ESTIMATION OF AGE DISTRIBUTIONS, CENSUS COVERAGE AND DEATH REGISTRATION COMPLETENESS IN KENYA

BY

MONICA AKINYI MAGADI

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DECLARATION

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

signature ----------------
MAGADI M. A.

This thesis has been submitted for examination with our approval as university supervisors:

signature ------------------
DR. J. A. M. OTTIENO

signature ----------------------
PROF. C. HAMMERSLOUGH

signature ---------------------
DR. Z. MUGANZI

Population Studies and Research Institute
University of Nairobi
P. O. Box 30197,
Nairobi

DEDICATION

This thesis is dedicated to my husband, Joseph Ponono Magadi

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ABSTRACT

This thesis has examined two aspects of demography, namely; the completeness of death registration and relative coverage of censuses in Kenya at the national level and by sex. The data used was the 1969 and 1979 censuses and the death registration during the period between 1969 and 1979. Two techniques were used, namely; Hill's version of the generalized growth balance technique and the Palloni - Kominski foward - backward projection method.

The results showed that the completeness of death registration was 26.18 percent for males and 18.25 percent for females using Hill's technique. The Palloni - Kominski method gave relatively lower death registration completeness of 19.39 percent for males and 14.50 percent for females. The relative coverage of the the 1979 census with respect to the 1969 census was 98.79 percent for males and 97.11 percent for females by the Hill's technique. Using the Palloni - Kominski method, however the coverage was 103.58 percent for males and 100.57 percent for females.

The second aspect of the thesis was the detection and correction of errors due to age misreporting. For detection, the age ratio technique and the age specific growth rate technique were used. For correction, the Demeny - Shorter method and the Saxena - Gogte method were used. Having corrected the errors due to age misreporting individually and jointly, then the age specific growth rate technique was again applied to the corrected data for

a check up. The effect of changes in census coverage, mortality level and life expectancy at old age was also looked into.

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LIST OF ABBREVIATIONS

ART - Age Ratio Technique

ASGRT - Age Specific Growth Rate Technique

DSM - Demeny-Shorter Method

SGT - Saxena-Gogte Technique

WFS - World Fertility Survey

CHAPTER 1

THE GENERAL INTRODUCTION

1.1 INTRODUCTION

Demographic data compiled by national population censuses in the developing countries are often subject to a number of limitations resulting from age misreporting and coverage errors. The inadequacy of the age statistics can generally be attributed to one or both of two basic sources, namely; failure to report ages, (or) mis-statement of ages that are reported. When the former occurs, and the proportion of unknown ages is significantly large, not much can be done unless the researcher has access to other data that would provide a basis for a realistic distribution of unknowns among the population with known ages. However, in most cases, the problem of unknown ages is secondary and it is errors in the ages reported that constitute the most serious source of bias in age data.

1.2 STATEMENT OF THE PROBLEM

One of the major difficulties in African population censuses and surveys is the measurement of age. The problem is not simply one of vagueness or digit preference by the respondent but more commonly of complete ignorance. The enumerator frequently has to make an estimate from appearance, memories of events, and marital status, among others. An examination of age distributions obtained in African censuses revealed great and systematic distortions (Brass and Coale, 1968). Several methods of estimating demographic parameters for developing countries depend on the relation between two age distributions. Age misreporting and variations in census coverage distort this relation and introduce biases in the estimate. Demographers have, therefore, made available several methods for graduating age distributions to make them conform to certain patterns of stable models on the assumption that deviations from these patterns are due to error. The main danger in applying this procedure is in imposing an unrealistic model on the data and thus mistaking inherent features as errors. Age errors are not always easy to detect and may be very difficult to measure. In a number of demographic studies that have been carried out using Kenyan age data, the authors have merely mentioned that the data is of poor quality, but no real systematic work has been done in detecting and making appropriate adjustments for the existing errors.

