.	Children Everborn	Children Dead	Parity P(i)	A_D
15-19	887722	284585	33051	0.320578	1.762298
20-24	686003	1272061	158674	1.854308	3.50829
25-29	541261	1976744	278829	3.652108	5.987717
30-34	412691	2223613	368762	5.388082	9.043136
35-39	325367	2105212	388507	6.470268	12.61479
40-45	273702	1921808	417855	7.021534	16.69122
45-49	221965	1592275	403093	7.173540	21.31534

Having calculated the D(i), and using coale-Trusell multipliers the q(x) values and the mortality level to which they correspond are interpolated from Coale- Demeny model life tables, specifically using North pattern which is appropriate for Kenyan mortality pattern. If these levels shows a consistent mortality decline, which they normally do not, all the level are taken and plotted the best fit is used to locate l_1 and l_2. These are used together with A_1 and A_2 in expression (10). This generates r^ - the rate of mortality decline, this was estimated as .03577. This can be interpreted to mean that at the time of census the mortality was decling at about 3.6%. This then was used in expression (9) to locate the mortality level at census time and was estimated as 16.0093. The survival probabilities p(x) values are obtained betweeen level 16 and level 17.

Other life table funtions were obtained in the normal fashion (see chapter 2 section 2.3). Using these processes the life table in the next page was generated (see table 4.8.2)

Table 4.3

LIFE TABLE FOR KENYA PALLONI'S SIMULATION

GROUP	nPx	nQx	l(x)	nDx	nLx	Tx	ex
0-1	0.917951	0.082048	100000	8204.86	94502.74	5478304.	54.78304
1-4	0.947118	0.052881	91795.14	4854.3	354326.3	5383801.	58.65018
5-9	0.976374	0.023625	86940.84	2053.99	429569.2	5029475.	57.84939
10-14	0.986338	0.013661	84886.85	1159.66	421535.1	4599905.	54.18867
15-19	0.982970	0.017029	83727.19	1425.83	415071.3	4178370.	49.90458
20-24	0.977161	0.022838	82301.36	1879.68	406807.6	3763299.	45.72584
25-29	0.975085	0.024914	80421.68	2003.64	397099.3	3356491.	41.73615
30-34	0.972575	0.027424	78418.04	2150.58	386713.7	2959392.	37.73867
35-39	0.968734	0.031265	76267.46	2384.56	375375.9	2572678.	33.73232
40-44	0.962566	0.037433	73882.9	2765.7	362500.2	2197302.	29.74034
45-49	0.955468	0.044531	71117.2	3166.97	347668.5	1834802.	25.79970
50-54	0.940685	0.059314	67950.23	4030.41	329675.1	1487134.	21.88563
55-59	0.921751	0.078248	63919.82	5001.64	307095	1157458.	18.10798
60-64	0.885663	0.114336	58918.18	6736.52	277749.6	850363.9	14.43296
65-69	0.829770	0.170229	52181.66	8882.84	238701.2	572614.3	10.97347
70-74	0.743710	0.256289	43298.82	11097.05	188751.4	333913.1	7.711830
75+	0	1	32201.77	32201.77	145161.7	145161.7	4.507879

4.9.0 : RESULTS AND DISCUSSIONS.

The model we have outlined enables us to estimate with consistency the year to which the infant and childhood risks refer. This is generated by simple manipulation of A_D values in conjunction with the census year.

Table 4.4.1 gives the q(x) values and the mean year they refer to. Each of the q(x) can be considered as estimates of the birth cohort in those age groups who on the average were born A_D years precceding the census. And thus if one is insterested in locating the time in history when these births occured one only needs to substract the values of A_D from the time of census, these generates a series of years which are understood to be the years that the mortality risks refer to.

Table 4.4[illegible]: The probabilities of dying in those indicated ages, and the mean years to which those probabilities refer.

index x	q(x)	A_D	Mean year to which the cohort was born
1	0.136177	1.76	1977.91
2	0.129331	3.5	1976.17
3	0.13515	5.98	1973.69
5	0.162649	9.04	1970.63
10	0.191397	12.61	1967.06
15	0.222323	16.69	1962.98
20	0.254524	21.31	1958.36

Alternatively, as we have pointed out earlier, the A_D values can be construed to show the mean age since birth for those individuals who have died before census. This means that for the whole country those birth cohorts born of women in the age group (15-19), on average died by age 1.76, and those born of women in age group (20-24) died at age 3.5.

Using the foregoing procedure, the infant mortality rate for the whole country was estimated at 82 deaths per 1000 live births. The life expectancy at birth was estimated at 55 (see first entry in table 4.6[illegible]).

4.10.0: RESULTS AND DISCUSSIONS FOR OTHER REGIONS.

In table 4.5[illegible], we present the q(x) estimates and their associated parameter-A_D. The sequences of q(x) are uniquely defined as portrayed in the table, this is true for all birth cohorts of what ever age group and also for all regions. These sequences characterises the mortality conditions experienced by the birth cohorts born A_D years earlier. The value of A_D, which depends only on the variable x, increases strictly monotonically. This parameter although is independent

Table. 4.5 : The values of q(x) and the time in years in the past, precceding the census in which they refer (bracketed).

