Estimating child mortality in Kenya using preceding birth technique with DHS 1998 data

BY

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Declarat ion

This project is my original work and has not been presented for a degree in any other university

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Dedication

This project is dedicated to my daughters Elizabeth, Jemima and Betty who encouraged me and remained patient and understanding for the entire two years of my studies. This also extends to my wife, parents, brothers and sisters.

Abstract

Due to non-functioning and incomplete vital registration systems in many developing countries, estimates of mortality is by indirect methods which derive data from retrospective information obtained at the time of national censuses or from specialized demographic sample surveys. Most of these methods suffer from various weaknesses varying from low quality of original data, large volume of data requirement, historical data i.e not up-to-date and hence likely to suffer recall errors, high costs of data collection, and are very complicated and difficult to use especially in the field. Preceding Birth Technique is an indirect method providing early childhood mortality estimates derived from minimal data about preceding births and their survival status. It is simple, easy to administer even in the field and gives almost up-to-date estimates. The proportion dead among the preceding births, Π, has been found to estimate child mortality by age two years. This study seeks to estimate early child mortality in Kenya and to establish reliability of the technique in producing differential effects from mothers' socio-economic characteristics. The findings are inconclusive using medical data. While results derived from survival data on all preceding births reported in the survey indicate that the technique is suitable in the moderate to high mortality zones, though it consistently underestimate mortality. Comparing medical assisted proportion dead, Πm, to all preceding births, Πa, derived from data based on two years reporting period gave statistically significant differences while data based on five years reporting period improved the results. The significant difference is therefore attributed to selection bias and small sample sizes, which could not give meaningful results. Comparing Π to life table proportion, q(2) provided plausible results in overall for all preceding births reported in the survey and in particular in the moderate to high early child mortality zones in Kenya.

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Chapter 1

Introduction and Problem Statement

1.1 Introduction

Infant and child mortality rates are considered the most sensitive indicators of a nation's health status and socio-economic development (Mahadevan *et al*, 1985, Hope, 1992). Consequently, a study of methods of estimation and continuous monitoring of child mortality is relevant to various aspects of social, economic and health policy, planning and programming.

The conventional measurement of child mortality requires information on the number of deaths and on the population subject to the risk of dying. Typically, information on the number of deaths is derived from registration systems that record deaths as they occur; while on the population at risk is obtained mostly from censuses. In the majority of developing countries, either vital registration systems do not exist or omission and other errors are so common that measures based on the data produced fail to reflect properly levels or trends of mortality.

Over the past 30 years, considerable advances have been made to compensate for lack of reliable vital registration data. A number of methods for estimating mortality based on information obtained exclusively from census or surveys have been developed, and census and survey data have become more commonly available.

Most of these methods suffer from various weaknesses varying from low quality of original data, large volume of data requirement, historical data i.e not up-to-date and hence likely to suffer recall errors, high costs of data collection, very complicated and difficult to use especially in the field.

Notable among these methods is the Brass method which has been found to provide reliable estimates of child mortality in a variety of circumstances and is widely used, and recently the preceding birth technique.

Preceding birth techniques has attracted a great deal of attention as a way of estimating childhood mortality especially in local areas. Its popularity lies in its simplicity and minimal data requirements. The method was proposed by Macrae in 1979 and subsequently developed by Brass and Macrae in 1985.

In practical application, the technique would capture the reported mortality experiences of children born to women who deliver in hospitals or clinics or are assisted at delivery by medical personnel. It requires only that at the time of delivery, mothers state the survival status of their previous live birth. With this information, some simple birth-interval distributions and a variety of mortality models, Brass and Macrae demonstrated that the proportion dead of preceding births, referred to as Π approximate the probability of dying by age 2 years.

Hill and Aguirre have since shown that proportion dead among preceding births, Π, is simply the integrated product of two asymmetrical functions. The distribution of births over time before the most recent birth which is very skewed with no live births occurring during 9 months preceding current birth, but with concentration of births around the mean birth interval. And cumulative probability of dying taken from the early part of a life table which fall quickly during the first two years of life so that the cumulative probability dead $_xq_0$ flatten out beyond the age of 2 years.

The strength of the technique lies in monitoring short-term changes in early child mortality. The use of the method to estimate trends implicitly assumes that if Π is biased, the bias is consistent through time. Experimental application of the method have been extensively carried out in Latin American countries, African counties (Senegal and Mali 1996) and is so far promising to be useful in evaluating the impact of local health projects.

1.2 Problem statement

A vast array of methodological tools for collecting and analyzing mortality data do exist but, estimation of child mortality still remain difficult not only in Kenya, but everywhere in the developing countries and especially in sub-Saharan Africa.

Ideally, estimation of child mortality should be by direct method. The method utilizes data on births and deaths recorded as they occur to estimate the probability of dying at childhood. For the method to provide reliable mortality estimates, accurate and very complete vital statistics systems are required. In most developing countries these systems are non functioning or seriously incomplete thus leading to data deficiency and consequently inability to estimate child mortality directly.

In Kenya, 1998 statistics indicate coverage by vital registration system of about 32% births and 45% deaths. This is attributed to low level of literacy, high level of poverty, cultural and religious beliefs, uneven access to medical care and relevant administrative offices for reporting the vital events.

Failure of vital registration system, leave analysts with no other option than estimate mortality indirectly. Indirect methods are developed not as a possible replacement of the direct method, but rather as temporary tools for measuring mortality aspect of population where systems for registration of vital events do not exist or are too incomplete to be directly useful.

Indirect estimation suffers from various problems ranging from lack of reliable data due to high cost of collecting it, to availability of less complex and economical techniques adaptable in the field for continuous collecting and analyzing child mortality data.

In many developing countries estimates of mortality are therefore derived from retrospective information obtained at the time of national censuses or from specialized demographic sample surveys. Mortality during infancy or childhood is estimated by indirect techniques, by direct methods applied to maternal pregnancy histories, and by household change techniques using multi-round surveys (UN 1983,1984).

Notable among these methods is the Brass method which has been found to provide reliable estimates of child mortality q(5) in a variety of circumstances and is widely used. The technique was proposed by W Brass (1964) and modified by Sullivan and Trusell. The method in its simplest form requires data on children ever born, the number of children ever born who have died and the total female population of reproductive age. With the data classified by age of mothers, the method permits the estimation of mortality risk by making allowance for duration of exposure and thus become possible to derive estimates of various values of probability of dying between birth and exact age q(x) from the observed proportions of children dead.

Brass method suffers from various shortcomings raging from requiring large volume of census/survey data, requires historical data referring to periods far back in time thus quality of estimates affected by memory lapse, dependability on model life table to convert ratios to mortality probabilities of dying, ignores survival status of children of mothers in age groups 15-19 and 20-24 years and hence inability to provide reliable early child mortality estimates, q(1) and q(2), rather complicated and not easily adaptable in the field, assumption that mortality and fertility rates are constant in the recent past which is the exception rather than the rule in developing countries else hypothetical cohorts must be constructed which again requires more data, and estimates mortality way back (up-to 10 years)from the time census/survey data is collected thus affecting planning in the present time.

Recently, the existing indirect methodological tools have been augmented through the incorporation of what has become known as the preceding birth technique (PBT), which was introduced by Macrae (1979) and later outlined by Brass and Macrae (1985). The early child mortality estimates from the technique have been found to compare relatively well with others obtained using sophisticated methods - up-to about 1% difference (CELADE).

The procedure is simple, adaptable in various environment even in the field, economical as it requires very few data items, it provide up-to-date (almost current) estimate of early childhood mortality and its selectivity can be used to estimate mortality by cause of death, education level and locality. It only requires information on survival status of the preceding child at the time of current birth. This data is collected from mothers attending clinics at the time of delivery or any other first contact with health personnel after present birth.

The proportion dead among preceding born children denoted by Π, has been found to provide a good approximation of life table q(2) in populations where mortality and fertility levels are high and the average birth interval (I) approximate 30 months (Brass and Macrae 1987). In most developing countries, over 95% of mothers proceed to a second birth.

In the past, the technique has been used to developed mortality index to monitor mortality trend. Efforts to examine the consistency of Π with life table estimates q(2) that are representative of a more general population have been of limited scope since studies were confined to single localities(city or clinics). The technique has also not been tested using Kenyan data. Note that estimates obtained by applying more sophisticated methods are needed to validate preceding birth technique results. The assessment of new technique in terms of the old is to be expected and will probably continue for a few years.

The purpose of this study is therefore to establish how well Π - proportion dead among the next-to-last births (medical assisted deliveries and for all preceding births) approximates the life table estimate, q(2) for the general population in Kenya. And to examine the preceding birth technique's reliability in producing different effects from mother's place of residence, level of education, province and use of health services during delivery.

The effects of selection of mothers are important to consider when using the preceding birth technique to estimate overall early childhood mortality because proportions of mothers who give birth in hospitals or clinics varies widely especially in Sub-saharan Africa. For example in Kenya, about 56% of births are delivered away from health facilities (DHS 1998). Unless all mothers are asked the question on the survival of their previous child, there will be biases in the results obtained, attributable to selection of one kind or another. The selection effects can work in a variety of ways based on socio-economic status, physical access to health services, as well as age, parity and previous obstetric history.

By using surveys data, which are representative of the general population, the selection bias can be minimized and so, for the purpose of this study, 1998 DHS data for Kenya is used.

1.3 Justification/rationalization of the study

Early childhood mortality rates are considered the most sensitive indicators of a nation's health status and socio-economic development and so continuous monitoring of their levels and trend is essential.

Preceding birth technique has been found to be simple and economical, both in data collection and analysis and to estimate early childhood of previous births for a select area (clinics) satisfactorily compared to life table and to provide up-to-date (almost current) estimate of early childhood mortality. Its differentials have been used as indicators of the success of development programs undertaken to improve the welfare of the population for which the programs were designed.

If the technique is found suitable for estimating mortality in Kenya for the general population, then, it will be a cheap way of providing up-to-date (almost current) estimate of early childhood, which can be calculated easily from data generated with health programs aimed at mothers and children. It will also be used to identify problem areas for special focus, to monitor the impact of primary health care programs in the catchment areas of health facilities and to improve understanding of the distribution of risk or differential risks among population in an area.

The finding of this study will therefore be helpful in monitoring and evaluation of development programmes, policy making and planning not only in Kenya, but also in other developing world with similar fertility and mortality levels as Kenya.

1.4 Research question

The research question this study will be attempting to answer is:- To what extend does preceding birth technique method compare with the life table techniques for estimating probability of death by age 2 years in Kenya?. Note that estimates obtained by applying the life table methods are needed to validate preceding birth technique results.

1.5 Main Objective

To determine how well preceding birth technique estimates early child mortality in Kenya.

1.5.1 Specific objectives

(i) To estimate proportion dead for all preceding births (Π_a) and for medical reported preceding deliveries (Π_m) in two and five years reporting periods.

(ii) To directly estimate life table probability of dying, q(2) , for general population in the last five years prior to the KDHS 1998 survey.

(iii) To compare Π_m with Π_a

(iv) To compare both Π_a and Π_m with the life table estimates, q(2)

(v) To estimate proportion dead among the preceding births, Π_a and Π_m by mother's socioeconomic characteristics (level of education, residence, region/province).

(vi) To directly estimate life table probability q(2) by mother's socioeconomic characteristics (level of education, residence and region/province).

(vii) To compare Π_a and Π_m with the life table estimates q(2) by mother's socioeconomic characteristics (level of education, residence and by region)

1.6 Scope and Limitation of the study

The study covers Kenya and uses secondary data from the KDHS 1998. The sample size of 7881 women age 15-49 is grouped by region, place of residence, level of education and use of delivery services. Using the DHS data, a clinic situation is also simulated to reflect the field situation in which the technique has been found to work. This is due to limitation of time, manpower and finance required to conduct a meaningful field survey which is representative.

1.7 Background information of the study area

1.7.1 Geography and economy

Kenya is a sub-Saharan African country bordering Ethiopia and Sudan to the North, Tanzania to the South, Uganda to the West, and Somalia and 10km stretch of Indian Ocean to the East. It lies between 3 degrees North and 5 degrees Southern latitude, and 34 degrees and 41 degrees East longitude. It's a medium-size country with land area of 582,646 square kilometers, of which only 20 percent are arable and 80 percent is arid and semi arid and is mostly set aside for wildlife conservation.

The population of Kenya was estimated in 1999 to be 28.7million and growing at the rate of 2.9% per annum. It must be stressed that the population distribution is very uneven especially in North Eastern region which covers 21.8% of land but comprises of only 3.4% of the population, because it offers a much more unfavourable environment for economic activities (its predominantly Arid). Kenya is primarily an agricultural country, with 80 percent of its population living in the 17% of land suited for agriculture. Almost half of the population is concentrated in only 6% of the land. The Nyanza, Western and Central province have the largest shares of arable land, leading to high population density in those provinces.

Geographically and ethinically, Kenya is diverse. Kenya has more than 42 ethnic groups, of which a dozen, including the Kikuyu, Luhya and Luo, are the most important in terms of population size. As of the 1999 census, the Bantu-speaking Kikuyu, who live mainly in Eastern and Central province, accounted for 29% of the total population of the country. The Luhya, concentrated in Western province, constitute 11.7 percent of the total population; and the Luo, living primarily in Nyanza province, account for 15.3%. Each ethnic group usually resides on its traditional land, in regions that differ significantly in their climate and geography. The regional differences in ecological conditions include altitude and temperature, rainfall and humidity, types of soils and terrain, and population density. These variations are associated with variations in health status and therefore with variations in mortality (Blacker and others, 1987). As a consequence of these variations and of geographical distribution of the population by ethinic group, an association between ethnicity and health status or mortality can be expected.

Kenya maintained a relatively steady economic and social development since it attained independence in 1963 to 1990. The annual growth rate of the gross domestic product was 6.4 % for the period 1965-1980 and 3.4% for the period 1980-1986 (World Bank, 1988) and 4.3% in 1990. Since then, it has been on the decline and recorded an ever low rate of 0.2% in 1993. Although the economy picked up a bit in 1994-95 period, it is still constrained. The declining trend has developed because external resources inflows have fallen, Kenya's main exports have performed poorly in the international markets, the economy has been unable to attain macro-economic balance and internal management has been poor, with policies often being implemented inconsistently, poor rainfall and reduced agricultural output.

Primarily, Kenyan economy is based on agriculture: farming accounts for 26% of the GDP and has a labour force of 80% (World Bank,1988) and manufacturing 14%. The main foreign exchange earners are Tea, Tourism, Coffee and horticulture.

1.7.2 Public health policy

The public-health policy in Kenya has been instrumental in achieving reductions in child mortality. Kenya has steadily improved its healthcare programme. With 6% of public expenditures devoted to that purpose in 1978 (Ewbank, Henin and Kekovole, 1986). Significant preventive measures are being taken, such as those related to health education, disease eradication, protection against environmental hazards and immunization against infectious diseases. In 1998, more than 67% of children aged 12-23 months had received the bacillus Calmette-Guerin (BCG), three doses of polio vaccine, three doses of diphtheria, pertussis and typhoid (DPT) vaccine and vaccine against measles (Kenya,1998).

The two most important aspects in the area of preventive measures are provision of safe drinking water and nutritional programmes. Policies have been formulated to improve the quality and quantity of drinking water in both urban and rural areas. As of 1976, most rural households had some source of potable water within a radius of two kilometers (Ewbank, Henin and Kekovole, 1986). In 1989, 47% of women aged 15-49 had water piped into their house or had access to a public tap or to a well (Kenya,1989).

The importance of food and nutrition has been recognized by the Government since the first development plan for the period 1974-1978, and it has given more prominence in subsequent plans. Provision of proper nutrition is an essential component of the development plan for 1989-1993 (Kenya, 1989). Indeed, several nutritional surveys conducted in Kenya in the late 1970s and the early 1980s indicated a high prevalence of protein-calorie malnutrition, especially among children under age 5. In 1978-79, among children aged 6-60 months, only from 47 to 74%, depending upon the province, were neither stunted nor wasted (Ewbank, Henin and Kikovole, 1986). Government efforts in the area of nutrition have been helped by increase of production and thus higher farm incomes. However, in the recent past malnutrition in Kenyan children is on the rise: it is now estimated at 37 per cent from 35 per cent four years ago (Ngare and Muthunga, 1999). This study indicates that level of malnutrition in the country is now 17 per cent higher than in developing countries. This study indicates that nutritional status of the Kenyan children has deteriorated markedly in the past five years because of the declining standards of living.