1.3 OBJECTIVES OF THE STUDY

The main objective of the study, therefore, is to estimate age distributions, census coverage and death registration completeness in Kenya. Specifically, the purpose of the study is to (a) estimate the relative completeness of the 1979 census coverage with respect to the 1969 census coverage; (b) estimate the completeness of death registration in Kenya during the period 1969-1979; (c) identify the nature and extent of age misreporting errors in Kenyan data by applying various techniques of detecting age misreporting; and (d) make appropriate adjustments for age misreporting errors, and thus attempt to estimate Kenya's age distribution.

1.4 STUDY RATIONALE / JUSTIFICATION

There are clearly many biases involved at various stages of data collection and analysis, and users of the data need to recognise the presence of biases and the potential distortions of various measurements. Information on age is a basic variable in constructing many demographic parameters. Errors in reported age distributions affect the estimation of demographic measures, especially in the developing countries. The reliability of the derived estimates for these countries depend to a large extent on the degree of error and bias inherent in the age reporting of their populations. An evaluation of the nature and extent of distortions in reported age data will alert users of the data to their limitations and provide a guide to future census operations in the country. Improved knowledge on the distribution by age and its biases should, therefore, rank high in the order of priorities in African demogaphy, since no thorough demographic analysis is possible without it.

It should also be recognised that mortality estimates are not only important in estimating population growth, but are also valuable indicators of public health achievement and level of socio-economic developement. The analysis of mortality, therefore, is an indispensable part of informed decision making and evaluating public policies, including life insurance. For this reason, it is essential that attempts be made to obtain mortality estimates of the highest possible degree of accuracy. It is. therefore, necessary that errors in mortality data, such as the degree of incompleteness of death registration be identified.

1.5 SCOPE AND LIMITATION OF THE STUDY

Since most of the techniques to be employed in this study are based on the assumption that the population under study is closed to migration, the study will only be carried out at the national level, migration being insignificant at this level. Methods for making appropriate adjustments for the effect of migration may be available, but their application to data at district level is hindered by the limited amount of time available for this study. The study will utilize secondry data obtained from censuses and vital death registration. Specifically, the study will make use of single and five-year age distributions of the 1969 and 1979 population censuses clasified by sex and the 1969, 1974 and 1979 death registration by five-year age groups and by sex.

1.6 LITERATURE REVIEW

The literature review has been split into three categories. The first category deals with studies on detecting age misreporting while the second category focuses on methods of correcting age distributions; and, finally, the last category giving techniques of estimating completeness of death registration, and census enumerations.

Existing analytic techniques of detecting age misreporting are of several types. The first type consists of indices of digit preference for each digit. Myers (1940) proposed the measure still most frequently used while Bachi (1951) and the United Nations (1961) put foward variants of Myers' approach. The second type of measures consist of summary indices of digit preference or undifferentiated age misstatement. Marten (1924) made use of the index known as Whipple Index. Myers (1940) presented a summary index derived from his indices of preference for each digit. An index of all types of age misstatement was proposed by the United Nations (1955) and a variant by Das Gupta (1955). Barclay (1958), however, observed that a demographic analyst is not really interested in an index of digit preference for the entire age distribution since some parts are more likely to be of more interest than the whole.

Nagi, Stockwell and Snavley (1973) examined the extent of digit preference and avoidance in the age statistics of African censuses, paying particular attention to identifying some of the social and economic correlates of age heaping. They calculated age ratios to detect age heaping at particular ages and applied Myers' (1940) blending technique to the single year age statistics of selected 31 African nations, by socio-economic differentials. The same technique was later applied to World Fertility Survey (WFS) data from various regions, namely: Nepal (Goldman, Coale and Weinstein, 1979), Mexico (Ordorica and potter, 1981), Jordan (Blacker, Hill and Moser, 1983), Ghana

(Owusu,1984), Cameroon (Santow and Bioumla, 1984) and Lesotho (Timaeus and Balasubramanian, 1985). Apart from using Myers' blending technique. detection of age misreporting in the WFS data was also achieved through: examination of single-year and five-year age group distributions as fitted by stable population distributions; use of Whipples, United Nations and rectangular indices; matching of age reports; and examination of age-sex pyramids and sex ratios.