Regions	q(1)	q(2)	q(3)	q(5)	q(10)	q(15)	q(20)
Kenya	0.136177 (1.76)	0.12933 (3.5)	0.13515 (5.98)	0.162649 (9.04)	0.191397 (12.61)	0.222323 (16.69)	0.254524 (21.31)
Nairobi	0.087397 (1.58)	0.088478 (3.2)	0.087994 (5.56)	0.099685 (8.55)	0.123975 (12.08)	0.153755 (16.15)	0.169395 (20.77)
Central-Province	0.068991 (1.47)	0.064686 (3.06)	0.072666 (5.43)	0.092706 (8.47)	0.116879 (12.09)	0.145846 (16.22)	0.176508 (20.89)
Nyandarua	0.06871 (1.44)	0.066838 (3.2)	0.068676 (5.52)	0.082686 (8.67)	0.10231 (12.34)	0.1343 (16.7)	0.16231 (21.0)
Kiambu	0.076498 (1.58)	0.069187 (3.2)	0.070702 (5.56)	0.086485 (8.55)	0.109033 (12.08)	0.13195 (16.15)	0.159953 (20.77)
Murang'a	0.07998 (1.55)	0.066964 (3.15)	0.076842 (5.52)	0.098969 (8.52)	0.129322 (12.07)	0.160695 (16.16)	0.190705 (20.79)
Kirinyaga	0.076299 (1.54)	0.079861 (3.13)	0.101313 (5.47)	0.130487 (8.47)	0.159801 (11.98)	0.196222 (16.05)	0.232708 (20.67)
Nyeri	0.051319 (1.47)	0.047555 (3.04)	0.052857 (5.42)	0.067517 (8.43)	0.072417 (12.12)	0.089562 (16.31)	0.090193 (20.79)
Western Province	0.141162 (1.68)	0.145059 (3.39)	0.160153 (5.87)	0.190695 (8.9)	0.227022 (12.5)	0.257331 (16.6)	0.292895 (21.3)
Bungoma	0.1343 (1.77)	0.140712 (3.63)	0.150233 (6.28)	0.170455 (9.52)	0.200454 (13.2)	0.231214 (17.5)	0.26272 (22.2)
Kakamega	0.150718 (1.68)	0.143253 (3.39)	0.156784 (5.87)	0.182084 (8.9)	0.219601 (12.5)	0.24465 (16.6)	0.281806 (21.3)
Busia	0.19705 (1.67)	0.200513 (3.43)	0.213996 (6.38)	0.263643 (9.72)	0.306974 (13.4)	0.346537 (17.6)	0.37998 (21.9)
Nyanza Province	0.143139 (1.68)	0.163007 (3.39)	0.18669 (5.85)	0.229714 (8.95)	0.267229 (12.53)	0.301621 (16.67)	0.33769 (21.32)
Kisii	0.143139 (1.68)	0.163007 (3.39)	0.18669 (5.85)	0.229714 (8.95)	0.267229 (12.53)	0.301621 (16.67)	0.33769 (21.32)
Kisumu	0.163024 (1.82)	0.182999 (3.78)	0.209221 (6.55)	0.253516 (9.89)	0.29869 (13.74)	0.338364 (18.04)	0.374732 (22.7)
Siaya	0.201635 (1.77)	0.214713 (3.63)	0.22853 (6.28)	0.274375 (9.52)	0.320434 (13.2)	0.34725 (17.5)	0.382103 (22.2)
South Nyanza	0.228126 (1.98)	0.223945 (3.84)	0.238143 (6.39)	0.276387 (9.46)	0.311741 (13.00)	0.343903 (17.03)	0.37526 (21.63)
Coast province	0.123849 (1.68)	0.114368 (3.39)	0.143199 (5.87)	0.14522 (8.95)	0.174778 (12.56)	0.195397 (16.67)	0.207345 (21.32)
Kilifi	0.228541 (1.8)	0.218345 (3.75)	0.21664 (6.34)	0.256321 (9.72)	0.283943 (13.56)	0.313221 (18.1)	0.326138 (22.34)
Kwale	0.159618 (1.82)	0.17597 (3.78)	0.192556 (6.55)	0.222855 (9.89)	0.253694 (13.74)	0.285434 (18.04)	0.299095 (22.47)
Lamu	0.191872 (1.78)	0.202819 (3.7)	0.177458 (6.6)	0.206899 (9.8)	0.238471 (13.76)	0.253661 (18.4)	0.256267 (22.7)
Mombasa	0.123849 (1.68)	0.114368 (3.39)	0.143199 (5.89)	0.14522 (8.85)	0.174778 (12.5)	0.195397 (16.67)	0.207345 (21.32)
Taita-Taveta	0.131515 (1.68)	0.112035 (3.24)	0.122440 (6.04)	0.147583 (10.04)	0.180331 (14.95)	0.221875 (17.3)	0.26042 (21.9)
Tana-River	0.218302 (1.82)	0.182133 (3.78)	0.169577 (6.55)	0.203552 (9.89)	0.229819 (13.7)	0.252614 (18.04)	0.282392 (22.77)

Table (4.5 .) continues.