Worse still, is the fact that Health-care services are not adequate for the rural population, a problem common to many developing countries; and there is still a shortage of skilled medical personnel, medications, equipment etc (Ikamari, 1996).

1.7.3 Recent trends in early childhood mortality

Birth and death registration in Kenya is not sufficiently complete to provide a satisfactory basis for measuring either levels or trends in early child mortality. Child mortality is therefore derived from censuses and survey data. The analyses of available data indicate a rapid decline in childhood mortality during the last four decades prior to 1989 (Brass and Jolly, 1993). Table 1 shows a considerable decline in infant, child and under-five mortality between 1948 and 1989. According to various census reports, Infant mortality declined from 194 deaths per 1000 live births in 1948 to 146 deaths in 1962, 118 deaths in 1969 and 84 in 1979. Under five also followed same trend. The decline continued to 57.6 in 1979-1983.

The improvement in mortality observed in Table 1 is as a result of the improvements in the social and economic conditions coupled with the application of modern medical technology and public health measures. Since Independence in 1963, Kenya has been implementing various development programs aimed at improving the average standards of living and to reduce mortality particularly infant and child mortality. These include massive investment in the education sector and the development of an extensive public health infrastructure to provide both curative and preventive services (including family planning), and provision of clean drinking water (MPND, 1984; 1989).

Table 1 Levels and Trends in childhood mortality rates in Kenya(1948-98)

Period	Infant mortality	Child mortality	Under- five Mortality
1948	194		262
1962	146		211
1969	118		167
1979	84	-	105
1979-1983	58	37.8	93.1
1984-1988	60	31.5	89.2
1989-1993	62	36.7	96.1
1994-1998	74	40.8	111.5

Source: Compiled from various census reports and the 1989 KDHS, 1993 KDHS and 1999 KDHS Country Reports published by NCPD et al., 1989, 1994 and 1999, respectively.

However as from 1989, early childhood mortality rates have taken an upward trend. Infant mortality rose from 59.6 for the 1984-88 period to 61.7 in the 1989-1993 period to 74.7 in the 1994-1999 period. Child mortality increased from 31.5 for the 1984-88 period to 46.7 during the 1989-93 period and to 40.8 in the 1994-98 period. Similarly, the under-five mortality rose from 89.2 in the 1984-88 period to 96.1 during the 1989-93 period and to 111.5 in the 1994-98 period. The upward trend has been attributed to vagaries of weather, HIV/AIDS and increased poverty levels and inabilty of public health sector to provide services. This is partly as a result of Structural adjustment programmes which aims at reducing budgetary allocations to the social sectors, mainly health and education, relating prices to market levels, liberalising trade, adjusting exchange rates (mainly through devaluation of currency), and controlling the supply of money and credit (Cornia *et al*, 1987; Adepoju, 1993).

Chapter 2

Literature review and Analytical frame work

2.1 Literature review

Estimation of infant and child mortality in developing countries is by indirect estimation because of the lack of reliable vital-registration statistics. The most commonly used is the Brass method. The method uses retrospective information on the children that women have borne. It was developed by Brass in 1964 and has since been modified by and Trussel(1975), Palloni and Heligman(1986), and others to provide various version whose main difference is in the model life table they use. The method is proven to produced reliable estimates of child mortality in a variety of circumstances. Other indirect methods also exist for estimating child mortality but they either require considerably more information or have proved less reliable.

The original Brass method was based on certain simplifying assumptions that may not be entirely satisfied in practice. It assumed constant mortality, which has since been relaxed through contributions by Feeney (1980), Coale and Trussell (1978) and others. Others are mortality risk of children of women who do not report their child-bearing experience are the same as those of children whose mothers do, survivorship of children is independent of that of their mothers, fertility has remained constant during 30 to 35 years preceding survey or census, reported proportion of children dead are correct i.e ignores omission which is known to be prevalent in older women.

Reported limitations of Brass method vary from incapability of providing reliable estimates of very recent mortality conditions i.e 2 to 3 years preceding interview and reliance on model life table to convert mortality proportions to probabilities of dying.

Where reliable data about the prevalent pattern of mortality in childhood is lacking, there is always uncertainty about which mortality model to use. Most reliable estimates produced by the method usually refer to a period between 3 to 10 years preceding the time of interview, which limits their usefulness for timely evaluation of the effects of health or development programmes.

Preceding birth techniques is a recent development that requires only information on the survival status of the preceding child at the time of current birth. It is another indirect method of estimation that is promising to be useful especially in evaluating the impact of local projects as it is simple to calculate, easy to administer and provides up-to-date estimates.

The growing interest in reliability of Π as a measure of $q(2)$ is reflected in the numerous studies published on the topic in recent years. The PBT has been discussed primarily as a method for estimating mortality using clinic records for small region. The ideal way to evaluate the technique is to use it in multiple clinic settings and compare computation of Π with life table estimates of child mortality (by 2 years of age) obtained from reliable census, Vital registration or survey data for areas covered by the clinics.

The method was proposed by Brass, and developed by Brass and Macrae in 1984. With some simple birth interval distributions and a variety of mortality models, they showed that proportion dead of the preceding births,Π, approximate to probability of dying by age 2 years for population with medium to high fertility levels.

$$\text{i.e } \Pi \approx q(2)$$

In various studies conducted in Latin America, Oceania, Africa and Middle East the technique has been found to provide rates quite close to those obtained by means of more sophisticated techniques e.g. Brass method. Various studies have shown a maximum difference of 1% between estimates derived from preceding birth technique (hereafter referred to as PBT) and the other sophisticated techniques used to estimate early child mortality. No such a study has been carried out in Kenya.

In a study by Hill and others (1985) with data collected in five health facilities in Bamako, Mali starting from January 1985, the results q(2)=0.1422 was in line with estimates obtained using original Brass method from a large survey conducted by the Sahel Institute among a representative sample of Bamako household about the same time.

Brass and Macrae (1984) using data gathered through the birth notification scheme operating in Solomon Islands during the period 1968-75, presented q(2) estimates which showed sustained mortality decline as expected. The trend provided an example of a more realistic use of PBT than does the case of Mali. Even if the estimated q(2) values are not perfect, their declining trend is indicative of changes taking place and might serve as an adequate evaluation tool.

Brass and macrae (1984) noted that some selection bias is likely since the births notified may be to women who are better educated or otherwise socially advantaged. Such selectivity could be assessed by gathering additional information on the women giving birth, including their age, parity, educational level, work status and place of residence.

The main drawback of the technique is that the data it uses may not be representative. Indeed since the procedure envisages that only women about to give birth will be asked about the survivorship of their previous birth, the children whose mortality is being measured may not be representative of all children In cases where only women giving birth in hospitals/ government clinics (about 45% in Kenya) are interviewed, the data will be even less representative of the total population. The technique also does not give mortality estimates by age of the child.

Maria Li (1992) in an attempt to assess the capability and consistency of the technique to provide national estimates of mortality in childhood gave mixed results. she pointed out that application of cross-national results to individual nations, require a great deal of care and consideration. In her words " we cannot predict how well the preceding birth technique will work in a particular country".

Maria Li (1992) offered some suggestions as to when Preceding birth technique is likely to work best. Given that reporting is restricted to clinics births, it seems reasonable to assume that Π will be most reliable if the following conditions are satisfied: 1) medical assistance at delivery is generally available, 2) changes in fertility and mortality occur slowly; 3) estimates are based on sufficiently large sample sizes, especially with respect to the numerator (i.e. the number of next-to-last births dead); 4) relatively low mortality conditions prevail or the age distribution of deaths is such that a substantial portion of deaths among next-to-last births occur prior to age 2years; 5)data collection is characterized by minimal omissions and misreporting.

Most of the anticipated and actual biases of the early child mortality estimate Π in estimating early childhood mortality have been investigated and explained accordingly in various studies as follows:-

The 30 months assumed for average birth interval, I, is reasonable. Brass and Macrae using models showed in their first article that in most of the countries in which application of the technique are likely, the interval will not vary a great deal from 30 Months. This compares very well with D.P. Smith (1985) calculations. D. P. Smith calculated median birth intervals by Life Table method for 38 developing countries included in WFS. His findings from 23 countries where total fertility is five or more, median interval was 31 months, countries with total fertility less than five, median interval was 35 months, and only in 6 countries was the median interval outside 28-34 months. Kenya has a total fertility rate of 4.7 and a median birth interval of 33 months (KDHS 1998).

The incorrect specification of mean birth of upto 2 months is not overly important in the estimation of q(2) as the probability around age 2years do not differ substantially (Chackiel and Gough 1989). However, if the mean interval substantially vary from 30 months, Π will underestimate or overestimate q(2) for lower and higher average birth intervals respectively.

Brass and Macrae combined mortality patterns and the birth interval distributions to produce the empirical result that the weighted average of the probability of dying is equal to the Life Table probability of dying by an age less than the mean birth interval 'I'. They then used 2 sets of Π calculated for hypothetical population to demonstrate that it approximates to q(αI) when α is about 0.8. Mbacke using 2 Senegalese Life tables and Coale and Demeny model life tables collaborated the findings.

The strength and consistency of the birth interval-mortality association is compelling, even after taking into accounts various extraneous factors (Boerma and Bicego,1992;Hobcrat,1994). Bicego (1996) in a comparative study involving 20 developing countries, found a relative infant mortality risk of 1.57 for births with less than 2 years birth interval in Kenya and 1.37 for under five years.

Bias attributable to different birth interval lengths can be estimated simply by linear interpolation on the logits of a model life table. In developing countries, the bias is small e.g 3% for 24 months. If the interval is less than 24 months, Aquire and Brass (1989) suggested that an adjustment should be made but did not specify.

Bias attributable to early death can also be ignored. Reacting to Krishnamoorty (1986) remark on association between birth interval and child survival, Aguire and Hills (1990) demonstrated that the bias is negligible. An infant mortality of about 0.150 and 0.200, resulted in an overstatement of Π of 1% and 2% respectively which is negligible compared to all other biases including reporting errors and selection effects. Its negligible because of the fixed one year in-built in birth interval as a result of gestation (9 months), waiting time (1-2months) and non lactational amenorrhoea. Only in rare cases with long post-partum amenorrhoea and high mortality during second year of life will the bias be larger than 1 or 2 percent.

Omission of first births would be significant if a large proportion of mothers were to stop after a single birth and if their mortality experiences were very different from the rest. In developing countries, 95% of women with one birth proceed to the next parity and so the effect can be ignored. Omission of last births especially when parity is more than five as risk increase with parity. Again this is a small proportion and can be ignored. It works in opposite direction with mothers with one child as they tend to be of higher socio-economic status.

The fact that the experience of last-born children, including only children is never reflected in the mortality estimates. Although mortality among both first and higher order births is expected to be higher than average, it has been argued that the exclusion of these births will not serious bias mortality in population of moderate to high fertility. Brass and Macrae (1984), Hill and Aguirre (1990) gave the reason that it constitutes a small proportion of all births. Rutstein (1998) pointed out that although mortality experience of last births in higher fertility countries will be higher than average, the proportion of children excluded from calculation of Π will not be large. While Aguirre and Hill (1987) argued that the direction of the biases due to the omissions of last births and only births cancel out since women who stop at one birth are likely to be women of higher socioeconomic status whose births would subject to lower risks of mortality.

For information collected at other times other than at current birth, Aguirre and Hill (1989) demonstrated that difference in duration of the exposure period by 1 - 2 months to the risk of dying is unimportant as mortality around second birthday change only slightly within the space of a few months. They showed that

$$q(2)/q(3) \approx 90\%$$

Other contributions to early childhood mortality relevant to this study are on various groups of differentials. The identified groups will act as bootstrap sample and for each group, both q(2)s and their corresponding proportions dead among the preceding births, 'Π' are estimated. In general, some localities and some population groups have higher child mortality rates. These differentials are related to the differing social and economic conditions found in the various localities and to the differing circumstances in which the various population groups lives. Accordingly, attention in this study will focus on geographical variation of mortality rates, on urban-rural and levels of education. Kibet (1987) identified mothers level of education, place of residence and regional variations as some of the important determinants of early child mortality important for Kenya's.

According to Kibet (1987), clustering of high and low mortality regions is due mainly to ecological and cultural variations such as altitude, climate and perhaps to beliefs concerning hygiene, breastfeeding and nutrition. Others are socio-economic development such as communications, schools availability of health service, urbanization and education levels.

Various studies have found that with regard to early child mortality rates in developing countries, rural population tend to have higher mortality rate than urban. In a study using census data of 12 Latin American countries, Behm in 1979 found that risk of death in the first two years of life was lower in urban than in rural population. Out of the 12 Latin American countries, 2/3 of the countries gave 30-60% more rural deaths than urban. An earlier survey by Smith and Backer 1963 suggested that 1/3 African children die before 5years in rural areas compared to 1/4 in Urban (UN,1973). In Kenya, rural women have higher child mortality than urban (Henin and Mott, 1970). This is explained by the findings of Anker and Knowles 1977, who found that within developing countries, groups with high socio-economic status as measured by income, occupation, education have lower average mortality.

In developing countries, rural mortality is higher because of differentials in standard of living and health conditions in general, and differential availability and access to public and health facilities in particular, and better public sanitation, higher level of hygiene and improved feeding habit for the infants and literacy level.

According to Mott(1982), young women experience higher incidences of neo-natal deaths than older women. These findings suggest that physiological and psychological immaturity probably account for high rates of spontaneous abortions. In Kenya, adolescent childbearing is common. Nearly half of 19 years old are pregnant or are already mothers (KDHS 1998). Previous demographic research in Kenya has infant mortality is high among first births but declines with increasing parity until the 6^{th} birth, after which it again rises steeply with more births.

Large regional differentials are found in infant and child mortality. In a study in Kenya, Mott (1982) found substantial excess mortality for children in the areas bordering the Indian Ocean and Lake Victoria. Such regional differentials probably reflect variations in standard of living not adequately incorporated into the analysis and also ecological factors associated with aetiologies of important diseases of childhood. In Kenya, the areas identified as having excess child mortality are economically disadvantaged, but they are also areas where malaria is most prevalent.

Regional child mortality differentials in Kenya are also as a result of different ethnic groups and the groups' cultural practices (Ayiemba 19985), prevalence of malaria (Kibet 1987) and sleeping sickness. Malaria accounts for 10% of child mortality in Kenya (Omondi-Odhiambo et al. 1984). Anker and Knowles (1977), in an analysis at the microlevel and macrolevel in Kenya, identified endemic malaria as the most relevant variable for the mortality differentials among children under age 3 years.

According to republic of Kenya (1984), Nyanza, Coast and Eastern provinces experiences high child mortality, Eastern and Rift Valley intermediate and Nairobi and Central province lowest. Socio-economic development and environmental conditions follows the same pattern in Kenya. Central and Rift Valley have good access to health care and above average nutrition while Coast province has least access to health care and inadequate nutrition, and the Lake Victoria basin of Nyanza and Western Kenya and the Coastal region are malarious zones.

Previous studies suggest that mortality decline with increase in the level of education. In a study by Hobcraft, McDonald and Rutstein (1984), mother's education was found to be more important for mortality in age group 1-4. Non-educated mothers experience higher incidence of child mortality than educated mothers. Non educated women have greater probability of having low personal hygiene, poor nutrition standards and living in rural areas with relatively poor access to medical facilities. Caldwell, Reddy and Caldwell(1983) noted that mother's education is related to the greater role played by mothers in family decision-making about resource allocation distribution of food among members and recourse to modern medicine despite traditional belies about procreation and the causes of illness and their treatment. This partly explains the high mortality levels in rural areas.

Mott (1982) in a multivariate study of infant mortality in Kenya, found that some primary schooling of the mother reduces infant mortality risk of the children by over 10%, and some secondary schooling reduces such risks by over 25%. Hobcraft et al. (1984) results closely paralleled Mott's child mortality pattern.