Nagi and associates (1973) observed that the degree of heaping was more pronounced for the Islamic than non-Islamic regions. Age heaping was also observed to be greater for females than males. Apart from a few exceptions, digit preference was found to increase with age and conformed to the following pattern, namely; 0 was the most prefered, followed by: 5, 2 and 8, 4 and 6, 3 and 7, and finally, 1 and 9 were the most avoided. These results were consistent with the findings of the pattern of age misreporting in the WFS data. It was also observed that greater accuracy in age reporting was associated with higher level of socio-economic developement.

Techniques for smoothing age distribution data by graduating five or ten-year age groupings and interpolating for single years had been presented by Bachi (1951), Jaffe (1951), Wolfenden (1954), Carrier and Farrag (1955), and Shryock and Siegel (1971). Such methods are open to the criticism that no graduated series can properly be assumed to be a representation of the numbers which should have been recorded in the sense that the difference between the graduated and the ungraduated series are only misstatement of age. Futhermore, different methods of graduation vary greatly in their smoothing power, and may produce very different estimates of error (Wolfenden, 1954).

Demeny and Shorter (1968) devised a special method of correcting age misreporting that could separate true irregularities from reported errors. The method is based on the following assumptions: (a) the pattern of age misreporting is systematic and repeats itself from one census to the next; (b) the population is assumed to experience an appropriate mortality schedule; and (c) the total population was enumerated correctly, or at least that the coverage of the two censuses was reasonably close. The correction factors obtained after applying this technique to the pairs of Turkish censuses for 1935-40 and 1955-60 provided the following information about age misreporting: The ages of young children were exaggerated, causing a relative deficit at ages 0-4 and contributing to an excess at ages 5-9. This was true for both sexes. Women near the age of puberty and early marriage tended to exaggerate their ages once these events were passed and this depleted the reported size of the 10-14 and 15-19 age groups. They continued to be transferred upwards across the age boundaries at 25 and 30, causing excessive proportions to be reported at ages 25-29 and 30-34. For males, the pattern of misreporting indicated smaller errors and a different progression of the events which influenced judgement on age. This was attributed to higher male literacy and the importance of age in determining the time for military service. The fact that males were transferred downwards across the boundaries at ages 15 and 20 could have been due to a tendency to assign lower than true ages to men who were later than usual in maturing physically or performing military service. The errors at ages above 40 for both sexes had a saw-tooth pattern, containing a relatively large component of digit preference at multiples of 10. Since the pattern of errors was so closely similar for the pairs of censuses separated by 20 years, the assumption that systematic repetitive error occured appeared to be fully supported.

Das Gupta (1975) observed that the Demeny-Shorter method gave excellent results when the true age distributions for the two censuses were identical or reasonably close. However, as the disparity between them widened, it became increasingly difficult for the method to satisfy simultaneously the three underlying assumptions. To remove this limitation, Das Gupta modified the method by relaxing the first assumption while keeping the other two unchanged. This method, though more complicated, is always consistent, irrespective of the population under consideration (Das Gupta, 1975).

Ntozi (1978) presented a method based on the same idea as the Demeny-Shorter method but utilizing three instead of two successive censuses. Unlike the Demeny-Shorter method which assumed same coverage and similar pattern of age misreporting for the two censuses, the three census method allows for, and estimates the likely changes in census coverage and different patterns of age errors in successive censuses. Unfortunately, the method is restricted to countries with three censuses which must be of equal intervals. Furthermore, a comparison of results with the Demeny-Shoter method showed that the correction factors from the two methods were reasonably close in many age groups and the pattern of age errors disclosed by the two approaches similar. He, therefore, stated that the Demeny-Shorter assumptions were reasonably accurate with regard to age misreporting.