Regions	q(1)	q(2)	q(3)	q(5)	q(10)	q(15)	q(20)
Eastern province	0.095939	0.095197	0.107105	0.139214	0.166533	0.192004	0.212445
	(1.68)	(3.39)	(5.87)	(8.95)	(12.5)	(16.6)	(21.3)
Embu	0.078067	0.081392	0.094992	0.1237	0.153569	0.182681	0.205577
	(1.67)	(3.49)	(5.67)	(8.85)	(12.75)	(16.7)	(21.42)
Meru	0.079253	0.07654	0.090675	0.12026	0.145449	0.169419	0.192841
	(1.49)	(3.12)	(5.55)	(8.64)	(12.3)	(16.5)	(21.2)
Isiolo	0.123849	0.114368	0.143199	0.14522	0.174778	0.195397	0.207345
	(1.68)	(3.39)	(5.87)	(8.87)	(12.56)	(16.67)	(21.32)
Kitui	0.148919	0.141212	0.152605	0.185797	0.218076	0.251045	0.277111
	(1.52)	(3.43)	(5.58)	(9.87)	(13.42)	(17.4)	(22.8)
Machakos	0.097688	0.0958	0.103174	0.13066	0.160076	0.181483	0.202234
	(1.49)	(3.12)	(5.55)	(8.64)	(12.3)	(16.4)	(21.8)
Marsabit	0.119383	0.129368	0.12929	0.143274	0.169713	0.183211	0.197826
	(1.48)	(3.27)	(5.95)	(9.34)	(13.2)	(17.7)	(22.5)
N.Eastern	0.13308	0.131028	0.131346	0.163288	0.177013	0.205768	0.208624
	(1.52)	(3.87)	(6.01)	(9.72)	(13.92)	(17.2)	(22.4)
Garissa	0.129906	0.128012	0.130202	0.164902	0.176897	0.213473	0.207913
	(1.43)	(3.06)	(5.41)	(8.45)	(12.7)	(18.1)	(20.6)
Mandera	0.142005	0.142365	0.135755	0.163293	0.169595	0.196921	0.212828
	(1.49)	(3.07)	(5.42)	(5.42)	(8.44)	(12.05)	(20.8)
Wajir	0.128068	0.126918	0.131482	0.164068	0.18476	0.207462	0.208195
	(1.44)	(3.00)	(5.35)	(8.37)	(11.9)	(16.11)	(20.78)
R.Valley	0.093012	0.110139	0.112889	0.136081	0.161192	0.184425	0.20586
	(2.3)	(4.14)	(6.51)	(9.26)	(12.4)	(16.2)	(20.6)
Nakuru	0.100682	0.097925	0.106512	0.126918	0.151411	0.178932	0.206986
	(1.75)	(3.5)	(5.99)	(9.06)	(12.65)	(16.74)	(21.37)
Kajiado	0.073397	0.090071	0.083854	0.0946	0.11632	0.137425	0.140792
	(2.3)	(4.14)	(6.5)	(9.29)	(12.45)	(16.17)	(20.61)
Uasin-Gishu	0.087528	0.092366	0.1016	0.123099	0.155367	0.173227	0.19367
	(1.7)	(3.5)	(6.09)	(9.29)	(13.01)	(17.22)	(21.91)
Trans-Nzoia	0.106793	0.115347	0.123357	0.144144	0.174346	0.20171	0.198549
	(1.7)	(3.54)	(6.18)	(9.44)	(13.23)	(17.48)	(22.2)
Samburu	0.07801	0.076636	0.08606	0.099417	0.112716	0.13193	0.143806
	(1.69)	(3.42)	(5.91)	(9.01)	(12.6)	(16.74)	(21.42)
Laikipia	0.079431	0.077563	0.086446	0.100325	0.128345	0.146928	0.185357
	(1.71)	(3.47)	(5.98)	(9.09)	(12.72)	(16.86)	(21.51)
Kericho	.091101	0.093068	0.101864	0.11995	0.13866	0.160211	0.175139
	(1.85)	(3.65)	(6.17)	(9.23)	(12.8)	(16.87)	(21.48)
Narok	0.093456	0.100116	0.108557	0.131101	0.154745	0.168019	0.186693
	(2.10)	(4.02)	(6.59)	(9.64)	(13.14)	(17.14)	(21.72)
Nandi	0.110978	0.112158	0.117023	0.141189	0.165581	0.197123	0.216133
	(1.76)	(3.63)	(6.3)	(9.57)	(13.35)	(17.61)	(22.31)
Turkana	0.141576	0.133649	0.140649	0.177823	0.199081	0.214822	0.226581
	(1.69)	(3.48)	(6.05)	(9.23)	(12.94)	(17.14)	(21.82)
West-Pokot	0.208063	0.192135	0.208116	0.241093	0.279566	0.310195	0.336963
	(1.79)	(3.64)	(6.26)	(9.45)	(13.15)	(17.33)	(22.0)
Baringo	0.18514	0.171935	0.168209	0.197718	0.218365	0.24926	0.268736
	(1.57)	(3.46)	(5.96)	(8.43)	(12.22)	(18.23)	(21.9)
Elgeyo-Marakwet	0.13179	0.125588	0.132699	0.153498	0.183896	0.197469	0.142644
	(1.4)	(3.2)	(5.86)	(9.19)	(13.10)	(17.47)	(22.28)

of mortality decline and its proportionality of decline which is an essential parameter for estimation of the mortality decline .These mortality risks as portrayed by q(x) refer to morbidity structures which operated in the past, A_D years precceding census, hence are only representational of those past mortality structures. Thus when we talk of q(2) for Busia as 0.20053, strictly speaking, this mortality structure was on the average experienced about 3.63 years precceding the census. All other values should be understood in that sense.