2.2 Summary of issues from the literature review

The literature review on the technical issues involved in estimating early childhood mortality from the proportions of preceding children who have died show that most of the potential problems, apart from incomplete coverage of all women who give birth and the possibility of reporting errors, are not very important. The requirements of the technique translate into very straightforward set of field procedures, and in many instances the minor adjustments may be unnecessary.

Many previous examinations of the method's performance simply compared the mortality estimate based on the preceding birth technique with Life Table estimate q(2) based on the same births (Hill and Aguirre 1990, Bicero et al 1989, Guzman 1988)). However, the comparison of mortality estimates derived from different methods, but based on both the same data source and the same births cannot provide an indication of the reasonableness of Π as a measure of mortality conditions faced by all births in a population for a given period because it fails to account for selection biases. The proposed study intends to compare estimates derived from two different methods using same data source but different births.

Preceding birth technique is facility-based and may not be a measure of true overall mortality in the surrounding population due to selection bias. For this reason, it has been used to follow mortality trends over time, rather than estimate absolute levels of mortality.

For practical purposes, inferences about mortality of the general population of births are desired. The evaluation criteria therefore should include an examination of how well 'Π' estimate not only the Life table estimate of q(2) for next-to-last births, but also the estimate of mortality for all births. The few studies that have attempted to examine whether the method can successfully estimate the mortality level for general population have produced mixed results.

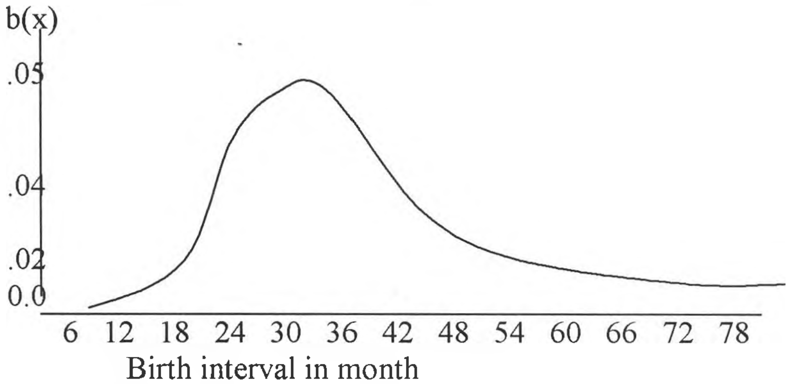
The present investigation undertakes this task with data on Kenya in the DHS 1998. Since this study relies on reports of more recent events, the combined impact on Π and LT estimates of q(2) from omissions of distant births, misreporting and the cross sectional nature of the reports on socioeconomic status is not likely to be large. Besides the relatively low cost of using archieved data, another advantage of using DHS retrospective surveys is that children born outside the hospital/clinics system can be include.

2.3 Analytical framework

Preceding birth technique is based on two functions whose integrated product Hill and Aguirre have shown approximate to the proportion dead of preceding births and is referred to as Π.

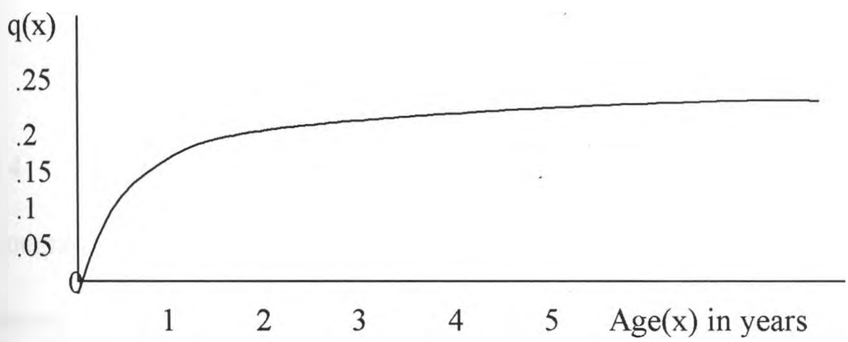
The two asymmetrical functions are:-

1) **b(x)** - the distribution of births over time before the most recent birth.



Monthly distribution of previous births is very skewed with no live births occurring during 9 months preceding current birth but with concentration of births around the mean birth interval, say 30 months, and a long tail falling off with time.

2) **q(a)** - Cumulative probability of dying taken from the early part of a life table i,.e. under 5 years



The monthly probabilities of dying in children in any life table fall quickly during the first two years of life so that the cumulative probability dead $_xq_0$ flatten out beyond the age of 2 years.

This mortality pattern q(x) and the birth interval distributions b(x) can be combined to produce the empirical result that the weighted average of the probability of dying is equal to the Life Table probability of dying by an age less than the mean birth interval, I.

The integrate function is

$$\int b(x)q(x)dx = q(\alpha I) = \Pi$$

But Π depend on the prevailing fertility and mortality conditions and therefore α for a particular population must be determined empirically.

From the findings of Brass and Macrae, and Mbacke outlined in the literature review, where median birth interval does not vary significantly from 30 months, α=0.8. And therefore

$$\Pi = q(\alpha I) = q(30*0.8) = q(24)$$

where

Π: is the proportion dead among the preceding births

I: is the median birth interval

α: is a constant

2.4 Hypotheses to test

Comparison between proportion dead among the preceding births, Π and the corresponding life table estimates of q(2) will be done. The hypothesis will then be that the difference between the two estimates is not statistically significant.

$$H_{(0)}: \Pi - q(2) \neq 0$$

$$H_{(1)}: \Pi - q(2) = 0$$

Chapter 3

Sources of data and Methodology

3.1 Source of data

The data to be used in this study are secondary data on child mortality derived from 1998 Demographic and health survey (hereafter referred to as KDHS 1998). KDHS 1998 is national in scope and was carried out by the National Council for Population and Development (NCPD) in collaboration with the Central Bureau of Statistics (CBS).

The survey utilised a two-stage, stratified sample consists of 536 select sample units but six of the 536 clusters were not surveyed due to inaccessibility. The excluded population is from all district in North Eastern province and four other districts - Samburu and Turkana in Rift Valley, and isiolo and Marsabit in Eastern province. The excluded districts although covering a large area of Kenya, they account for less than four percent of Kenya's population.

The survey was designed to provide data on the family planning and fertility behaviour of the Kenya population, to examine the basic indicators of maternal and child health, provide information on adult and maternal mortality levels, nuptiality, fertility preferences, awareness and use of family planning methods, use of maternal and child health services. And to describe levels and pattern of knowledge and behavior related to the prevention of AIDS and other sexually transmitted diseases among other objectives.

To achieve these objectives, the survey utilised three types of questionnaires to collect data:- the household questionnaire, Women's questionnaire, and the men's questionnaire which were translated into Kiswahili and nine other widely spoken local languages: Kikuyu, Luo, Luhya, Kalenjin, Kamba, Kisii, Meru and Mijikenda.

For the purpose of this study, I limit myself to data derived from women questionnaire. And specifically, on the birth history of women aged between 15 and 49 years with parity two or higher as reported in the survey. These data include information:-

(i) for background variables namely mother's level of education, place of residence and region/province

(ii) on births (biological) namely date of birth, survival status, age at death, birth and birth interval of the last two live births

(iii) Health practices, births last 5 years, medical attendance at delivery

The data is then classified by age of child for each category i.e. mothers level of education, place of residence (rural/urban) and region/province.

3.2 Quality of data

All estimates derived from sample survey data are affected by two types of errors: non-sampling and sampling errors. 1) Non sampling errors are the results of shortcoming in the implementation of data collection and data processing such as failure to locate and interview the correct household, misunderstanding of questions on the part of either interview or respondent and data entry errors. Efforts were made on KDHS 1998 to minimize this type of error but non-sampling errors are impossible to entirely avoid and difficult to evaluate statistically. Estimated accuracy attributed to locating and interviewing the correct household is 95.7%.

2) Sampling errors are a measure of the variability between all possible samples in a population. The degree of variability is not known exactly but can be estimated from the survey results. The KDHS sample was as result of a multiple stage stratified design, which requires complex procedure to estimate sampling errors. In the DHS 1998, ISSA sampling Error Module (computer software) was used to calculate the sampling errors.

Standard errors calculated for selected variables considered to be of primary interest and relevant to this study i.e national woman sample gave low relative standard error of an average 4.2% and 2.4% when characteristic with low values (rare) were omitted. Urban population gave a relative standard error of 0.028, population with no education 0.045 and secondary and higher level of education 0.04 while child mortality was 0.055. Thus in general relative sample errors for most estimates for the country as a whole are small.

3.3 Methods of data analysis

3.3.1 Demographic technique

Type of technique used demographic analysis depends on the available data. In sub-Saharan Africa, one of the most difficult problem facing demographers is the estimate of mortality levels and life table functions (Clairin. R, 1968). It is therefore necessary to obtain the best possible estimates.

(a) Life table methodology for estimating childhood mortality qx

Life tables for the five years period are constructed with two types of data. The first is the mortality, which is tabulated by age of the child and by mothers' characteristics. The second type of data required is the set of age-specific population counts to represent the number of persons at risk of mortality. While it is anticipated that mortality data is representative of all deaths in the population, the available counts of the sample are known to have serious errors interms of undernumeration, age misreporting and misclassification.

Surveys often provide birth histories (including survival status of births) which permit the analysis of infant mortality by the same or even greater number of characteristics as does census information. Birth history provided in the KDHS1998 provides the basic data to construct general childhood life table (table3.1) and others based on characteristic of the mother (education) and family (place of residence and region) (appendix).

Probabilities of dying (q_x) and of surviving (l_x) are then derived from the basic data provided by the birth histories. Life tables based on these data are usually calculated only up to 5 or age 10, because only older women will have children over those ages, and few women interviewed (15-49 years) will have adult children. The estimates derived are referred to as direct estimates because they do not rely on fertility and mortality models.

For the purpose of this study, life tables are constructed for children born 0-4 years before KDHS 1998 survey from a table showing the survival status of each child at the time of the survey, if alive, or age at death, if dead. The table will give us the numbers dying at various ages, and numbers who were interviewed at each age. The later statistics are needed to take into account the numbers of children who do not enter into the calculation of the population at risk of dying.

Construction

The procedure for calculating synthetic cohort probabilities of dying is based on the procedure first developed by Somoza (1980) and modified by Rutstein (1984). Probabilities of dying are built up from probabilities calculated for specific age intervals. The probability of dying is the result of dividing the number of deaths occuring in the relevant age interval for children who were exposed to death in a specific calendar period by the number of children exposed in the calendar period.

Table 3.1 present raw data by age (column 1 to 3) and the life table (column 4 to 11) functions derived from it using direct method. Column 4 is the number of children under five years who are alive at the start of the interval, column 5 is the number of children aged X months (as per column 1) and column 6 are the number of deaths occurring in the interval. For each successive interval, column 4 is the total entering the previous interval – (minus) population interviewed in the previous interval (Col.5)- minus number of deaths in the preceding interval (col.6).

I.e col4x=col4x-1-col5x-1-col6x-1

Where x is the age interval

Example (table 3.1 col4): 5778-60-170=5548

To compute the number of children exposed to the risk of dying during the interval, subtract half the number of children interviewed in the age interval (col.5) from the number alive at beginning of the interval (col.4).

I.e col7x=col4x-1/2col5x

Where x is the age interval

Example (table 3.1 row 4,col7): 5778-(60/2)=5748

With the two data items i.e counts of both deaths and and population at risk in the age interval, the rest of life table column are derived at as follow

- Probability of dying during the interval, denoted by ${}_nq_x$(col.8)=

  Number of deaths during interval (col. 6)/Number exposed to the risk (col. 7)

  For example: 170/5748 = 0.0296

- Probability of surviving in the interval, denoted by ${}_np_x$ (col.9)=

  1-probability of dying in the interval, ${}_nq_x$ (col. 8)

  For example: 1-0.0296=0.97

- Cumulative probability of surviving to the start of the interval, denoted by lx (col.10)= probability of surviving in previous interval multiplied by cumulative probability of surviving to the start of previous interval

  i.e $lx = {}_np_{x-1}$ (l_{x-1})=Col. (9) * col. (10)

  For example: 1 – 2 months

  $l_2 = p_1 * l_1$. =.997 *.97= .968

Since l_x represents the cumulative probability of surviving to age (x), one finds the probability of dying by age (x) (col.11) by subtracting l_x from 1.

For example, to find the probability of dying by age 2 (24 months) we find the cumulative probability of surviving to 24 months, i.e., l (24) is the cumulative probability of surviving to exact age 2. Thus q_2 from the data in Table 2 is equal to (1-0.911)*1000= 88.5 per 1000.

Table3.1: Life table for births reported in Kenya in the last five years

	Basic data		Alive at	Pop.	Deaths	Pop. At	nqx	npx	lx	qx
Age	Alive	Dead	Beginning	age X	in Intrvl	risk				
Col1	Col2	Col3	Col.4	Col.5	Col.6	Col.7	Col.8	Col.9	Col.10	Col.11
0	60	170	5778	60	170	5748	0.030	0.970	1.000	0.000
1	98	16	5548	98	16	5499	0.003	0.997	0.970	0.030
2	92	23	5434	92	23	5388	0.004	0.996	0.968	0.032
3	95	36	5319	95	36	5272	0.007	0.993	0.963	0.037
4	93	26	5188	93	26	5142	0.005	0.995	0.957	0.043
5	87	18	5069	87	18	5026	0.004	0.996	0.952	0.048
6	106	20	4964	106	20	4911	0.004	0.996	0.949	0.051
7	102	15	4838	102	15	4787	0.003	0.997	0.945	0.055
8	101	27	4721	101	27	4671	0.006	0.994	0.942	0.058
9	88	18	4593	88	18	4549	0.004	0.996	0.936	0.064
10	88	8	4487	88	8	4443	0.002	0.998	0.933	0.067
11	98	8	4391	98	8	4342	0.002	0.998	0.931	0.069
12	106	37	4285	106	37	4232	0.009	0.991	0.929	0.071
13	90	4	4142	90	4	4097	0.001	0.999	0.921	0.079
14	91	7	4048	91	7	4003	0.002	0.998	0.920	0.080
15	89	4	3950	89	4	3906	0.001	0.999	0.919	0.081
16	118	0	3857	118	0	3798	0.000	1.000	0.918	0.082
17	82	3	3739	82	3	3698	0.001	0.999	0.918	0.082
18	90	13	3654	90	13	3609	0.004	0.996	0.917	0.083
19	85	2	3551	85	2	3509	0.001	0.999	0.914	0.086
20	91	2	3464	91	2	3419	0.001	0.999	0.913	0.087
21	92	2	3371	92	2	3325	0.001	0.999	0.913	0.087
23	193	2	3277	193	2	3181	0.001	0.999	0.912	0.088
24	1040	15	3082	1040	15	2562	0.006	0.994	0.911	0.089
36	962	11	2027	962	11	1546	0.007	0.993	0.906	0.094
48	949	7	1054	949	7	580	0.012	0.988	0.9	0.101
60	98	0	98	98	0	49	0.000	1.000	0.889	0.1112
	5284	494								

Source: Calculated from birth history data in KDHS, 1998

(b) Proportion dead among preceding births - Π

The procedure require responses of just two questions in order to permit the application of method in its simplest form i.e

- Have you ever had a child before this one?
- Is the child who was born immediately before this one living or dead ?
- And for the purpose of this study, a question on mothers' socioeconomic characteristics is desired.

To obtain this data, mothers may be surveyed at the following contact points:

- delivery at maternity clinics
- antenatal visits
- first vaccination contact (BCG) for her recently born child

This study aims at establishing reliability of the index as a general measure of early childhood mortality in Kenya and so uses data from KDHS 1998 data which is national in scope.

The count of preceding live births reported as dead (deaths) is then divided by the count of preceding births (births) reported by the survey to arrive at the proportion dead among the preceding births, denoted by Π.

I.e $\frac{\text{number of preceding live births reported dead (deaths)}}{\text{Number of preceding live births reported (births)}} = \Pi \approx q2$

Where,

q2 is the probability of dying between birth and age 2 years

For example: Using medical assisted delivery data collected two years prior to KDHS 1998, preceding births=611 and deaths among preceding births reported=49 (table 4.1 column 4, row 4 and 5).