Saxena and Gogte (1985) investigated the possibility that a simpler procedure, for correcting age heaping on multiples of five, could yield equally effective results as the Feeney's (1979) procedure. A nine-point moving average was selected for comparison. The nine-point moving average was applied once (method A), then twice (method B) to census age distributions for India (1971), Tanganyika (1967) and Indonesia (1971), and results compared with those obtained by applying Feeney's method (method C). The results showed that all the three methods performed equally well for the three countries considered. They concluded that method A is more preferable, because it is the simplest to apply.

Gray (1987) presented a new method for adjusting age distributions to remove the effect of digit preference, by modifying Zelnik's (1961) procedure. For practical applications attention was restricted to Q1 and Q2 operators. Census age-sex pyramids for Bangladesh (1974), Libya (1973) and Australian Aborigines (1981) were transformed using Q1 and Q2 linear operators. A comparison of results appeared to favour use of Q2 rather than Q1, although there was virtually no difference in the case of Australian Aboriginal data, which had least irregularities in the beginning. Gray, therefore, suggested that slightly irregular data may be adjusted adequately with the Q1 operator, but greater irregularities require use of Q2 operator to obtain adequate results. He claimed that the method is easy to use and superior to graduation methods in that it is based on a specific model of age misstatement and age pyramid shape, and superior to Zelnik's approach in that the pattern of age misstatement is more clearly specified and the method is biased in less restricted conditions.

No real systematic work has been done in detecting and making appropriate adjustments for age misreporting in Kenya. However, Rono (1982) assesed the quality of age reporting in the 1969 and 1979 censuses using United Nations summary index (United Nations, 1955), Myers' summary index, and Whipple indices for the ten terminal digits. He observed that the quality of age reporting, judged by the extent of digit preference, was quite poor and more pronounced for the females. Heaping was observed to be more substantial for terminal digits 0, 5 and 8 in that order.

Over the last few years, there has been a considerable amount of research on techniques of estimating the completeness of adult death registration from incomplete and inaccurate vital statistics. Around 1980, three methods were proposed to relax the assumptions of stability in the growth balance equation developed by Brass (1975) to estimate the completeness of death registration relative to the completeness of census coverage.

Martin (1980) generalised the growth balance equation by allowing the growth rate to vary with age. No explicit allowance was made, however, for the possibility that the two censuses could be of different coverage. Preston and Hill (1980) and Brass (1979) proposed methods that sought specifically to estimate the relative coverage of two census enumerations and the completeness of death registration, relative to one census or the other.

The Preston-Hill procedure relies on the fact that in the absence of age misreporting, the intercensal survival ratios constructed from enumerated populations are related to the cohort intercensal death rates. Regretably, even after cummulation is used, the procedure remains very sensitive to age misreporting and frequently produces implausible results. Palloni and Kominski (1984) reconstructed the population-based survival ratios with the aid of foward and backward projections in order to minimise the effects of age misreporting. They applied the procedure to the female populations of El Salvador (1961-71) and Honduras (1961-71) and tested the completeness of death registration and census coverage estimates for both internal and external consistency. The estimates obtained by applying the foward and backward projections were observed to be more reliable than those obtained by Preston-Hill method, less variable than those generated by Bennett-Horiuchi (1981) procedure, and consistent with estimates generated by Preston-Bennett (1983) or maternal orphanhood techniques.