We have aslo construed A_D to imply the mean age since birth for those individuals who have died before census. The table gives variation in this parameter, some values are higher while others are relatively lower. When the first age group is considered, Narok , Kajiado , and Rift Valley province shows higher values. Other districts with high values are: Siaya (1.77) South-Nyanza (1.98); Kwale (1.82). e.t.c.

In this respect, when the first age group is considered, the oldest child may be about 4 years while the youngest may be some few months. If deaths were to be distributed according to a particular mortality shedule on each of the regions considered, the value of A_1 would be the same, but this being not the case, the deaths are thus distributed uniquely depending on different schedules.Thus Value of A_D shows to which side, the deaths are concentrated. Those area with low values indicates that deaths are concentrated in early years of their lives. It can then be deduced that those may on a larger extent be attributed to endogenous factors as opposed to exogenous variables.

Table 4.6 : Estimates of mortality levels at the time of census and the rate of mortality decline at the time of census.

Regions	IMR	4q1	e(0)	e(5)	lo^	ro^
Kenya	82	52	55.1	58.65	16.14	-0.035
Nairobi	55	30	61.3	63.5	18.7	-0.042
Central *	45	21	63.8	65.8	19.9	-0.032
Nyandarua	46	22	63.5	65.5	19.7	-0.019
Kiambu	44	20	64.2	66.1	19.9	-0.031
Murang'a	43	20	64.4	66.3	20.0	-0.033
Kirinyaga	51	24	61.7	64.0	18.9	-0.033
Nyeri	36	14	66.2	67.6	20.9	-0.020
Western *	98	69	51.2	55.7	14.4	-0.021
Bungoma	90	60	53.0	57.3	15.3	-0.024
Kakamega	96	66	51.6	56.0	14.6	-0.028
Busia	122	96	46.2	57.5	12.3	-0.039
Nyanza *	104	75	50.0	54.8	13.8	-0.041
Kisii	58	36	59.7	62	17.7	-.027
Kisumu	122	95	46.6	52.1	12.4	-0.012
Siaya	142	114	42.4	48.4	10.8	-0.045
S.Nyanza	138	111	43.1	49.0	11.1	-0.048
Coast *	93	64	52.2	56.5	14.8	-0.020
Kilifi	143	118	43.5	49.6	10.7	-0.047
Kwale	129	102	45.6	51.3	11.8	-0.025
Lamu	129	103	45.5	51.2	11.8	-0.020
Mombasa	84	54	54.0	58.0	15.6	-0.015
T.Taveta	74	43	56.3	59.7	16.6	-0.023
TanaRiver	120	93	46.9	52.3	12.5	-0.024
Eastern *	56	26	59.9	62.5	18.3	-0.019
Embu	56	25	60.1	62.6	18.3	-0.025
Meru	49	24	62.4	64.6	19.2	-0.011
Isiolo	53	23	60.6	63.0	18.5	-0.032
Kitui	94	63	50.4	54.6	14.6	-0.050
Machakos	54	24	60.3	62.0	18.3	-0.017
Marsabit	64	37	58.8	61.4	17.8	-0.049
N.Eastern*	71	44	56.7	60.2	17.0	-0.054
Garissa	85	56	54.1	58.1	15.7	-0.035
Mandera	95	66	51.8	56.3	14.7	-0.034
Wajir	83	54	54.4	58.3	15.8	-0.037
R.Valley*	71	32	57.3	60.6	17.1	-0.009
Nakuru	53	23	61.6	64.1	18.9	-0.028
Laikipia	43	29	63.1	64.9	19.9	-0.038
Kericho	61	35	59.5	62.4	18.0	-0.030
Kajiado	60	26	60.0	62.8	18.2	-0.029
Uasin	64	37	59.0	62.1	17.7	-0.025
T.Nzoia	73	45	56.7	60.2	16.9	-0.035
Samburu	45	21	63.5	65.9	19.8	-0.026
Narok	61	34	59.6	62.5	18.1	-0.028
Nandi	82	59	54.7	58.6	15.9	-0.022
Turkana	103	74	52.3	57.3	14.0	-0.0014
W.Pokot	142	114	42.7	48.7	10.8	-0.019
Baringo	118	92	47.1	52.3	12.7	-0.035
Elgeyo	94	65	52	56.4	14.8	-0.038

* Indicates provinces.

We present in table 4.60 ., the estimates of infant and childhood mortality together with their associated life expectancies. Also included in the table are, the rate of mortality decline and the level of mortality at census time.

The rate of mortality decline are in the aforesaid table, their magnitude vary considerably ranging from as low as 0.00952 in Rift valley province to as high as 0.05488 in North Eastern province. These values depends very much on the estimated levels $\hat{l}_1$ and $\hat{l}_2$. The errors arising from the estimated mortality decline are believed to result from cummulation of errors from the assumption of linear decline as well from errors from the estimated levels $\hat{l}_1$ and $\hat{l}_2$. The closer the two levels the smaller in magnitude is the error.Conversely if they are far apart,then rates are higher comparativel

4.11.0 : SUMMARY

Application of this technique (Palloni's) yielded estimates for infant and childhood for several districts and provinces. It did also permit the estimation of pace of mortality decline in variuos regions. These estimates are consistent with other estimates already calculated in chapter3. Several disricts had life expectancies well over 60 years, all disricts in central province and some in Eastern Province Embu, Meru, Isiolo and Machakos were in this category. Others were Nakuru, Laikipia, Samburu, and Kajiado in Rift valley.