Therefore

Π=49/611=0.0801 I,e 80 deaths per 1000 births by age two years.

In instances when the date of death of preceding child coincided with the date of birth of the last child, we assume that the death of the preceding child occurred before the subsequent birth in calculating Π, and in case of multiple births, they are all included in the analysis.

(c) Estimation of the reference period

For the probability of dying q(2), the estimation period to which this refers (T) has been established by Aguirre (1992) as

T=0.75*I

Where

I: birth interval between the last two births

For example: Using Kenya Demographic and Health Survey 1998 data, preceding birth interval for all last births=33 months (table 4.1) column 2.

Therefore

T=0.75*33 = 24.8 months

i.e the estimates refers to two years prior to KDHS 1998.

3.3.2 Statistical methods

The study will employ frequency, cross-tabulation analysis and chi-square to examine the hypothesized association between the two estimates by a set of socio-economic characteristics of the mothers.

(a) Frequency procedure

The frequency procedure provided statistics for describing types of variables. For a first look at KDHS 1998 data, the procedure was a good place to start. It gave the frequency counts of births and deaths by socioeconomic characteristics, mean and standard deviation of the percentage differences between the frequencies derived from computed proportion dead among the preceding births and the life table probabilities of dying by age two years as reported by women 15-49 years in the last five and two years before the survey.

(b) Cross-tabulation

Crosstabs procedure forms two-way and multi-way tables and provides a variety of tests and measure of association for two-way tables. The structure of the table and whether categories are ordered determine what test or measure to use. In this study, crosstabulation procedure is used to related variables and to summarize KDHS 1998 data in tabular form. Survival status variable is cross tabulated by socioeconomic characteristics of mother to allow for comparison, and to compute chi-square value of the difference between the estimates namely life table probability of dying by two years (q2) and proportion dead among the reported preceding births (Π).

(c) Chi-square test

As percentage in a bivariate frequency table do not allow for quantification and testing of the relationship between variables, an index that measures extent of association as well as statistical test of hypothesis that there is no association is needed. The $\chi 2$ test is one of the simplest and widely used non-paramedic test in statistical analysis under cross tabulation. This is a method of analysis, which tests the existence of associate between variables in a contingency table. It's commonly used in the social science to evaluate whether or not frequencies which are empirically obtained differ significantly from the expected frequencies under certain assumptions (Blalock, 1963). The larger the difference between observed and expected frequencies, the larger is the $\chi2$ (Gupta,1979).The $\chi2$ test enables the researcher to know whether a given discrepancy between theory and observation can be attributed to chance or whether it results from the inadequacy of the theory to fit the observed facts.

$$\chi2 = \Sigma[(f_e - f_o)^2 / f_o]$$

where

f_e = expected frequency

f_0 = observed frequency

After specifying the null hypothesis Ho that there is no association between the mortality estimates considered, the calculated value of $\chi2$ is compared with the table $\chi2$ for given degrees of freedom at 1% and 5% levels of significance. If the observed level of significance is less than the chosen significance levels that is $\alpha=0.01$ and $\alpha=0.05$ the null hypothesis of independence is rejected and the alternative hypothesis is accepted as the calculated $\chi2$ value at these chosen levels falls in the rejection region.

3.4 Reliability

Reliability of proportion dead among the preceding births denoted by π as an estimate of early childhood mortality is determined through calculating percentage difference between π and the life table probability of dying by age two years q2. i.e to measure the extent to which probability of dying based on π differ from those based on q2 is evaluated as the % difference between the two sets of proportions

For any given comparison between π and q(2) we propose as the null hypothesis H(o) that the percentage difference between the estimates is not statistically significant

$$\text{i.e} \quad [\pi - q(2)]/q2 \times 100 = 0$$

With n comparison at level of significance α we would expect to find on average no more than N associated with statistically significant difference. If more than αN percent difference are found to be statistically significant, then we have reason to reject the null hypothesis that the % differences are few overall. $\chi 2$ test is used to test the degree to which 2 statistics exceed or fall short of the critical value.

Chapter 4

A Comparative Analysis of PBT and Lifetable technique in Estimating Probability of death at age 2 years

4.1 Basic data and proportion dead: Two years reporting period

Children survival depend principally on the care they receive from either parents, on selected genetic characteristics, on the environment where they are raised, and on the health facilities that society can offer them. Censuses and surveys have collected data that usually permits the grouping of individuals or families according to specific characteristics. For the purpose of this study, KDHS 1998 information on survival status of preceding births reported and the median preceding birth intervals are crosstabulated by characteristics of the mother and family (place of residence, education and region). For all preceding births reported by mothers in the survey and those reported by mothers who have had medical assisted last birth.

Table4.1 presents preceding births and their survival status and their birth intervals to current births as reported by mothers who have had births in the last two years prior to 1998 Kenya demographic and health survey. The proportions dead among the reported preceding births denoted by Π in this population, is examined by region, by residence, education and overall for both medical attended births and for all births. The correlation coefficient between Π medical and all preceding births reported was found to be 0.849. An indicator that the two are highly related (Appendix chart 1).

The variability of estimates of probability of death by 2 years, Π, by province for medical attended deliveries indicate that, in Kenya,(table 4.1) Nyanza province registered the highest mortality rate at 177 deaths per thousand followed by Western province with 113 and Coast province with71, while Central registered the least at 22 and Nairobi 29 deaths per thousand births. The other provinces, Eastern and Rift Valley reported 53 and 63 deaths per thousand preceding births. The pattern is similar to the findings of Mott (1982).

The same pattern is observed in region attribute when all preceding births are considered (Appendix chart 1) except for Coast province, which moved from position three to two. The rates again varied widely from 166 deaths per thousand in Nyanza to 22 in Central province. Coast recorded 79 deaths per thousand, Western 76, Eastern 71, Rift Valley 57 and Nairobi 59.

The relationship of early child mortality observed by region is more likely therefore, to be related to general development and modernisation level of each region and malaria prevalence pattern in Kenya. Studies in developing countries have found that groups with high socio-economic status as measured by income, occupation, education have lower average child mortality (Anker and Knowles,1977).

Preceding birth interval also varied substantially amongst the province. It varied from 39 months in Central province to 30 in Western province. Nairobi and Coast province recorded 36 months while Eastern had 34 and Nyanza 32 months. The long birth intervals in Nairobi and Central province could be related to the high contraceptive use among women. In Coast province, it is partly attributed to intensive and long breastfeeding.

The relative risk of medical deliveries varies widely from 65 percent in Nairobi and Central province to 21 percent in Western province. Others are Eastern 42%, Nyanza 34%, Rift Valley 28% and Coast province 26 percent. The low percentage in Coast province confirm the low tendency of the population to consume health services which may include contraceptive use and so the long birth interval observed early is most likely attributed to breastfeeding.

Previous studies have shown that births from educated mothers have a higher chance of survival than those of non-educated mothers (Hobcraft et al. 1985). In this study, proportion dead also varied by education level. But, in the three grouping identified namely none, primary and secondary or higher, a high of 83 deaths per thousand was recorded for those with primary education and a low of 58 per thousand for population with no formal education among medically assisted deliveries. Atleast secondary school level of education category reported 81 deaths per thousand births. The puzzling pattern of a lower proportion dead among mothers with no education compared to those with higher levels of education may be attributed to the sample size, which is too small to make meaningful analysis. A sample size of fifty two cases, recorded in no-education category is too low for a study of rare event like child mortality.

The risk of medical attended delivery also varied by education. The risk varied from 21 percent for population with no education to 57 percent in secondary school category. Primary school category has 29 percent. No variation was recorded for birth interval.

Table4.1: Study population – Preceding births and their survival status reported in the last two years prior to the survey

Mother's characteristics	Birth Interval Months	Medical reported births	Medical reported deaths	All cases reported births	All cases reported deaths	Percent medical Deliverie	Proportion dead medical	Proportion dead All	Percent variance
Overall	33	611	49	1820	149	45	0.080	0.082	-2.04
Nairobi	36	33	1	51	3	65	0.030	0.059	-48.5*
Central	39	89	2	136	3	65	0.022	0.022	1.873
Coast	36	70	5	267	21	26	0.071	0.079	-9.18
Eastern	34	95	5	224	16	42	0.053	0.071	-26.3*
Nyanza	32	113	20	331	55	34	0.177	0.166	6.516
Rift Valley	32	158	10	561	32	28	0.063	0.057	10.96
Western	30	53	6	250	19	21	0.113	0.076	48.96*
Ed.None	34	52	3	248	24	21	0.058	0.097	-40.4*
Primary	34	337	28	1184	103	29	0.083	0.087	-4.49
Secondary+	34	222	18	388	22	57	0.081	0.057	43*
Res Rural	33	464	40	1587	131	29	0.086	0.083	4.44
Urban	35	137	9	233	18	59	0.066	0.077	-15

Note: Correlation coefficient = 0.849
* denotes percentage variance greater than 15%
Sources: Kenya Demographic and Health Survey 1998

When all preceding deliveries regardless of type of assistance accorded during delivery were considered, the sample sizes grew by between 75% and 380%. Population with no education had the highest growth and when analysed, reported highest level of mortality at age two with 97 deaths per thousand while secondary and higher level of education experienced least deaths of 57 per thousand. Primary level category reported 87. This pattern is in line with the findings of various childhood mortality studies carried out in various African countries (Arriga, E, 1980; Hobcraft et al, 1985). A research by Mott(1982) in Kenya produced similar results.

When compared, the two proportions of deaths among the preceding births Π i.e medical and all reported preceding births in the two years prior to KDHS 1998 survey, varied substantially among those with no education -40% and those with secondary education or higher 43% (table4.2). For Primary education category, proportion dead reported by women who had medical attended last births approximated estimates of all reported preceding births.

Estimates of child mortality for Kenya based on information on survival status of the preceding births reported in KDHS 1998 showed that child mortality from birth to age two years was higher in rural areas than in urban areas. The probabilities of dying by place of residence (table 4.1) gave 86 and 66 deaths per thousand births for rural and urban population respectively for medical assisted deliveries and 83 and 77 for all preceding deliveries. The urban and rural mortality differentials could be due to the socioeconomic characteristics of the families and areas (Anker and knowles, 1977).

Also notable is the variation in preceding birth interval and the risk of medical delivery in the residence attribute. Urban residence tend to delay next birth by 35 months while in rural area is 33months. The relative risk of medical delivery is 29% in rural areas and 59 per cent in Urban areas.

The variation of proportion dead among preceding births reported by women whose last birth was medically assisted and all women who reported preceding births in the two years, by place of residence attribute did not vary substantially. This indicate that Π-medical can be used to estimate Π all births by age two years.

When the whole population is considered without categorising, the total proportion dead among the preceding births associated with medical delivery reported 80 deaths per thousand and approximated to 82 deaths per thousand births reported for all preceding births. The difference can be associated to low percentage medical assisted deliveries in Kenya (45%). And as studies have found, trained medical attendance during delivery can help ensure a healthy and safe birth for both mother and child (KDHS 1998).

Some categories reported very high variation between medical associated proportion dead and proportion dead for all preceding births. Among the identified categories are Nairobi -48%, Eastern -26%, Western 49%, and population with no education -40% and secondary and higher level of education 43%. This can be attributed to sampling variability and sample size and so, medical assisted deliveries are not representative of the experience of the general population.

Notable is the tendency of proportion dead reported during medical assisted delivery to underestimate mortality at age two in Nairobi and Eastern province, and for the population with no formal education. At the same time, it overestimates in Western province and for primary level of education category. This observation can be attributed to the usual selection bias associated with hospital data (Leeuwenberg et al.1984; Northrup 1986).

Among the attribute categories identified (table4.1), in Central province, the two proportions dead are approximate with a variability of 1.9% followed by overall with -2%, rural population 4.4% and primary level of education -4.5%. Others providing an acceptable level of variability are Nyanza, with 6.5%, Coast -9.2%, Rift valley province

11% and urban population with -15%. For these attribute categories, it can be concluded that medical associated proportion can be used to estimate Π for all preceding births by category in the two years reporting period.

4.2 Basic data and proportion dead : Five years reporting period

The two year basic data (table 4.1) failed to provide the expected differentials in some categories such as comparative mortality levels for education attribute. Proportion dead among preceding births reported by women with medical assisted last births was higher for both primary level and secondary level than for those with no education. This was attributed to small sample size from which no meaningful analysis could be made.

Data collected for reported preceding births covering five years gave slightly more cases - an improvement to two years reporting period. With five years data, proportion dead reported by women in medical grouping was higher for non-educated than secondary school category. Primary level category remained higher than for the other two categories.

Table4.2 presents a crosstabulation of preceding births and their survival status by mother's attributes (education) and family attributes(place of residence and region) as reported by mothers who have had births in the last five years prior to 1998 Kenya demographic and health survey. Included in the table are proportions dead estimates derived from the basic data provided. Like in two years reporting period (table4.1), the variability followed a similar pattern although with higher proportions for both women with medical assisted last delivery and all preceding births. Exceptions are Eastern, Western province and secondary plus level of education for medical grouping.

Notable is a tremendous reduction in disparity of ∏ medical and all births especially among categories that had presented high proportions (Appendix chart 1 and 2). Nairobi reduced differences from -48% to -6%, Western from 49% to 6%, Eastern from -26% to -17% , and those with no education from -40% to -26% and Secondary school category from 43% to 25% (table4.2). This can be partly attributed to increase in sample size thus reducing errors of omission and commission especially among the medical assisted deliveries. Correlation coefficient also increased to 0.962. This indicates that the two measures of mortality of under two years may be quite close (Appendix chart 2).

Improved also is the number of attribute categories with an acceptable level of variability of upto 15% from eight in the two years reporting period to nine. Nairobi enters the acceptable level with -6%, Western province with 6% while Central province increases to 27% thus leaving the bracket.

Based on the recorded variability, medical reported proportion dead can be used to estimate proportion dead for all preceding births in the following attribute categories:- Nairobi 94 deaths per thousand, Nyanza 177, Coast 77, Rift valley 60, Western 96 and, for those with primary education 91, and for both rural 87 and Urban 75 deaths per thousand births and for the overall a pie of 85 deaths per thousand births. The puzzling high mortality rate reported in Nairobi can be taken as an error due to the few cases recorded for any meaningful analysis. Sample sizes of 95 and 45 for all second births reported and medical associated reporting respectively are too small to analyse a rare event like child mortality in Nairobi.

Table4.2: Study population – Preceding births and their survival status reported in the last five years prior to the survey

Mother's Characteristic	Birth Interval	Medical reported births	Medical reported deaths	All cases Reported births	All cases Reported Deaths	Percent medical deliveries	Proportion dead Medical	Proportion dead all	Percent variance
Overall	33	812	68	2958	251	27.5	0.084	0.085	-1.3
Nairobi	36	45	4	95	9	47.4	0.089	0.095	-6.2
Central	39	113	3	239	5	47.3	0.027	0.021	26.9*
Coast	36	87	7	431	33	20.2	0.081	0.077	5.1
Eastern	34	142	6	411	21	34.6	0.042	0.051	-17.3*
Nyanza	32	141	27	537	95	26.3	0.191	0.177	8.2
Rift Valley	32	215	14	869	52	24.7	0.065	0.060	8.8
Western	30	69	7	376	36	18.4	0.101	0.096	6.0
Ed.None	34	66	5	432	44	15.3	0.076	0.102	-25.6*
Primary	34	431	40	1847	168	23.3	0.093	0.091	2.0
Secondary+	34	315	22	680	38	46.3	0.070	0.056	25.0*
Res Rural	33	630	54	2556	221	24.7	0.086	0.087	-0.9
Urban	35	182	14	402	30	45.3	0.077	0.075	3.1

Note: Correlation coefficient=0.962

* denotes percentage variance greater than 15%

Sources: Kenya Demographic and Health Survey 1998

In Central and Eastern province, mortality experience among the preceding births reported by women with medical assisted last births, differs significantly from that of the general population. The same can be said about the population with no formal education and that with atleast Secondary school level of education i.e. a disparity of more than 15%.

The high number of categories providing reasonably low disparities between the two estimates derived from medical data and all preceding births for the two sets of reporting periods, indicate that hospital data although subject to selection bias, can provide mortality estimates representative of the experience of the general population. And so, where census or survey data is unavailable with some reasonably high level of accuracy, medical related proportion dead may be used to estimate the general mortality experience at two years of life.