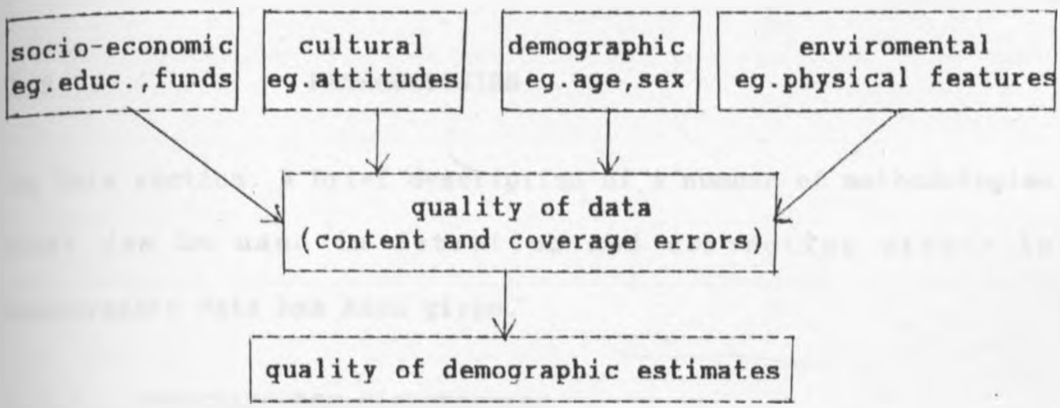
Hill (1987) presented a new method for estimating the relative completeness of two census enumerations and of intercensal deaths by extending Martin's (1980) formulation. Whereas Brass (1979) used deaths by cohorts, in Hill's study, deaths by age group rather than deaths by cohort were used on the grounds that age group comparisons would be less distorted by age misreporting than cohort comparisons, if the patterns of age misreporting were similar for the two successive censuses. The method was applied to the female population of South Korea in 1970 and 1975 censuses, and registered deaths in the period 1971 to 1975. The obtained estimates of completeness indicated that the 1975 census was 0.45% more completely enumerated than the 1970 census and registration of deaths was 62.6% complete. Using the Bennett-Horiuchi method, death registration completeness had been obtained to be 65%. Hill's explanation for the difference in the two estimates of completeness of death registration was that higher enumeration completeness at the second census would inflate the age specific growth rates. In the Bennett-Horiuchi formulation, this exaggeration of growth rates would increase the population at each age, a, calculated from deaths and growth rates over age a. and this would make registered deaths appear to be more complete than they actually are. Hill stated that, compared to the Bennett-Horiuchi procedure which uses age specific growth rates to assess completeness of death registration, his method is free from inconvenient assumptions about the open interval or distribution of deaths within age groups.

In Kenya, Nyokangi (1984) and Kizito (1985) applied the Bennett-Horiuchi technique to estimate the completeness of death registration in 1979. They used the 1969 and 1979 census data as well as the 1979 vital death registration data. Nyokangi carried out his study at the national level and observed that the completeness of death registration was as low as 22% for males and 13% for females. Kizito's study, which was carried out at district level, revealed that differentials in mortality existed by districts, and also confirmed better death registration data for males as compared to females.

1.7 THEORETICAL FRAMEWORK

From the foregoing literature review, and several other studies that have been conducted to assess the quality of demographic data, it is evident that data from the developing countries suffer from severe content and coverage errors. Under content errors, the most serious is age misreporting which takes the form of: age heaping on particular prefered digits, or systematic age transference across age group boundaries. The most common source of age misreporting is illiteracy of the respondent, leading to estimation of age by the respondent or by the interviewer based on external clues. Age heaping has been observed to increase with age and, in most cases, more pronounced for females than for males. Frequently, age exaggeration or heaping at particular age groups has been observed to reflect the importance attached to various age groups by the society. Lack of written records, poor training of enumerators, short interview time, and poor supervision also contribute to the poor quality of demographic data in the developing countries. Event displacement and omission of vital events has frequently been observed when analysing maternal history data from various countries (Potter,1975; Brass,1978). Coverage errors often result from: either failure to cover the entire geographical region, due to socio-economic and enviromental factors or inaccurate enumerations resulting from omissions or double counting. Under-enumeration has been observed to decrease with age and, in most cases, more pronounced for females than for males. Often, it is difficult to tell the extent of each kind of error since coverage errors also distort age distributions. Futhermore, it has been observed that further errors in the data may be introduced by the data processing procedures. In short, it has been observed that socio-economic, cultural, demographic and enviromental factors either directly or indirectly influence the quality of data obtained in censuses or surveys. Errors in these data will in turn affect the demographic estimates derived from them either directly or using indirect estimation techniques.