For these regions studied it is possible to study the absolute as well as the percentage errors resulting from using the static assumption instead of declining assumption.

CHAPTER 5

5.0 SUMMARY AND CONCLUSION

5.1.0 INTRODUCTION.

This work has been devoted to an anyalysis of alternative techniques of estimating infant and childhood mortality when mortality conditions are changing. Specifically we concentrated on the contention that mortality conditions are known or are suspected to have been declining in the recent past, in which case it was further assumed that the mortality declined linearly over different cohorts.

This being the major objective of our study, three different techniques simulated for estimation of infant and childhood mortality were studied. They were, Hypothetical cohort- Additive synthetic, "Kraly -Norris" procedure and Palloni's technique.

The synthetic technique- an indirect method used in demographic estimation when trends in fertility and mortality are suspected was essentially designed to minimize the effect these trends. Hence, was used in this study to eliminate those trends in the intercensal period.

Kraly-Norris" procedure uses regression coefficents obtained from data simulated for declining conditions of mortality. These were used in adjusting q(x) values obtained under static assumption of mortality, thus generating new estimates of q(x) which were then used in mortality estimation.

Palloni's technique depends majorly on violation of constant assumption of mortality. Hence the technique is suited for a linear decline of mortality over cohorts. This provides rate of decline at census time and thus is used in locating the level of mortality as at census time.

5.1.1. SUMMARY OF HYPOTHETICAL COHORT: ADDITIVE SYNTHETIC.

This technique was developed and applied to mortality studies by Zlotnik and Hill (1981) (Chapter 2). The technique made possible use of two censuses separated by 10 years apart in studying mortality situation in the country under changing conditions of mortality. The availability of second census made it possible to trace the survivors of the first census. The two data sets were chained together to simulate the effect of intercensal vital rates on a hypthetical cohort of respondents exposed indefinately to such vital rates, and a standard procedure of analysis was then applied to the constructed third data set to estimate intercensal rates.

5.1.2. APPRAISAL OF HYPOTHETICAL COHORT ADDITIVE SYNTHETIVE.

In using this method, the assumptions that age misreporting, migration, and differential mortality in the age group were of minimal significance was inevitable. If a significant number of respondents mis-reported their ages as well as those of their offsprings, then the chaining process will result in inaccurate rates, as that does not reflect the correct birth cohort. This will also be the case in places where migration has occured, the change in mortality values should only be an indication of the impact of mortality on the population under study. Migration as we know it has been going on since independent, major affected areas are South-Nyanza, Trans-Nzoia, Elgeyo Marakwet and Rift-Valley. This makes the results obtained by using this method to treated with a lot of caution.

The intercensal method of estimation described and used in this work assumes constant fertility, that is why for the third data set, the parities for the 1st and second age groups were assumed to be equal to those of second census. Indeed in Kenya fertility levels have been risen between 1969 and 1979. In such a circumstance the infant and childhood mortality will be underestimated, since that parities will be higher than those used leading to values that indicates that a small proportion of children died in the intercensal period. These parities ratios used as independent variables in estimating the multipliers, may not reflect adequately the true experience of the population.

The data set referring to a hypothetical cohort is constructed by cumulating the successive differences between the observed data in the two census. This makes the procedure very sensitive to change in the type and magnitude of errors present in the observed data set. If there exists any error in equal magnitude in both two data sets, then the same magnitude will occur in synthetic data set; exaggeration error in synthetic data set will occur if there is variation in the error. This is what makes the assumption of comparative quality of data a necessary condition. However, this sensitivity should not be regardly entirely as a vice, since their sensitivity to errors makes the technique well equiped in detecting it.

It may be concluded that, the hypothetical cohort approach seems to have work well in estimating the rates in the period 1969 - 1979, the levels were higher for the hypothetical meaning lower mortality than those of 1969. It should be noted that in cases where an underlying mortality trend is not the only factor distorting the results, the approach may yield worse result due to the violation of those assumption already mentioned.

5.1.3. SUMMARY AND APPRAISAL OF "KRALY-NORRIS" MODEL.

In this technique (Chapter 3) we analysed the errors contributed to the estimates when the statictic conditions of mortality has been violated. The Brass method of estimating childhood mortality, we noted earlier, has its goal in estimating mortality values associated with the life table prevailing at the time of census. The value of q(x) refer to cohort mortality - the probability of dying before age x, for a person born x years before the census. As result the D(i) refers to average of past cohort mortality experience. Clearly if mortality has been constant, themm all cohorts will have experienced the same current mortality. If however, mortality has been declining, the D(i) values would refer to averages of changing cohort conditons. Thus making the resulting estimates also averages of past mortality experience and are thus upwardly biased if interpreted as estimates of mortality at the time of the survey.

Thus the correction technique used, required the knowledge of mortality decline measured by d q(x)/dt or d e(0)/dt, we opted for the latter. The knowledge of fertility schedule as measured by P(2)/P(3) was also a necessary ingredient in the technique. In cases where mortality was suspected to be declining, the appropriate regression equation was fitted to adjust for the decling conditions of mortality.

Clearly the biggest drawback of this correction technique is the requirement that mortality has declined and thus this rate be calculated. The efficiency of this technique depends on this rate. The rate depends on data collected two points in history. In our case we used 1969 and 1979 to generate this rate. Thus errors emanating from those two estimates will obviously affect the end results.