It is also worth noting that to improve on findings derived from medical data, inorder to be representative of the general population, it is required that the sample size be reasonably large to minimise the variability caused by erroneous grouping or/and omission of cases.

When five years mortality experience is considered, proportion dead reported among the preceding births by women with medical assisted last births, is again consistently less or approximate estimates derived from all reported preceding births except for Central province and Secondary category. This maybe interpreted as that women from Central province and those with atleast secondary school level of education, are more likely to seek medical services at delivery when they have had child mortality experience.

The high negative percentages recorded by Eastern province and population with no formal education (table 4.2) can be attributed to selection bias associated with use of medical data. The sample sizes in these two categories within the medical assisted grouping, may also be too small for meaningful analysis thus magnifying the errors of omission.

4.3 Comparing of proportion dead with Life table mortality estimate q2

Previous studies have shown lifetable estimates of early child mortality to vary by characteristics of mother and family among others. For the purpose of this study, attributes analysed are mother's level of education, region and place of residence. Table4.3a presents basic data used to construct life tables and the probabilities of dying by two years q2 derived from them. The lifetable probabilities are classified by attribute categories of the mother based on births and survival status of children under five years reported in the demographic and health survey 1998.

The regional lifetables presents large differentials. Nyanza has the highest probability of dying by age two years with 194 deaths per thousand followed by Western province with 82 deaths and Coast province with 79 rank third. Central and Nairobi province have low child mortality of 30 and 44 deaths per thousand births while Eastern and Rift Valley province returned 65 and 62 respectively (table 4.3a). The life table estimates are within the range of estimates at age one and under five years mortality estimates provide in the KDHS1998.

These results are similar to findings of other studies. According to Ayiemba (1985), Kenya can be divided into clusters of high and low mortality zones. The cluster of high mortality rates encompasses parts of the lake Victoria basin, namely, Nyanza and Western province and coast province where incidences of malaria and sleeping sickness are extremely high. The intermediate cluster includes part of Rift valley and Eastern provinces where mortality rates are moderate while Central and Nairobi provinces have low mortality. The pattern is also in conformity with the findings of a study by Mott (1982).

The pattern provided by lifetable proportions at age two years (table4.3a) is similar to that of proportion dead among the preceding births born of mothers who had medical assisted last births in the last two years (table4.1). Exceptions are Eastern and Rift valley (both in moderate child mortality zone) province which interchanged positions 4 and 5.

In the education category, those with no formal education reported the highest mortality by age two years with 100 deaths per thousand births, followed by the group with upto primary level education with 97. Secondary school level and higher reported 59 deaths per thousand deaths. These findings are in line with the published KDHS 1998 mortality differentials. A similar pattern has been reported by Hobcraft et al.(1984). Mott in a muti-variate study in Kenya (1985) found that primary schooling reduces infant mortality risks of children by 10 percent and secondary schooling by over 25 percent.

Place of residence category, provided higher life table probabilities in rural area with 90 deaths per thousand, while urban recorded 81 deaths per thousand. Proportion dead among the preceding births Π, provided a similar pattern but the disparities were rather high at 20 deaths compared to 9 deaths per thousand when q2 is applied.

Table4.3a: Mortality estimates for both sexes by age two reported by women with Medical assisted last deliveries reported in the last two years.

	Life table basic data			Medical	%
	Brths	Dths	q2	Pie	Disparity.
Overall	5778	494	89	80	-9.41
Nairobi	185	8	44	30	-31.30*
Central	470	15	30	22	-26.19*
Coast	850	65	79	71	-9.60
Eastern	780	48	65	53	-18.69*
Nyanza	1041	188	194	177	-8.65
Rift Valley	1670	103	63	63	1.22
Western	779	64	82	113	37.63*
Ed.None	708	73	100	58	-42.38*
Primary	3676	340	97	83	-14.54
Secondary+	1394	81	59	81	36.58*
Res Rural	4951	431	90	86	-4.00
Urban	827	63	81	66	-18.91
Mean			82.5	74.235	
Sd			39.2	39.726	
Se			10.9	11.468	

Note: Correlation coefficient=0.85

q2 denotes lifetable probability of dying by age two years

Π is the proportion dead among the preceding births as reported by mothers who have had a birth in the last

* denotes absolute percentage disparity greater than 15%

Sources: Kenya Demographic and Health Survey 1998

The overall q2 for Kenya in the prevailing period was found to be 89 deaths per thousand births using KDHS1998 data. This compared well with proportion reported dead among the preceding births in the last two years by women whose last delivery was medically assisted. Only a difference of -9% was observed.

Generally, the proportion dead among the preceding births -∏, compared very well to q2 for some attribute categories namely Nyanza with a disparity of -8.6%, Rift valley 1.2%, population with primary level of education 15% and rural residence 4%. Others such as population with no education -43%, Western province 38% and population with secondary education 37%, Nairobi -31% and Central -26% were far off the mark. Common characteristic of all categories with large variation between ∏ and q2 is the small sample size. Sample sizes for Nairobi 33, Central 89, Western 53 and population with no education 53 cases are rather too small to allow meaningful mortality analysis (table4.1). This together with sampling variability may be the cause of the big variation.

Although the overall estimate -∏ underestimates q2 by 9.4% only, the high number of attribute categories (7 out of 13) with percentage variability greater than 15%, make proportion dead among the preceding births computed from medical data inconclusive estimator of q2 in Kenya.

Also observed is the fact that proportion dead reported by category tend to underestimates or approximate lifetable probabilities of dying by age two (q2) except for Western province and secondary school category where they deviates by 37.6% and 36.6% respectively.

4.3.1 Child mortality by age two years reported by all women

When data from all women who gave birth in the last two years prior to KDHS 1998, was used, percentage difference between the lifetable estimate at age two (q2) and proportion dead among preceding births reported reduced/improved tremendously for some categories. Table 4.3b below presents the percentage difference between the two estimates by mothers' socioeconomic characteristics.

Categories with notable improvement are Western province whose absolute percentage difference between the two estimates reduced -7.6, Eastern 10.4 and Coast province 0.5. Other attribute recording great improvement is education. For population with no formal education, disparity reduced from 43% to 3.3% and secondary level from 36.6% to 4.5. Difference in Urban category also improved to 4.6% (table 4.3b). Nairobi and central province show marginal increase from 33% and 28% from 31% and 26% respectively. The other categories have maintained fairly low difference with marginal changes.

Other indicators of improvement are mean and standard deviation. The observed mean – 9.8 % and standard deviation 26.1 in the medical category improved to -4.1 and 14.1 respectively. The correlation coefficient improved from 0.85 to 0.98, meaning that both indicators may be quite close and the number of categories reporting less than 15% absolute difference increasing to eleven, with the exception of Nairobi and Central province (table4.3b) i.e. low mortality zones..

The improvement can be attributed to increase in sample size, reduced sample variability and elimination of selection bias associated with use of medical data. Some attribute categories, which had sample sizes of less than 100 case increased and as a result, the quality of Π improved thus reducing the variability. Notable are Western, Eastern province and population with no education where variability reduced to -7.6%, 10.4%

and -3.3% respectively. Nairobi and Central province where sample sizes remained small, maintained the high percentages similar to the one where medical data is used.

Table4.3b: Proportion dead by age two years reported by all women in the last two years

	Life table basic data			All	Percent
	Birth	Dths	q2	Pie	Disparity.
Overall	5778	494	89	82	-7.52
Nairobi	185	8	44	59	33.35*
Central	470	15	30	22	-27.55*
Coast	850	65	79	79	-0.45
Eastern	780	48	65	71	10.35
Nyanza	1041	188	194	166	-14.23
Rift Valley	1670	103	63	57	-8.78
Western	779	64	82	76	-7.61
Ed.None	708	73	100	97	-3.34
Primary	3676	340	97	87	-10.52
Secondary+	1394	81	59	57	-4.49
Res Rural	4951	431	90	83	-8.07
Urban	827	63	81	77	-4.64
mean			82.5	77.869	-4.1
sd			39.2	32.506	14.1
se			10.9	9.3837	

Note: Correlation coefficient=0.981
* denotes absolute percentage disparity greater than 15%
Source:Study data

Use of all preceding births reported in the two years to compute proportion dead therefore, provides a better estimate of lifetable estimate -q2 compared to medical data. This is demonstrated by improved mean variability of -4.1 and a standard deviation of 14.1 compared to -9.8 and a standard deviation of 26.1 arrived at using medical data. Correlation coefficient between the two indexes Π and q2 also improved to 0.98.

4.3.2 Five years reporting period

To improve on sample size, data of survival status of children born to women who had delivery in the last five years was used to compute the proportions dead among the preceding births reported. These probabilities were classified by socioeconomic characteristics of the mothers and compared to life table probabilities of dying by age two q2.

4.3.3 Comparison - Life table estimates to estimates from women with medical assisted deliveries

Table 4.4a compares lifetable q2 and proportion dead Π computed from medical assisted births and their survival status reported over a period of five years prior to the survey. Use of data generated over a period of five years has greatly improved the variability compared to use of medical data generated over a period of two years. The mean variability has reduced to 4.3% compared to -9.8%, standard deviation remained high due to the high variability for Nairobi which increased from -31% to 102%. Correlation coefficient also increased to 0.898 from 0.850 with two years medical data.

Number of attribute category with more than 15% variability also reduced from seven (table 4.3a) to five. In Central province and urban population, variability reduced below the stated level. It is worth noting that most of the categories with high percentage variability have small sample sizes, which may be the cause.

Nevertheless, Π medical can be used to estimate q2 for Central 27 deaths per a thousand births, Coast 80, Nyanza 191 and Rift valley province 65 deaths per thousand births by age two years when five years KDHS 1998 medical data is used.

Table 4.4a : Mortality estimates for both sexes by age two reported by women With medical assisted last deliveries reported in the last two years.

	Life table basic data			Medical	Percent
	Brths	Dths	q2	Pie	disparity.
Overall	5778	494	89	84	-5.40
Nairobi	185	8	44	89	101.51
Central	470	15	30	27	-12.80
Coast	850	65	79	80	1.83
Eastern	780	48	65	42	-34.72
Nyanza	1041	188	194	191	-1.16
Rift Valley	1670	103	63	65	4.14
Western	779	64	82	101	23.33
Ed.None	708	73	100	76	-24.33
Primary	3676	340	97	93	-4.54
Secondary+	1394	81	59	70	17.64
Res Rural	4951	431	90	86	-4.55
Urban	827	63	81	77	-5.05
Mean			82.5	83.153	4.3
Sd			39.2	38.389	32.9
s.e			10.9	11.082	

Note: Correlation coefficient=0.898
Source: Study data

4.3.4 Comparison - Lifetable estimates to estimates derived from all women

Table 4.4b compares q2 and Π computed from all preceding births and their survival status reported over a period of five years prior to the survey. The results obtained indicate a low variability mean of 2.8%, but a rather high standard deviation of 35. Correlation coefficient has also declined from 0.98 to 0.902 compared to preceding birth estimator $\prod$ for all preceding births in a two years reporting period (table 4.4b). The high standard deviation can be attributed to high percentage difference experienced in Nairobi.

Table 4.4b: Proportion dead by age two years reported by all women in the last five years

	Life table basic data			All births	Percent
	Brths	Dths	q2	Pie	disparity.
Overall	5778	494	89	85	-4.15
Nairobi	185	8	44	95	114.76
Central	470	15	30	21	-31.29
Coast	850	65	79	77	-3.09
Eastern	780	48	65	51	-21.06
Nyanza	1041	188	194	177	-8.69
Rift Valley	1670	103	63	60	-4.30
Western	779	64	82	96	16.40
Ed.None	708	73	100	102	1.728
Primary	3676	340	97	91	-6.45
Secondary+	1394	81	59	56	-5.87
Res Rural	4951	431	90	86	-3.71
Urban	827	63	81	75	-7.89
mean		9	82.5	82.3	2.8
sd			39.2	36.3	
s.e			10.9	10.5	

Note: Correlation coefficient=0.902
Source: Study data

The number of attribute categories with a percentage variability greater than 15% has increased from two to three. Western joins Nairobi and central province - categories whose q2 may not be estimated using Π when survival status of all preceding births reported in five years is used to compute q2.

The consistent high positive variability noted for Nairobi may also be attributed to small family size i.e two or three children per woman. In small family, a large proportion of first-born children is included in the data used for estimation of mortality using PBT. But their mortality experience may not be representative of average mortality levels in the total population of children. Bicego (1994) using DHS data calculated a relative risk of 1.24 in Kenya at infant for first births relative to children of birth order 2-3 years.

The preliminary results indicate that proportion dead derived from women reporting survival status of their preceding births provided the highest categories qualifying under 15 percent difference rule with 11 categories, All births reported in the last five years had 9 categories , five years medical had 8 while medical two years had 6.

Based on absolute mean difference, all births in last five years was best with 2.8, all births last two years had -4.1%, medical two years 4.3 and medical 2 years -9.8. All births in the last two years prior to survey gave the best correlation coefficient of 0.98 followed by all births in the last five years 0.902, medical 5 years is 0.898 while medical two years had 0.85 (table 4.5).

Out of four comparison made, proportions dead for Nairobi failed to approximate lifetable estimates at all, Central and Western provinces failed three times. Nyanza and Rift Valley and Coast province qualified all through while Eastern failed once. Western province failed in all comparisons where medical data is used. This then indicate that where child mortality levels are moderate or high, ∏ may be used to estimate prevailing child mortality of the general population.

In conclusion therefore, estimates derived from status of all preceding births reported by women giving births in the last two years prior to KDHS 1998 provides the best estimator of lifetable probability of dying by age two years. The other estimators are also good considering the high correlation coefficient they registered and the low absolute percentage difference for the overall category (table 4.5).

It is also worth noting that where medical records are the only sources of data, proportion dead among preceding births ∏, can be used to estimate lifetable probability q2 when it is computed from preceding births reported in the five years prior to the survey. Examining individual categories for reliability of respective ∏ to estimate q2 and to be able to generalise, statistical tests are required.

Table 4.5: Preliminary results

period	Group	Categories <15%	Mean var.	Std dev	coefficient	overall
2 years	Medical	6	-9.80	26.07	0.850	-9.41
2 years	All	11	-4.12	14.09	0.980	-7.52
5 years	Medical	8	4.30	32.91	0.898	-5.40
5 years	All	9	2.80	35.40	0.902	-4.15

Source: Study population

4.4 Procedure for statistical tests

For the purpose of this study the proportion dead will be subjected to two statistical tests:- level of significance to test deviation of proportion reported dead among the preceding births Π from q2 and chi-square denoted by $\chi 2$ to test the significance of the deviation to establish the reliability of Π as an estimator of q2 in order to generalise the results.

Table 4.6 presents the lifetable proportions at age two and proportion dead among preceding births reported in the four groups (two years medical assisted, two years all births, five years medical assisted and five years all births). The estimates are cross tabulated by mothers socioeconomic characteristic.

Statistical intervals at 5% and 10% level of significance for q2 are computed as follows:

- $q2 \pm 1.96s.e$ for 5% level of confidence
- $q2 \pm 1.64s.e$ for 10% level of confidence

The values of Π are then fitted in the intervals

Proportion dead computed from medical related data gathered two years prior to KDHS 1998 at both 5 and 10 percent level of significance is tested and found that three out of the thirteen attribute categories were significantly different from q2. Western province113 deaths per thousand births, population with no formal education 38 and those with at least secondary school level of education 81 deaths per a thousand births are significantly different from q2 at both 5 and 10 percent level of confidence (table4.6).