FIGURE 1:1. A DIAGRAM SUMMARISING THE PROPOSED RELATIONSHIP BETWEEN THE CONCEPTS



Source: compiled by the author

This study will only focus on the content (age misreporting) and coverage (census coverage and completeness of death registration) errors. The following conceptual hypotheses will be tested in the study, namely; (a) the pattern of errors is systemmatic and repeats itself from one census to the next; and (b) demographic data in the developing countries suffer severe content and coverage errors.

1.8 OPERATIONAL HYPOTHESES

(1) The degree of census coverage in the 1969 and 1979 census were reasonably close.

(2) The degree and nature of age heaping in the 1969 and the 1979 censuses were reasonably close.

(3) During the period 1969 - 1979, only less than a quarter of all deaths were registered.

(4) The degree of age misreporting increases with age.

(5) Age misreporting in Kenya includes considerable age transfer across age group boundaries.

1.9 METHODOLOGIES

In this section, a brief description of a number of methodologies that can be used in detecting and correcting errors in demographic data has been given.

1.9.1 DETECTING AGE MISREPORTING

1.9.1.1 Myers' Index

Myers'(1940) technique derives a `blended' population which is essentially a weighted sum of the number of persons reporting ages ending in each of the ten terminal digits. The underlying assumption of this method is that if there are no systematic irregularities in the reporting of age, then the `blended' sum of each terminal digit should be approximately equal to 10% of the total `blended' population. If the sum at any given digit exceeds 10% of the total `blended' population, it indicates preference of ages ending in that digit. The converse indicates avoidance of ages ending in that digit. An overall measure of the extent to which there is digit preference and/or digit avoidance is obtained by taking one-half of the absolute sum of the deviations for each of the ten terminal digits.

1.9.1.2 Age Ratio

An age ratio for a specific age is computed by taking the ratio of the number reporting that age to the arithmatic mean of the five ages immediately below and five ages immediately above the age in question. An age ratio less than one indicates avoidance for that age, whereas an age ratio greater than one indicates preference for that particular age.

1.9.1.3 Whipple's Index

Whipple's index may be used to measure the degree of age heaping on the terminal digits 0 and 5. The index is derived by comparing the sum of the population at ages ending in 0 and 5 with one-fifth of the total population.

1.9.1.4 United Nations age/sex Index

This is one way of detecting and measuring the overall extent of age misreporting by examining the age and sex ratios of the population under study and calculating an index of age accuracy from the regularity of these ratios. The index is three times the mean difference in sex ratios, plus the mean of the male and female age ratios.

1.9.1.5 The Age Specific Growth Rate Technique

Let $T(x)$ be the person-years lived by those aged x years and above. Then the ratio $T(x)/T(5)$ or $T(x)/T(10)$ is a useful tool in detecting age misreporting.

Let $C(x,x+5)$ be the proportion of people between ages x and x+5

$r(x,x+5)$ be the growth rate for for those aged x to x+5 years

$L(x,x+5)$ be the person years lived between ages x and x+5

Then,

$$L(x,x+5)/L(0,5)=C(x,x+5)/C(0,5).\exp\{2.5r(0,5)+5[r(5,10)+\ldots+r(x-5,x)]+2.5r(x,x+5)\}.$$

$T(x)/L(0,5)$ is obtained by adding the column of $L(x,x+5)/L(o,5)$ from down.

Then $T(x)/T(5)=[T(x)/L(0,5)]/[T(5)/L(0,5)]$.

and $T(x)/T(10)=[T(x)/L(0,5)]/[T(10)/L0,5)]$.