Nonetheless, the estimates were quite different as compared with those obtained under constant assumption of mortality. Indeed they showed higher values for life expectancies and low values for infant and childhood mortality rates for all regions.

5.1.4. PALLONI'S TECHNIQUE: SUMMARY, APPRAISAL AND CONCLUSION

The last chapter was devoted for analysis of Palloni's technique suited for a linear decline in mortality. We did study the cases, in which it was assumed that the mortality had declined linearly over the cohorts and that the cohorts mortality was uniquely defined. It has shown that with this condition and othe specified conditons of fertility history and the standard mortality - independent of the rate of mortality decline, the value of AD - which was equal to the number of years preceeding the census to which the level of mortality estimated under assumption of constancy corresponds. Although a variety of ways existed in estimating AD, we choose only the fertility history as predicted by parity ratios of P(1), P(2) and P(3) fitted in a regression equation.

The basic assumption in development of this technique was the linearity of mortality decline. Whatever the functional form of the hypothetical decline, the derivation of the procedure required the proportionality for approximating mortality function to be fitted in the usual approximation $q(x) = k\ qs(x)$. The calculation of r - the rate of mortality decline at the time of inquiry was essential in estimating the level of mortality at census time. This then enabled the construction of life table in the usual manner.

Although the application may prove adequate for measurement purposes, there are numerous types of errors that beset it.

(a) The most serious error is bound to result from wrong assumption of decling mortality. Given type of data normally we have in developing countries, this makes the estimates of mortality levels a bit inaccurate. Fluctuation in mortality makes the linear decline assumption rather inaccurate.

(b) The method is based on reports by women who generally tend to underestimate the proportion of children who have since died. This is normally larger for older women resulting higher levels hence lower mortality contrary to our expectation.

(c) If levels of infant and childhood mortality were not associated with mothers, the existence of a trend would normally represent geniune change in mortality over time. This being not the case as infant mortality is strongly influenced by other factors. The present technique is inadequate in distangling the relationship.

(d) The estimated trends are in most cases very sensitive to reporting errors. Even when the fit is appropriately fitted, there is still scope for an erroneous inferences. A better way would probably be a comparison of estimates associated with one age group of mothers at two points in time.

(e) In the whole of this study, we have used North pattern of mortality as our model. This I believe is a major difficulty, since the selection of this underlying mortality pattern models implies the availability of information of good quality data, which in most developing countries are lacking.

Nonetheless, on average, districts in central province, Rift-Valley, and Eastern province seems to have benefited from a substantial reduction in mortality. Districts in Nyanza province as well as coast province seems to have experienced a less drastic change in mortality reduction.

5.2.0 COMPARISON OF INFANT MORTALITY RATES.

Table 5. 1:Comparison of infant mortality rates for all techniques used

Regions	Unadjusted	Synthetic	"K-N"	Palloni	Diff 1 *	Diff 2 **	Diff 3***
Kenya	97	98	88	82	6	9	15
Nairobi	67	69	64	55	9	3	12
Central	56	60	51	45	6	5	11
Nyandarua	56	57	56	46	10	0	10
Kiambu	56	62	51	44	7	5	12
Murang'a	59	56	47	43	4	12	16
Kirinyaga	73	78	58	51	7	15	22
Nyeri	43	43	33	36	-3	10	7
Western	115	119	103	98	5	12	17
Bungoma	103	105	96	90	6	7	13
Kakamega	120	109	102	96	6	18	24
Busia	135	150	133	122	11	2	13
Nyanza	131	133	107	104	3	24	27
Kisii	80	83	66	59	7	14	21
Kisumu	144	164	124	122	2	20	22
Siaya	162	158	140	142	-2	22	20
S.Nyanza	166	164	145	138	7	21	28
Coast	93	100	72	93	-21	21	0
Kilifi	153	119	149	143	6	4	10
Kwale	134	138	128	129	-1	6	5
Lamu	133	138	150	129	21	-17	4
Mombasa	93	92	89	84	5	4	9
T.Taveta	89	99	66	74	-8	23	15
TanaRiver	127	128	126	120	6	1	7
Eastern	80	84	61	56	5	19	24
Embu	71	70	53	56	-3	18	15
Meru	68	65	50	49	1	18	19
Isiolo	93	93	64	53	11	29	40
Kitui	111	116	105	94	11	6	17
Machakos	78	76	63	54	9	15	24
Marsabit	95	78	59	64	-5	36	31
N.Eastern	103	105	81	71	10	22	32
Garissa	98	96	88	85	3	10	13
Mandera	102	102	98	95	3	4	7
Wajir	97	94	92	83	9	5	14
R.Valley	82	84	75	71	4	7	11
Nakuru	78	65	59	53	6	19	25
Laikipia	64	63	51	43	8	13	21
Kericho	75	75	70	61	9	5	14
Kajiado	65	65	61	60	1	4	5
Uasin	75	75	70	64	6	5	11
T.Nzoia	90	87	78	73	5	12	17
Samburu	63	62	53	45	8	10	18
Narok	80	79	73	61	12	7	19
Nandi	87	87	74	82	-8	13	5
Turkana	104	105	101	103	-2	3	1
.Pokot	151	156	141	142	-1	10	9
ringo	122	136	128	118	10	-6	4
eyo	95	96	107	94	13	-12	1

For explanations of Diff 1 ,Diff 2, and Diff 3 see next page.