Table 4.6: Results of statistical test- Status of the preceding births reported

		At five percent confidence interval		At ten percent confidence Interval		Two years reporting period		Five years reporting period	
	q2	Lower	upper	Lower	Upper	∏m	∏a	∏m	∏a
Overall	89	67	110	71	106	80	82	84	85
Nairobi	44	23	65	26	62	30	59	89**	95**
Central	30	9	52	13	48	23	22	27	21
Coast	79	58	100	61	97	71	79	81	77
Eastern	65	43	86	47	83	53	71	42**	51
Nyanza	194	172	215	176	212	177	166**	191	177
Rift Valley	63	41	84	45	80	63	57	65	60
Western	82	61	104	64	100	113**	76	101*	96
Ed.None	100	79	121	82	118	58**	97	76**	102
Primary	97	76	119	79	115	83	87	93	91
Secondary+	59	38	81	42	77	81**	57	70	56
Res Rural	90	69	111	72	108	86	83	86	86
Urban	81	60	102	63	99	66	77	77	75
Mean	82.5								
Sd	39.2								
s.e	10.9								
Chi square						66.78	15.93	49.17	40.24
Ho (αN)	5%=	0.65		10%=	1.3				
No. Failed						3	1	3/4	1

Note: ∏m denotes proportion dead estimated from preceding births medically reported

∏a denotes proportion dead estimated from all preceding births reported

* denotes significant difference between the two estimates at 10% percent

** denotes significant difference between the two estimates at both 10% and 5 percent level

Source: Study population

In the following categories Nairobi, Central, Eastern, Nyanza, Rift Valley province, and population with primary level education, and both rural and urban population, proportion dead among preceding births ∏ falls within the acceptance interval and so is a good estimator of lifetable probability of dying by age two years q2. ∏ overall is equal to 80 - computed from unclassified preceding births reported in the two years prior to survey i.e place of residence, education and region was also found to be a good estimate of q2- for all births in the five years prior to the KDHS 1998.

The three out of thirteen categories i.e 23% characteristics, where ∏ is significantly different from q2 is greater than $\propto$N where $\propto$ denotes level of significance and N is the number of attribute categories which is thirteen. $\propto$N=0.65 and 1.3 when $\propto$=5% and 10% respectively. The three categories found to have a significant difference, is far much greater than $\propto$N and so, we reject the hypothesis that ∏ in the overall, is not significantly different from q2 in Kenya.

Chi square test confirmed that ∏ and q2 are different. The value of the statistic is 66.78 which corresponds to a significant level less than 0.01% which is less than the level of significance 5% hypothesized.

Pie, computed from data about the survivor status of all preceding births gathered two years prior to KDHS 1998 at both 5 and 10 percent level of significance is tested and found that all attribute categories are not significantly different from q2. Nyanza's166 deaths per a thousand births is the only exception.

Considering that the one case failure approximate to αN=0.65 and 1.3 hypothesized, then there is no reason to reject the hypothesis that in general, Π is not significantly different from q2. Therefore, Π can be used to estimate q2 for the attribute place of residence, region and level of education attained. It can also be used to estimate the overall q2. Chi square test performed, gave a value of 15.9 which corresponds to a percentage level of confidence higher than 10% and giving no reason to reject the hypothesis that the difference between Π and q2 are not significantly different at both 5 and 10% level of confidence.

Variability of pie medical (computed from data gathered five years prior to KDHS 1998) from q2 is tested for significance. Its found that three and four out of the thirteen attribute categories were significantly different from q2 at 5 and 10% level of confidence. Nairobi 88.9, Eastern 42, Western province101 and population without formal education 75.8 deaths per a thousand births are significantly different from q2 at 5 and 10% level of confidence.

In the other attribute categories namely Central province, Coast, Nyanza and Rift valley province, and population with primary and secondary level of education, and in both rural and urban population Π is a good estimate of q2. For the overall medically assisted deliveries, Π is again good estimate of q2.

The four and three categories found to have a significance difference are more than the value of $\propto N$ which is equal to 0.65 and 0.13 when $\propto$=5% and 10% respectively. For this reason, we reject the hypothesis that Π=q2 in Kenya. Chi square test gave a statistic equal to 49.17 which correspond to a level of confidence less than 0.01% and so at both 5 and 10% levels of confidence, the hypothesis that Π=q2 is again rejected.

Proportion dead, derived from basic data about the survivor status of all preceding births gathered five years prior to KDHS 1998 at both 5 and 10 percent level of significance is tested and found that all attribute categories are not significantly different from q2. Nairobi's 95 deaths per a thousand births is the only exception.

Therefore, Π can be used to estimate q2 for the attribute place of residence, region and level of education attained. It can also be used to estimate the overall q2. Chi square test performed, gave a value of 40.2 which corresponds to a percentage level of confidence higher than 10% and giving reason to reject the hypothesis that Π=q2 overall at both 5 and 10% level of confidence.

Chapter 5

Summary, Conclusion and Recommendations

5.1 Summary

This study had the main objective of determining how well preceding birth techniqu estimates early child mortality in Kenya. To achieve the main objective, the study was answering the question: Can preceding birth technique be used to estimate child mortality by age two years in Kenya? This question is divided into more focused questions which correspond to the specific objectives as follows:

(i) What is the proportion dead among the preceding births reported in Kenya by all mothers and by mothers with medically assisted last delivery classified by mother's socioeconomic characteristics? To answer this questions, which achieve the first and fifth specific objectives, the study analyzed the survival status of the preceding births reported by mothers who gave birth in the last two and five years prior to KDHS 1998 survey (findings are in the previous chapter- table4.1 and 4.2).

(ii) How well do mortality proportions at age two years derived from medical data compare to those derived from all the survey data? To answer this question, which achieves objective three, the study analyzed the difference between the two sets of estimates by mothers' socioeconomic characteristics (Analysis and findings are in the previous chapter- Tables 4.1 and 4.2).

(iii) What is the lifetable probability of dying by age two years in Kenya classified by mothers socioeconomic characteristics? To answer this question, which achieves the second and sixth objectives, the study analyzed the births and their survival status as reported in the last five years prior to survey (Analysis of these findings are in the Appendix).

(iv) How well do estimates derived from preceding births compare to lifetable probabilities of dying by age two years? To answer this question, which achieve the objectives four and seven, the study analyzed the difference between the two sets of estimates by mothers' socioeconomic characteristics (Analysis of these findings are in the previous chapter- Tables 4.3,4.4 and 4.6).

In Kenya only 45% births are medically assisted and vary by region, by level of education of mothers and by place of residence. To use the technique on hospital data, therefore we need to improve on household data to minimise selection bias and sampling variability.

Where there is low mortality the technique suffers from sampling variability and selection bias eg Eastern, Central and Nairobi provinces. High mortality zones such as Nyanza, Western and Coast province, the technique gave plausible results

Its suggested that more hospital data be obtained say from provincial hospital over a fairly long period to generate reasonable number of cases that can be categorised accordingly and still provide enough cases for differential analysis.

5.2 Conclusion

This study finally shows that its true that preceding birth technique can be used to estimate mortality in Kenya when survival status of all preceding births reported are considered. The suitability of the technique vary with the level of early child mortality in an area. The technique was found to work well only in moderate to high mortality population areas such Nyanza, Coast and Western province, population without formal education and those with upto primary level, and the rural population. In low child mortality populations coupled with higher birth intervals – way above 30 months such as Central and Nairobi, the hypothesis was rejected while Rift valley with moderate child mortality level but with a birth interval of about 32 months, it was accepted.

The results derived from the analysis based on medical data, do not give any conclusive findings about the reliability of use of preceding birth technique to estimate lifetable probability of dying by age two in Kenya. This is attributed to small sample sizes drawn, sampling variability, selectivity bias associated with medical data and the general tendency of the technique to underestimate mortality.

Samples drawn from the medical data used, gave very few cases of medical attended deliveries in Kenya by socioeconomic categories of the mother such that some categories such as Nairobi, Coast Western and population without formal education, could not allow for meaningful analysis. Increase in sample size, tended to improve the estimates as seen in Eastern province where estimate based on five years reporting period is better (larger sample) than in two years reporting period. Where sample sizes were large enough, the estimates still tended to underestimate early child mortality due to sampling variability.

The choice to use medical data was in order for it is easily and cheaply generated and so available in the less developed countries where complete data set are scarce. In Kenya, clinic system is unstable with only 45% mothers reporting medical assisted delivery thus does not give reliable estimates of mortality at age two. It is then advisable that mothers be surveyed at more representative contact points such as antenatal visits and first vaccination contact(BCG) for her recently born child.

From the analysis, it was found that just like when all preceding births are reported, the technique works well in moderate to high mortality region. In areas with low mortality, it suffers from sampling variability and selection bias associated with medical data. The small sample sizes derived from medical grouping for some categories also made it very difficult for a meaningful analysis thus the inconclusive results. Where reasonable sample sizes were available, the results improved tremendously e,g the overall medical two years gave proportion that approximated lifetable probability at age two years. Results of other categories also improved when five years data was used.

Underestimation tendency inherent in the technique is attributed to exclusion of the survival status of both the only child and the last birth in mothers' birth histories. Studies have found risk of child mortality to increase with age of mother and parity and so last births are more likely to die early in life than other births and yet preceding birth technique excludes the experience. The only child, in most cases, is but a first born to future subsequent births. In developing countries, most first births are born to young mothers without the experience of child care and others before the bodies are fully grown to minimise the risk of child mortality associated with child birth. As a result, these births are more likely to die. These counts are excluded by the preceding technique.

While judging the technique, we should not lose sight to the fact that it was meant to supplement the other techniques of estimating mortality where data were lacking or insufficient for complete computation of the estimates using other methods.

The technique should therefore help health planners, policy makers and health providers to monitor trends in early childhood mortality in their country or catchment area. Some uses of the index derived from the technique could be

(i) to identify problem areas for special focus

(ii) to monitor the impact of primary health care programs in the catchment areas of health facilities.

(iii) To improve understanding of the distribution of risk or differential risks among the population in the catchment area

(iv) To conduct family risk assessment to improve/set targeting strategies to reach high risk groups.

(v) Individuals patient management and follow-up of high risk mothers

(vi) Case investigation of adverse outcomes

(vii) Some cause of death inquiries may be possible, especially when data are obtained by health clinic staff

(viii) Evaluation of services by clinic staff

(ix) To increase local awareness and involve district health committees and organisations in setting priorities for community health services.

5.3 Recommendations

5.3.1 Policy Makers

The results of the study suggest that:

(i) The technique should be used only in moderate to high child mortality regions.

(ii) Clinic system in Kenya is unstable with only 45% mothers reporting medical assisted delivery. This needs to be improved by surveying mothers in more representative contact points such as antenatal visits which cover 67% and first vaccination contact (BCG) for their recently born children 92% (appendix table5.1).

Where hospital data is used, large enough samples should be drawn to minimise sampling variability. There is also need to intensify medical delivery promotion programs to ensure healthy and safe birth for both mother and child.

(iii) The technique should be used to supplement other techniques of estimating mortality

(iv) Due to the fact that the estimate derived from the technique underestimates mortality, it can only then be regarded as an index of mortality situation and so may be used to describe trend but not level of child mortality.

5.3.2 Researchers

Further research need to be done to establish reliability of the technique using medical data. The required data may be drawn from all maternity cases in a provincial or district hospital over a period of time long enough to generate substantial cases. Better still, is to identify more representative catchment areas such as:

(i) where the majority of pregnant women visit ante-natal clinics, a simple tally can be done from mother' birth history of the numbers of preceding children who have died (Appendix table 5.1)..

(ii) Collect data when mothers bring their most recently born child for immunisation The rate of childhood immunization by BCG is universally high and so, a more reliable contact point (Appendix table 5.1).

There is also need for a research to examine the trend in variability between the two estimates by the mothers' soci-economic characteristic. With the trend, an index may be developed which would be used to adjust medical associated estimates for underestimation.

Regarding methodological issues, there is need to gather longitudinal data continuously to facilitate analysis of early child mortality. This will allow managers and health providers to generate running estimates of childhood mortality trends for districts and sub-populations. The data collection process can fit into regular patient management since the indicator in question has meaning both to health professionals examining the individual mother, and to planners interested in the level and trend in early childhood mortality in the wider community.

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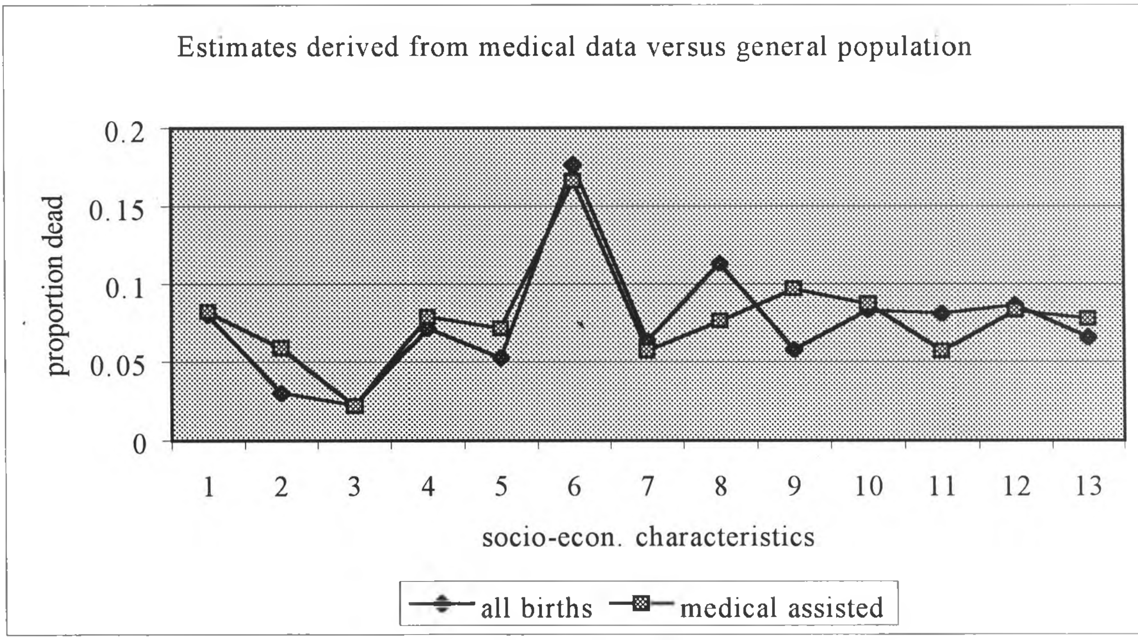
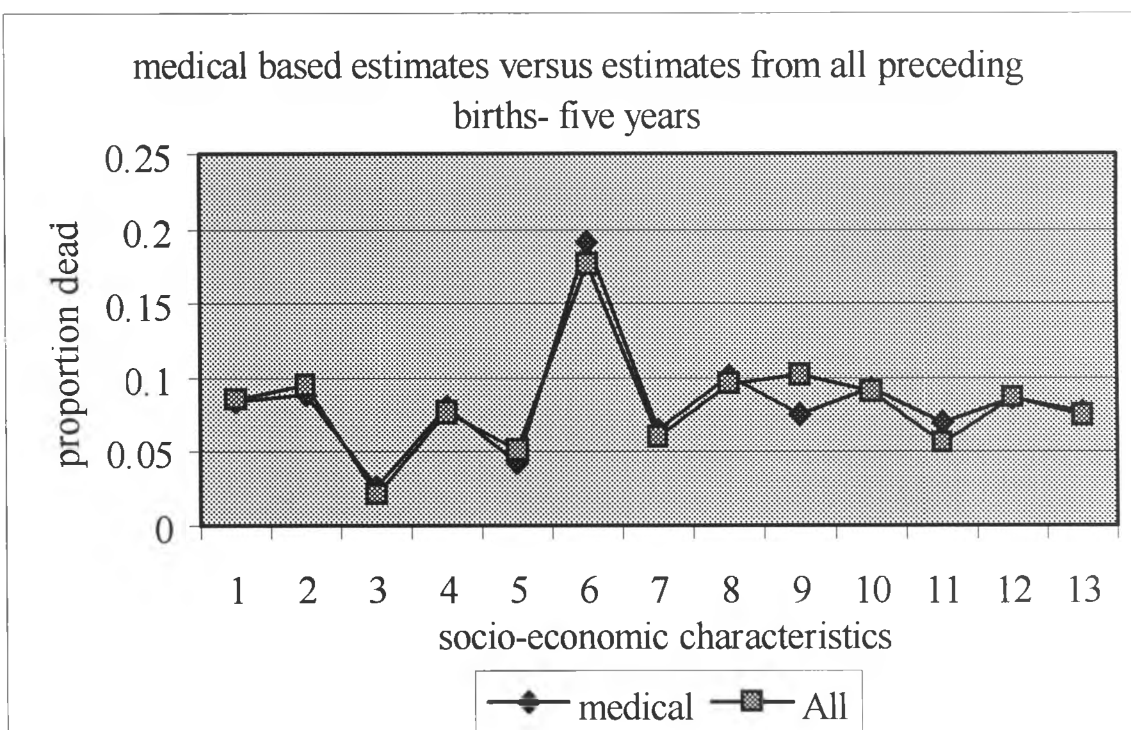
APPENDIX