From the Office of Population Research, Princeton University, computerized tables of $T(x)/T(5)$ and $T(x)/T(10)$ against mortality levels have been made for each region (East, West, North and South) and sex. A graph of age against mortality levels is then plotted. It is hypothesized that if the graph is rising, then there is an indication of overstatement of age. A graph showing a downward trend implies under-estimation of age, and a horizontal graph implies correct age statement.

1.9.2. CORRECTING AGE DISTRIBUTIONS

1.9.2.1 Demeny-Shorter Method

Starting with adjacent pair censuses, the youngest five-year age group in the first census is projected to the next census using an assumed mortality schedule. The projection is accepted as a preliminary estimate for that cohort on the second date. The ratio of this preliminary estimate to the reported provides a correction factor which is then used to correct the population in that age group at the date of the first census. Thus, it is assumed that errors are a stable fraction of the reported population in each age group from one census to the next. The corrected age group in the first census is then used as a basis for projecting to the next census, and the foregoing procedure is repeated all the way through the age distribution. The resulting figures for the two censuses are finally scaled to agree with the total size of the population as enumerated.

1.9.2.2 Saxena-Gogte Method

This is a simplification of Feeney's (1979) method of correcting age distributions for heaping on multiples of five.

Let $P(x)$ - number of persons aged x in completed years

$P(x-)$ - number of persons aged x-4 to x-1

$P(x+)$ - number of persons aged x+1 to x+4

Dx - the constant of proportionality

Then, for Dx=1, Feeney's procedure will imply that:

$$1/9[P(x-)+P(x)+P(x+)] = 1/8[P(x-)+P(x+)]$$

The quantity on the left hand side is a 9-point moving average and the quantity on the right hand side is an 8-point moving average that excludes P(x). For the two quantities to be equal, the final adjusted value of P(x) must be equal to a 9-point moving average of the final adjusted values of P(x-), P(x) and P(x+). This suggests that a 9-point moving average, or its repeated application, might yield approximately the same results as the Feeney's procedure.

1.9.2.3 Gray's Method

This is a simplification of Zelnik's 2*10-term moving average of adjusting for digit preference, by replacing the assumption of local linearity with an assumption that the underlying smooth age distribution curve may have upto two turning points. Gray replaced the linear operator, S, used by Zelnik, with an unbiased operator, Qk=(k+1)S-kS for k>0. For practical applications, Q1=2S-S and Q2=3S-2S should be used.

1.9.3 ESTIMATION OF COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE

1.9.3.1 Palloni-Kominski Method

Palloni and Kominski modified the Preston-Hill method of estimating the relative coverage of two census enumerations and the completeness of death registration, by reconstructing the population-based survival ratios with the aid of foward and backward projections, in order to minimise the effects of age misreporting. If the degree of coverage for the two censuses is not the same, foward or backward projections cannot by themselves retreive the correct mortality experience to which the population was exposed during the intercensal period. However, joint information provided by both types of projections, on one hand, and by the registered deaths, on the other hand, may provide good estimates of death registration completeness.

1.9.3.2 Hill's Procedure

The growth balance equation was developed by Brass (1975) to estimate the completeness of death registration, relative to the completeness of enumeration of a census. Martin (1980) generalised the growth balance equation by allowing the growth rate to be age specific. Hill's formulation is an extention of Martin's equation to allow explicitly for, and estimate changes in census coverage. The method assumes that the population is closed to migration and that the coverage factors involved are invariant with age, at least for the age range studied.

CHAPTER 2

COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE

2.1. INTRODUCTION

Population censuses and vital registration systems, particularly in the developing countries are often subject to omissions. A well - conducted census will enumerate all but a few percent of the population, and it is rare for a census to enumerate less than 90 percent of the target population. In contrast, the completeness of death registration varies widely, with many systems in the developing countries registering less than half of all the deaths that occur in the population (Hill, 1987). Where substantial omissions are suspected, it is necessary to assess the coverage of the census and death registration data. In this chapter, the completeness of death registration in Kenya and the degree of the 1979 census coverage, relative to the 1969 census coverage are estimated using two methods, namely: The Palloni - Kominski method and Hill's extension of the generalized growth balance equation.