Diff 1 * The difference between Kraly- Norris IMR and Palloni's IMR

Diff 2 ** The difference between Unadjusted and Kraly-Norris's IMR

Diff 3 *** The difference between Unadjusted IMR and Pallon's IMR

In table 5.2.1 we present estimates obtained by use of different techniques suited for changing conditions of mortality. These estimates are intended to refer to same period of time except Additive Synthetic, which refers to intercensal period (1969-1979). Thus, we shall only compare the unadjusted estimates for 1979 to those of Kraly-Norris, and to those of Palloni. This will enable us to analyse by how far these estimates differ under different assumptions. Comparison again is made of between Kraly -Norris procedure and Palloni's to visualize which one performs better under declining conditions of mortality.

Infant mortality estimates obtained by the use of Kraly-Norris procedure are higher than those of the unadjusted procedure except for Nyandarua district where their is no difference. Baringo and Lamu shows lower IMR for unadjusted than for Kraly-Norris procedure. In those districts where Kraly -Norris procedure is superior, the majority of these districts shows differences of more than 10 unit of the estimated parameter . In practical terms this means that 10 in 1000 deaths are believed to have occured by using the constanty assumption. Table 5.2.1 column 7 shows this descripancy. The highest difference is in Marsabit district (36).

When IMR obtained by Palloni's procedure were compared

5.3.0 COMPARISION OF LIFE EXPECTANCIES AT BIRTH.

Table 5.2. : Comparison of life expectancies-1979.

Regions	Unadjusted	Synthetic	"K-N"	Palloni	Diff 1 *	Diff 2 **	Diff 3***
Kenya	51.82	51.3	53.4	55	1.6	1.58	3.18
Nairobi	57.13	57.8	59.2	61.3	2.1	2.07	4.17
Central	59.82	60	62.5	63.8	1.3	2.68	3.98
Nyandarua	59.82	60.9	62.5	63.8	1.3	2.68	3.98
Kiambu	58.75	59.7	62.5	64.2	1.7	3.75	5.45
Murang'a	58.33	61.1	63.3	64.4	1.1	4.97	6.07
Kirinyaga	56.14	56.5	60.7	61.7	1	4.56	5.56
Nyeri	64.15	64.3	67	66.2	-0.8	2.85	2.05
Western	46.8	46.9	50.3	51.2	0.9	3.5	4.4
Bungoma	49.14	49.8	51.6	53	1.4	2.46	3.86
Kakamega	47.96	48.9	50.2	51.6	1.4	2.24	3.64
Busia	41.09	41.4	44.3	46.2	1.9	3.21	5.11
Nyanza	44.28	41.8	49.4	50.03	0.63	5.12	5.75
Kisii	54.95	45.7	58.4	59.7	1.3	3.45	4.75
Kisumu	41.46	40.4	46.3	46.6	0.3	4.84	5.14
Siaya	40.28	40.1	42.7	42.4	-0.3	2.42	2.12
S.Nyanza	39.48	39.1	42.2	43.12	0.92	2.72	3.64
Coast	50.7	50.9	56.7	52.2	-4.5	6	1.5
Kilifi	41.37	47.1	42.7	43.5	0.8	1.33	2.13
Kwale	43.14	43.5	45.7	45.6	-0.1	2.56	2.46
Lamu	43.51	44.2	42	45.5	3.5	-1.51	1.99
Mombasa	51.43	52.6	53	54	1	1.57	2.57
T.Taveta	51.09	51.4	57.94	56.3	-1.64	6.85	5.21
TanaRiver	43.36	45.6	46	46.9	0.9	2.64	3.54
Eastern	54.36	54.4	59.03	59.9	0.87	4.67	5.54
Embu	56.9	57.2	60.5	60.1	-0.4	3.6	3.2
Meru	58.33	58.7	62	62.4	0.4	3.67	4.07
Isiolo	50.09	52.4	58.4	60.6	2.2	8.31	10.51
Kitui	47.1	47.4	51.9	50.4	-1.5	4.8	3.3
Machakos	54.86	56.2	59.2	60.8	1.6	4.34	5.94
Marsabit	51.51	55.8	60.3	58.8	-1.5	8.79	7.29
N.Eastern	49.5	49.7	54	56.7	2.7	4.5	7.2
Garissa	49.95	51.8	53.3	54.1	0.8	3.35	4.15
Mandera	48.57	52.1	51.15	51.8	0.65	2.58	3.23
Wajir	51.37	50.4	52.6	54.4	1.8	1.23	3.03
R.Valley	54.14	54.4	56.1	57.3	1.2	1.96	3.16
Nakuru	55.59	58.8	59.7	61.6	1.9	4.11	6.01
Laikipia	58.3	59.3	62	63.1	1.1	3.7	4.8
Kericho	56.92	56.4	57.61	59.5	1.89	0.69	2.58
Kajiado	57.17	58.8	59.6	60	0.4	2.43	2.83
Uasin	56.68	56.2	57.3	59	1.7	0.62	2.32
T.Nzoia	53.68	53.8	55.5	56.7	1.2	1.82	3.02
Samburu	58.4	59.6	61.8	63.5	1.7	3.4	5.1
Narok	56.89	55.4	56.9	59.6	2.7	0.01	2.71
Nandi	54.03	53.5	56.5	54.7	-1.8	2.47	0.67
Turkana	49.62	53.3	51.58	52.3	0.72	1.96	2.68
W.Pokot	42.26	40.4	42.75	42.7	-0.05	0.49	0.44
Baringo	45.1	43.8	45.1	47.2	2.1	0	2.1
Elgeyo	50.55	51.8	49.3	52	2.7	-1.25	1.45

to those unadjusted all estimates obtained by Palloni's model were superior, except Coast Province which showed none. The majority of the selected areas showed differences between 10 to 30, with the highest in Isiolo (40).