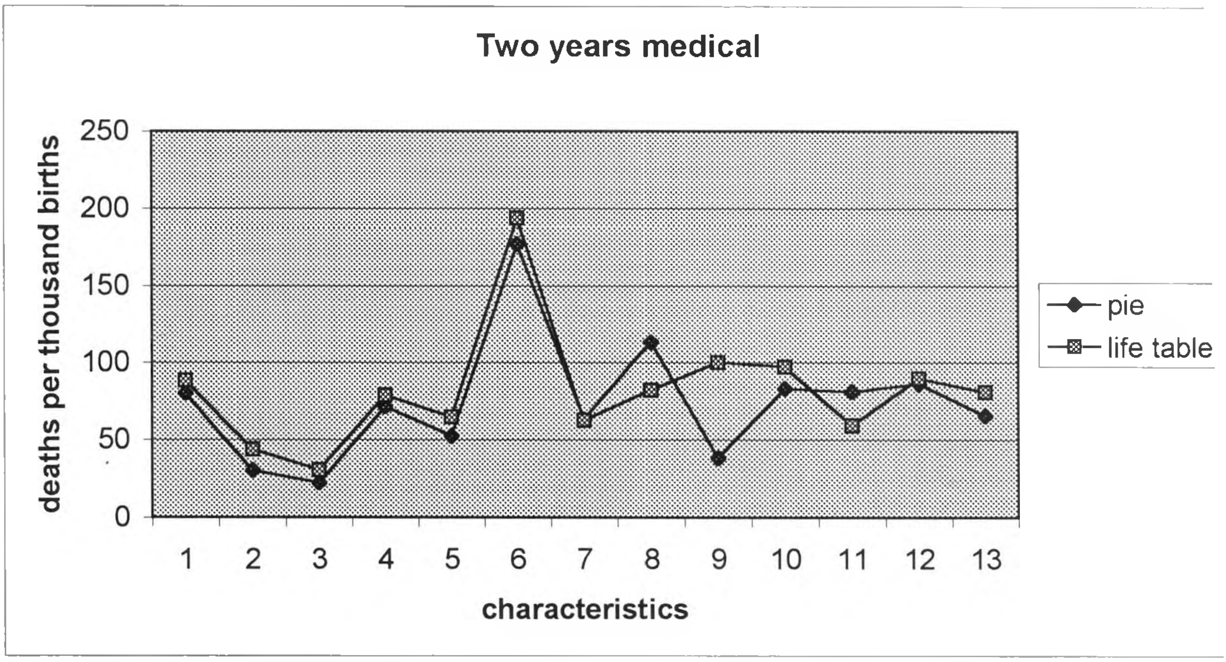
Appendix chart 1: Comparing estimates derived from medical data with those from general Population- two years reporting period



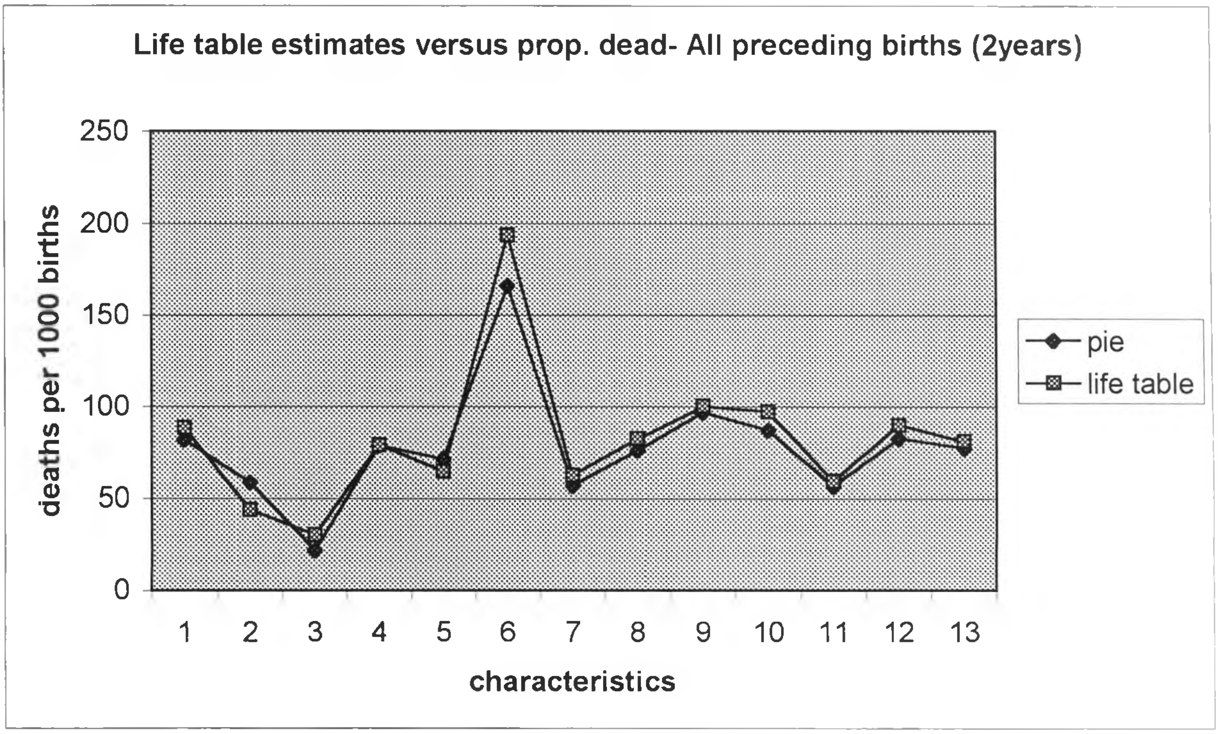
Appendix chart 2: Comparing estimates derived from medical data with those from all preceding births- five years



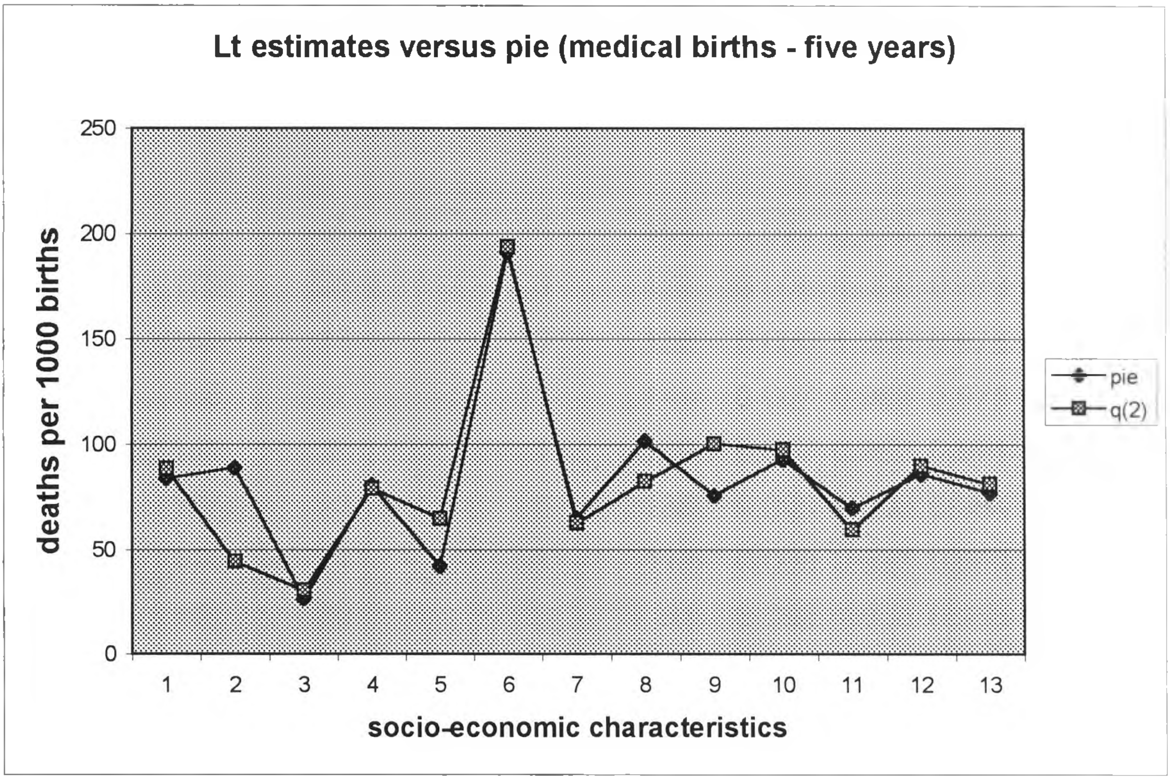
Appendix Chart 3: Comparing proportion dead reported in the last two years prior to survey by women delivering in clinics with lifetable estimates



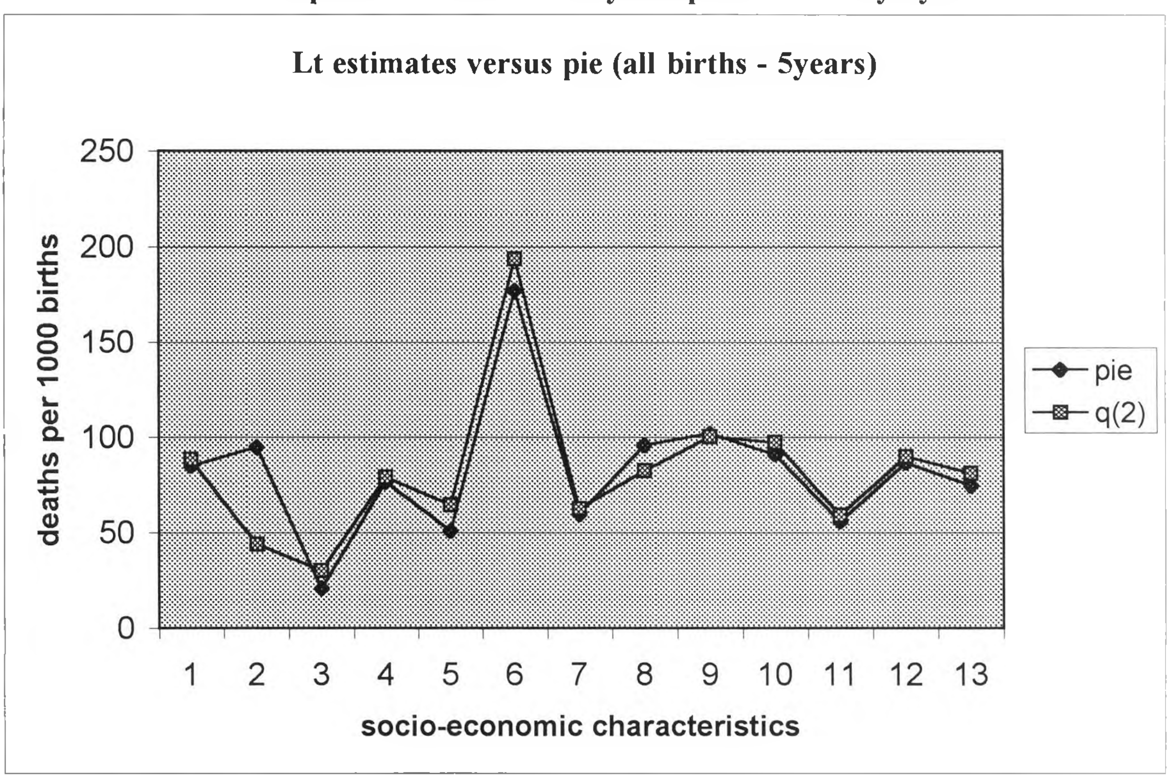
Appendix Chart4: Comparing proportion dead among preceding births reported in the last two years prior to survey by all women with lifetable estimates



Appendix Chart 5: Comparing proportion dead reported in the last five years prior to survey by women delivering in clinics with lifetable estimates



Appendix Chart 6:Comparing patterns in proportion dead among preceding births reported in the last five years prior to survey by all women



Appendix Table 3.2: Nairobi Life table

		Children						
Age in months	Alive at Begin. of Interval	Alive age x	Dead age x	At risk	nqx	npx	lx	qx
0	185	2	4	184	0.022	0.978	1.000	0.000
1	179	21	0	177	0.000	1.000	0.978	0.022
6	158	13	0	156	0.000	1.000	0.978	0.022
10	145	3	1	144	0.007	0.993	0.978	0.022
11	141	3	1	140	0.007	0.993	0.971	0.029
12	137	23	0	135	0.000	1.000	0.964	0.036
18	114	21	1	112	0.009	0.991	0.964	0.036
24	92	30	0	91	0.000	1.000	0.956	0.044
36	62	35	1	45	0.023	0.978	0.956	0.044
48	26	25	0	14	0.000	1.000	0.934	0.066
60	1	1	0	1	0.000	1.000	0.934	0.066

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.3: Central province -Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Children Dead age x	Children At risk	Nqx	npx	lx	qx
0	470	9	10	466	0.022	0.979	1.000	0.000
1	451	6	2	448	0.005	0.996	0.979	0.022
2	443	6	1	440	0.002	0.998	0.974	0.026
3	436	9	0	432	0.000	1.000	0.972	0.028
4	427	13	0	421	0.000	1.000	0.972	0.028
5	414	12	1	408	0.003	0.998	0.972	0.028
6	401	57	0	373	0.000	1.000	0.970	0.030
12	344	76	0	306	0.000	1.000	0.970	0.030
24	268	84	0	226	0.000	1.000	0.970	0.030
36	184	95	0	137	0.000	1.000	0.970	0.030
48	89	78	1	50	0.020	0.980	0.970	0.030
60	10	10	0	5	0.000	1.000	0.950	0.050

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.4: Coast Province-Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Children Dead age x	At risk	nqx	npx	lx	qx
0	850	8	23	846	0.027	0.973	1.000	0.000
1	819	20	5	809	0.006	0.994	0.973	0.027
2	794	15	1	787	0.001	0.999	0.967	0.033
3	778	11	3	773	0.004	0.996	0.966	0.034
4	764	16	4	756	0.005	0.995	0.962	0.038
5	744	12	0	738	0.000	1.000	0.957	0.043
6	732	15	7	725	0.010	0.990	0.957	0.043
7	710	14	1	703	0.001	0.999	0.947	0.053
8	695	18	5	686	0.007	0.993	0.946	0.054
9	672	10	0	667	0.000	1.000	0.939	0.061
10	662	12	0	656	0.000	1.000	0.939	0.061
11	650	8	2	646	0.003	0.997	0.939	0.061
12	640	21	6	630	0.010	0.990	0.936	0.064
13	613	15	1	606	0.002	0.998	0.927	0.073
14	597	15	1	590	0.002	0.998	0.926	0.074
15	581	14	1	574	0.002	0.998	0.924	0.076
16	566	20	0	556	0.000	1.000	0.923	0.077
17	546	13	1	540	0.002	0.998	0.923	0.077
18	532	88	0	488	0.000	1.000	0.921	0.079
24	444	153	2	368	0.005	0.995	0.921	0.079
36	289	127	2	226	0.009	0.991	0.916	0.084
48	160	142	0	89	0.000	1.000	0.908	0.092
60	18	18	0	9	0.000	1.000	0.908	0.092

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.5: Eastern Province -Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Dead age x	At risk	nqx	npx	lx	qx
0	780	8	24	776	0.031	0.969	1.000	0.000
1	748	12	1	742	0.001	0.999	0.969	0.031
2	735	16	3	727	0.004	0.996	0.968	0.032
3	716	15	5	709	0.007	0.993	0.964	0.036
4	696	8	0	692	0.000	1.000	0.957	0.043
5	688	11	0	683	0.000	1.000	0.957	0.043
6	677	15	0	670	0.000	1.000	0.957	0.043
7	662	19	3	653	0.005	0.995	0.957	0.043
8	640	13	3	634	0.005	0.995	0.953	0.047
9	624	8	3	620	0.005	0.995	0.948	0.052
10	613	8	1	609	0.002	0.998	0.943	0.057
11	604	15	0	597	0.000	1.000	0.942	0.058
12	589	11	2	584	0.003	0.997	0.942	0.058
13	576	15	0	569	0.000	1.000	0.939	0.061
14	561	13	1	555	0.002	0.998	0.939	0.061
15	547	10	1	542	0.002	0.998	0.937	0.06
16	536	99	0	487	0.000	1.000	0.935	0.065
24	437	159	1	358	0.003.	0.997	0.935	0.065
36	277	128	0	213	0.000	1.000	0.933	0.067
48	149	135	0	82	0.000	1.000	0.933	0.067
60	14	14	0	7	0.000	1.000	0.933	0.067

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.6 : Nyanza province -Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Children Dead age x	At risk	nqx	Npx	lx	qx
0	1041	13	42	1035	0.0406	0.959	1.000	0.000
1	986	16	5	978	0.0051	0.995	0.959	0.041
2	965	9	13	961	0.0135	0.986	0.954	0.046
3	943	23	18	932	0.019	0.981	0.942	0.058
4	902	14	14	895	0.016	0.984	0.923	0.077
5	874	9	12	870	0.014	0.986	0.909	0.091
6	853	21	9	843	0.011	0.989	0.896	0.104
7	823	15	7	816	0.009	0.991	0.887	0.113
8	801	24	13	789	0.017	0.984	0.879	0.121
9	764	14	7	757	0.009	0.991	0.865	0.135
10	743	13	3	737	0.004	0.996	0.857	0.143
11	727	16	2	719	0.003	0.997	0.853	0.147
12	709	16	15	701	0.021	0.979	0.851	0.149
13	678	18	1	669	0.002	0.999	0.833	0.167
14	659	13	4	653	0.006	0.994	0.831	0.169
15	642	35	0	625	0.000	1.000	0.826	0.174
17	607	5	2	605	0.003	0.997	0.826	0.174
18	600	16	6	592	0.010	0.990	0.824	0.176
19	578	19	2	569	0.004	0.996	0.815	0.185
20	557	19	2	548	0.004	0.996	0.812	0.188
21	536	11	1	531	0.002	0.998	0.809	0.191
22	524	14	0	517	0.000	1.000	0.808	0.192
23	510	17	1	502	0.002	0.998	0.808	0.192
24	492	160	6	412	0.015	0.985	0.806	0.194
36	326	148	3	252	0.012	0.988	0.795	0.205
48	175	157	0	97	0.000	1.000	0.785	0.215
60	18	18	0	9	0.000	1.000	0.785	0.215

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.7: Rift valley province -Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Dead age x	At risk	nqx	Npx	lx	qx
0	1670	10	52	1665	0.031	0.969	1.000	0.000
1	1608	31	3	1593	0.002	0.998	0.969	0.031
2	1574	24	3	1562	0.002	0.998	0.967	0.033
3	1547	21	7	1537	0.005	0.995	0.965	0.035
4	1519	23	2	1508	0.001	0.999	0.961	0.039
5	1494	29	1	1480	0.001	0.999	0.959	0.041
6	1464	27	1	1451	0.001	0.999	0.959	0.041
7	1436	32	2	1420	0.001	0.999	0.958	0.042
8	1402	22	5	1391	0.004	0.996	0.957	0.043
9	1375	29	6	1361	0.004	0.996	0.953	0.047
10	1340	33	2	1324	0.002	0.998	0.949	0.051
11	1305	37	1	1287	0.001	0.999	0.948	0.052
12	1267	24	7	1255	0.006	0.994	0.947	0.053
13	1236	24	1	1224	0.001	0.999	0.942	0.058
14	1211	21	0	1201	0.000	1.000	0.941	0.059
15	1190	28	1	1176	0.001	0.999	0.941	0.059
16	1161	74	0	1124	0.000	1.000	0.940	0.060
18	1087	22	3	1076	0.003	0.997	0.940	0.060
19	1062	139	0	993	0.000	1.000	0.937	0.063
24	923	301	2	773	0.003	0.997	0.937	0.063
36	620	287	2	477	0.004	0.996	0.935	0.065
48	331	299	2	182	0.011	0.989	0.931	0.069
60	30	30	0	15	0.000	1.000	0.921	0.079

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.8: Western province -Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Children Dead age x	At risk	nqx	Npx	lx	qx
0	782	10	15	777	0.019	0.981	1.000	0.000
1	757	12	0	751	0.000	1.000	0.981	0.019
2	745	16	2	737	0.003	0.997	0.981	0.019
3	727	9	3	723	0.004	0.996	0.978	0.022
4	715	14	6	708	0.009	0.992	0.974	0.026
5	695	12	4	689	0.006	0.994	0.966	0.034
6	679	17	3	671	0.005	0.996	0.96	0.040
7	659	6	2	656	0.003	0.997	0.956	0.044
8	651	10	1	646	0.002	0.998	0.953	0.047
9	640	14	2	633	0.003	0.997	0.951	0.049
10	624	10	1	619	0.002	0.998	0.948	0.052
11	613	12	2	607	0.003	0.997	0.947	0.053
12	599	21	7	589	0.012	0.988	0.944	0.056
13	571	9	1	567	0.002	0.998	0.933	0.068
14	561	15	1	554	0.002	0.998	0.931	0.069
15	545	11	1	540	0.002	0.998	0.929	0.071
16	533	32	0	517	0.000	1.000	0.927	0.073
18	501	10	3	496	0.006	0.994	0.927	0.073
19	488	22	0	477	0.000	1.000	0.922	0.078
21	466	16	1	458	0.002	0.998	0.922	0.078
22	449	11	0	444	0.000	1.000	0.920	0.080
23	438	11	1	433	0.002	0.998	0.920	0.080
24	426	153	4	350	0.011	0.989	0.918	0.082
36	269	142	3	198	0.015	0.985	0.907	0.093
48	124	113	4	68	0.059	0.941	0.893	0.107
60	7	7	0	4	0.000	1.000	0.841	0.160

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.9: No formal Education category -Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Dead age x	At risk	nqx	npx	lx	qx
0	708	3	24	707	0.034	0.966	1.000	0.000
1	681	9	2	677	0.003	0.997	0.966	0.034
2	670	6	2	667	0.003	0.997	0.963	0.037
3	662	9	4	658	0.006	0.994	0.960	0.040
4	649	6	5	646	0.008	0.992	0.954	0.046
5	638	11	2	633	0.003	0.997	0.947	0.053
6	625	11	6	620	0.010	0.990	0.944	0.056
7	608	9	4	604	0.007	0.993	0.935	0.065
8	595	12	1	589	0.002	0.998	0.929	0.071
9	582	10	4	577	0.007	0.993	0.927	0.073
10	568	18	0	559	0.000	1.000	0.921	0.079
12	550	15	9	543	0.017	0.983	0.921	0.079
13	526	9	1	522	0.002	0.998	0.905	0.095
14	516	12	1	510	0.002	0.998	0.904	0.096
15	503	59	0	474	0.000	1.000	0.902	0.098
21	444	11	1	439	0.002	0.998	0.902	0.098
22	432	30	0	417	0.000	1.000	0.900	0.100
24	402	136	2	334	0.006	0.994	0.900	0.100
36	264	119	3	205	0.015	0.985	0.894	0.106
48	142	123	2	81	0.025	0.975	0.881	0.119
60	17	17	0				0.859	0.141

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.10: Mothers with primary education -Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Dead age x	At risk	nqx	npx	lx	qx
0	3676	42	114	3655	0.031	0.969	1.000	0.000
1	3520	68	12	3486	0.003	0.997	0.969	0.031
2	3440	53	16	3414	0.005	0.995	0.965	0.035
3	3371	55	25	3344	0.008	0.993	0.961	0.039
4	3291	61	14	3261	0.004	0.996	0.954	0.046
5	3216	56	14	3188	0.004	0.996	0.950	0.050
6	3146	69	14	3112	0.005	0.996	0.945	0.055
7	3063	64	6	3031	0.002	0.998	0.941	0.059
8	2993	66	23	2960	0.008	0.992	0.939	0.061
9	2904	55	12	2877	0.004	0.996	0.932	0.068
10	2837	59	8	2808	0.003	0.997	0.928	0.072
11	2770	71	8	2735	0.003	0.997	0.926	0.075
12	2691	71	25	2656	0.009	0.991	0.923	0.077
13	2595	60	3	2565	0.001	0.999	0.914	0.086
14	2532	57	5	2504	0.002	0.998	0.913	0.087
15	2470	57	4	2442	0.002	0.998	0.911	0.089
16	2409	72	0	2373	0.000	1.000	0.910	0.090
17	2337	53	2	2311	0.001	0.999	0.910	0.090
18	2282	54	9	2255	0.004	0.996	0.909	0.091
19	2219	56	2	2191	0.001	0.999	0.905	0.095
20	2161	64	2	2129	0.001	0.999	0.905	0.095
21	2095	55	1	2068	0.001	1.000	0.904	0.096
22	2039	56	0	2011	0.000	1.000	0.903	0.097
23	1983	71	1	1948	0.001	0.999	0.903	0.097
24	1911	643	11	1590	0.007	0.993	0.903	0.097
36	1257	582	7	966	0.007	0.993	0.897	0.104
48	668	605	2	366	0.006	0.995	0.890	0.110
60	61	61	0				0.885	0.115

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.11: Mothers with at least secondary education -Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Dead age x	At risk	nqx	npx	lx	qx
0	1394	15	32	1387	0.023	0.977	1.000	0.000
1	1347	21	2	1337	0.002	0.999	0.977	0.023
2	1324	33	5	1308	0.004	0.996	0.975	0.025
3	1286	31	7	1271	0.006	0.994	0.972	0.028
4	1248	26	7	1235	0.006	0.994	0.966	0.034
5	1215	20	2	1205	0.002	0.998	0.961	0.039
6	1193	26	0	1180	0.000	1.000	0.959	0.041
7	1167	29	5	1153	0.004	0.996	0.959	0.041
8	1133	23	3	1122	0.003	0.997	0.955	0.045
9	1107	23	2	1096	0.002	0.998	0.953	0.047
10	1082	38	0	1063	0.000	1.000	0.951	0.049
12	1044	20	3	1034	0.003	0.997	0.951	0.049
13	1021	21	0	1011	0.000	1.000	0.948	0.052
14	1000	22	1	989	0.001	0.999	0.948	0.052
15	977	52	0	951	0.000	1.000	0.947	0.053
17	925	20	1	915	0.001	0.999	0.947	0.053
18	904	27	4	891	0.005	0.996	0.946	0.054
19	873	88	0	829	0.000	1.000	0.942	0.058
23	785	15	1	778	0.001	0.999	0.942	0.058
24	769	261	2	639	0.003	0.997	0.941	0.059
36	506	261	1	376	0.003	0.997	0.938	0.062
48	244	221	3	134	0.023	0.978	0.935	0.065
60	20	20	0				0.914	0.086

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.12: Urban population -Lifetable

Age in months	Alive at Begin. of Interval	Children Alive age x	Dead age x	At risk	nqx	npx	lx	qx
0	827	5	18	825	0.022	0.978	1.000	0.000
1	804	16	5	796	0.006	0.994	0.978	0.022
2	783	17	2	775	0.003	0.997	0.972	0.028
3	764	14	4	757	0.005	0.995	0.970	0.031
4	746	17	6	738	0.008	0.992	0.964	0.036
5	723	14	2	716	0.003	0.997	0.957	0.044
6	707	11	1	702	0.001	0.999	0.954	0.046
7	695	21	2	685	0.003	0.997	0.953	0.048
8	672	17	5	664	0.008	0.992	0.950	0.050
9	650	20	1	640	0.002	0.998	0.943	0.057
10	629	19	1	620	0.002	0.998	0.941	0.059
11	609	10	1	604	0.002	0.998	0.940	0.060
12	598	13	5	592	0.009	0.992	0.938	0.062
13	580	15	1	573	0.002	0.998	0.930	0.070
14	564	20	0	554	0.000	1.000	0.928	0.072
15	544	18	0	535	0.000	1.000	0.928	0.072
16	526	18	0	517	0.000	1.000	0.928	0.072
17	508	9	0	504	0.000	1.000	0.928	0.072
18	499	14	4	492	0.008	0.992	0.928	0.072
19	481	12	1	475	0.002	0.998	0.921	0.079
20	468	11	0	463	0.000	1.000	0.919	0.081
21	457	15	0	450	0.000	1.000	0.919	0.081
22	442	17	0	434	0.000	1.000	0.919	0.081
23	425	13	0	419	0.000	1.000	0.919	0.081
24	412	136	1	344	0.003	0.997	0.919	0.081
36	275	134	2	208	0.010	0.990	0.916	0.084
48	139	120	1	79	0.013	0.987	0.908	0.093
60	18	18	0	9	0.000	1.000	0.896	0.104

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 3.13: Rural population

Age in months	Alive at Begin. of Interval	Children Alive age x	Dead age x	At risk	nqx	npx	lx	qx
0	4951	55	152	4924	0.031	0.969	1.000	0.000
1	4744	82	11	4703	0.002	0.998	0.969	0.031
2	4651	75	21	4614	0.005	0.995	0.967	0.033
3	4555	81	32	4515	0.007	0.993	0.962	0.038
4	4442	76	20	4404	0.005	0.995	0.956	0.044
5	4346	73	16	4310	0.004	0.996	0.951	0.049
6	4257	95	19	4210	0.005	0.995	0.948	0.052
7	4143	81	13	4103	0.003	0.997	0.943	0.057
8	4049	84	22	4007	0.006	0.995	0.940	0.060
9	3943	68	17	3909	0.004	0.996	0.935	0.065
10	3858	69	7	3824	0.002	0.998	0.931	0.069
11	3782	88	7	3738	0.002	0.998	0.930	0.070
12	3687	93	32	3641	0.009	0.991	0.928	0.072
13	3562	75	3	3525	0.001	0.999	0.920	0.080
14	3484	71	7	3449	0.002	0.998	0.919	0.081
15	3406	171	4	3371	0.001	0.999	0.917	0.083
17	3231	73	3	3195	0.001	0.999	0.916	0.084
18	3155	76	9	3117	0.003	0.997	0.915	0.085
19	3070	73	1	3034	0.000	1.000	0.912	0.088
20	2996	80	2	2956	0.001	0.999	0.912	0.088
21	2914	77	2	2876	0.001	0.999	0.911	0.089
22	2834	75	0	2798	0.000	1.000	0.911	0.089
23	2759	88	2	2716	0.001	0.999	0.911	0.089
24	2669	904	14	2218	0.006	0.994	0.910	0.090
36	1751	828	9	1338	0.007	0.993	0.904	0.096
48	914	829	6	501	0.010	0.990	0.898	0.102
60	80	80	0	40	0.000	1.000	0.889	0.111

Source: Calculated from birth history data in KDHS, 1998

Appendix Table 5.1:DHS statistics

(i) Assistance delivery: Medical- 44, TBA-21%, Relative/others-24%, No one=10%. Trained medical attendance during delivery can help ensure a healthy and safe birth for both mother and child.

(ii) Adolescent childbearing is common in Kenya. Nearly half of 19 years old are pregnant or are already mothers

(iii) Median age at marriage =19.8 years

(iv) Median age at 1st intercourse 16.8 years

	Kenya	Mombasa	Muranga	Nyeri	Kilifi	Taveta	Machakos	Meru	Kisii	Siaya	S.Nyanza	Kericho	Nakuru	Nandi	Uasin Gish	Bungoma	Kakam
Births in health facility	42	56	62	87	17	29	31	77	37	24	24	36	36	23	28	27	22
%Immunisation	67	49	a	90	68	92	78	84	67	43	23	75	76	68	69	59	58
Antenatal care	92	94	96	97	88	97	87	96	91	95	88	94	90	93	92	92	93
15-19yrs old - pregnant or mothers	21	29	a	16	23	20	16	15	16	36	28	33		20	18	20	21

Source: Kenya Demographic and Health Survey 1998