In comparing the estimates obtained when the two procedures fitted for declining conditions of mortality namely: Kraly- Norris; and Palloni, the estimates were found to be rather close. On the whole, Palloni's estimates showed superior estimates.

In table 5.2 we present the life expectancies at birth for all districts and provinces, using the procedures discussed in chapter 2, 3 and 4. Just as expected, estimates obtained under condition of declining mortality were higher for all for all districts when compared to unadjusted.

When the estimates-e(0) obtained by the two procedures fitted for declining conditions of mortality, namely: Kraly-Norris, and Palloni, were compared the estimates shows considerable closeness. In absolute terms there were 19 areas whose absolute differences lie between 0 and 1, 22 areas whose differences lie between 1 and 2; 6 areas in between 2.1 and 3.0 ; and Lamu, and Coast province had 3.5 and 4.5 respectively.

The effect of adjustment on districts and provinces in Kenya for declining mortality conditions, in general gives IMR estimates that are low when compared to those of unadjusted Brass estimates. The life expectancies are higher showing a somewhat favuorably mortality conditions. However, it is not possible to know for certain whether the revised estimates are closer to the true values than the unadjusted. Nontheless, the increased consistency and conformity between results obtained by Kraly-Norris procedure and that of Palloni and increased similarity to others estimates of mortality in Kenya (cf.Mott, 1980; Ewbank. et.al 1986) suggests that the adjustment for the declining mortality improves the quality of estimates which is appropriately needed for policy reccomedations.

This increased consistency suggest that least errors are introduced into the estimates when procedures suited for changing conditions are used. Of course, the effect of these adjustments differ from one district to the next, depending on the pace of mortality decline and more seriously on quality of data generated from respondents. In the case of Kraly-Norris procedure, errors obtained increased monotonically with childhood age.

5.4.0 CONCLUSIONS

An evaluation of the Brass infant and childhood mortality estimates under conditions of changing mortality particularly in the case of declining mortality shows the estimates to overestimates current mortality. This was evident in all districts in Kenya, with some districts estimates more overestimated than the others.

The violation of the constancy assumption brings inconsistency and unreliability in the estimates. Specifically the breakdown makes the estimates much more higher than the true estimates of infant and childhood rates, thus making them upwardly biased. This is true for ages 2,3, and 5. Errors emanating from such a violation was found to be a fuction of pace of mortality and childhood age. The errors changed monotonically by childhood age, and their magnitude differed from one district to the next, of course, depending on pace of mortality decline; geographical location and quality of data generated from respondents. Those regions in the highland areas showed high magnitude of errors. Where as the lake shore and Coastal regions showed low figures of errors. In North Eastern Province, the districts showed minimal errors, showing that pace of mortality decline was quite slow.

The mortality level estimated from indirect procedure employing Hypothetic additive Synthetic behaves exactly the way they would be expected exactly under declining mortality schedules. The levels were higher(indicating lower mortality) for the intercensal period than for 1969, age group by age group. The mortality levels declined with age group of the mother indicating increased exposure of older children to divergent mortality schedules.

The estimates obtained by "Kraly-Norris"and Palloni's techniques for current mortality showed consistency and coherence , and thus were interpreted to represent mortality levels at the time of census.

The accuracy of an indirect method of estimating infant and childhood mortality depends on the appropriatness of the theory inherent in the method used to real demographic situation as well as the quality of data used.

5.5.0 RECOMMEDATIONS.

(A) POLICY RECOMMEDATIONS.

(1) Since the measures of infant and childhood mortality provides a useful index of a society's health status, standard of living, nuptial behaviour and how the goverment distributes its resources, it is investigator contention that such an index should be accurately measured, of course, depending on the real demographic situation in the country. Thus time and again indirect techniques suited for stable and quasi-stable population theory needs to be adjusted sinces these estimates provides planners with an excellent opportunity to plan effectively.

(2) Infant and childhood mortality rates as we know, are influenced by many factors, major amongs them are: the effect of birth order; the effect of sex ratio; the recent fluctuation in mortality schedules and the age of the mother. If accuracy and consistency of mortality estimates is to be achieved, then planners of demographic surveys and census should obtain data that enables a researcher to adjusted for these factors affecting the estimates. If we need to rely on estimates for policy statements and planning purposes, then the quality of data generated from respondents should be given utmost priority

(B) FURTHER RESEARCH

(1) A re-vistation should be made on those estimates obtained on the basis of stable population theory. Stable population theory as we noted in this work do not hold true

in developing countries experiencing fast mortality decline, in which case Kenya is no exception.

(2) Techgniques should be developed simulated to disentangle the effects of birth order, sex ratio,and the age of the mother on mortality of their children.

(3) Sincerely, mortality decline do not neccesarily follow a linear trend, the trend could be quadratic or curvilear. Thus Palloni's technique should be tested on Kenya data under the assumption of curvilinear mortality trend instead of being rigid on on a linear decline.

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