2.2. HILL'S TECHNIQUE

2.2.1 HE THEORY

Hill's method of estimating census and death registration completeness is an extension of a generalization of the growth balance equation developed by Brass (1975). Based on the assumptions that the: (i) population was closed to migration;

(ii) population was demographically stable; (iii) completeness of death registration was constant for all ages after early childhood; and (iv) completeness of census coverage was constant for all ages, Brass proposed the following relationship:

$$\frac{N(x)}{N(x+)} = r + \frac{D(x+)}{N(x+)} \qquad (2.2.1)$$

Where:

$N(x)$ is the true density of the population at exact age x,

$N(x+)$ is the total population above age x,

r is the stable population growth rate, and

$D(x+)$ is the true total deaths at ages x and above

Modifications have been made on the growth balance equation by Martin (1980), Preston and Hill (1980), and Brass(1979). Martin generalised the growth balance equation by allowing the growth rate, r, to vary with age. Thus, equation (2.2.1) becomes:

$$\frac{N(x)}{N(x+)} = r(x+) + \frac{D(x+)}{N(x+)} \qquad (2.2.2)$$

Hill's method may be seen as an extension of Martin's formulation to allow explicitly for changes in census coverage.

Thus $D'(x) = k.D(x+)$ (2.2.3a)

$N1'(x) = k1.N1(x)$ (2.2.3b)

and $N2'(x) = k2.N2(x)$ (2.2.3c)

Where the subscript (') denotes the observed quantities and the completeness factors k, k1 and k2 represent completeness of death registration, coverage of first census and coverage of the second census, respectively.

We wish to express equation (2.2.2) in terms of the observed values as follows:

$$\text{from} \quad r(x+) = \frac{\text{Log } N2(x+) - \text{Log } N1(x+)}{t2 - t1}, \qquad (2.2.4a)$$

We have,

$$r(x+) = \frac{\text{Log } [N2'(x+)]/k2 - \text{Log } [N1'(x+)]/k1}{t2 - t1}$$

$$= \frac{1}{t2 - t1} \text{Log } \left(\frac{k1}{k2}\right) + \frac{\text{Log } N2'(x+) - \text{Log } N1'(x+)}{t2 - t1}$$

Thus,

$$r(x+) = \frac{1}{t2 - t1} \text{Log } \left(\frac{k1}{k2}\right) + r'(x+) \qquad (2.2.4b)$$

Next, using the definitions of a geometric mean and of N(x),

$$N(x) = t.\text{SQRT } [N1(x).N2(x)] = t. \frac{\text{SQRT } [N1'(x).N2'(x)]}{k1.k2}$$

$$= \frac{t}{\text{SQRT } [k1.k2]} \text{SQRT } [N1'(x).N2'(x)]$$

Where N(x) is the population having xth birthday during the intercensal period.

Thus,

$$N(x) = \frac{1}{\text{SQRT } [k1.k2]} N'(x) \qquad (2.2.5a)$$

$$\text{and} \quad N(x+) = \frac{1}{\text{SQRT } [k1.k2]} N'(x+) \qquad (2.2.5b)$$

$$\text{Where} \quad N'(x+) = t.\text{SQRT } [N1'(x+).N2'(x+)] \qquad (2.2.5c)$$

To obtain N(x) from 5-year age groups, we recall that:

$$5Nx = \text{SQRT } [5N1(x).5N2(x)]$$

$$= \text{SQRT } \left[\frac{5N1'(x).5N2'(x)}{k1.k2}\right]$$

$$= \frac{1}{\mathrm{SQRT}\ [k1.k2]} \ \mathrm{SQRT}\ [5N1'(x).5N2'(x)] \qquad (2.2.6a)$$

This implies that:

$$5N(x-5) = \frac{1}{\mathrm{SQRT}\ [k1.k2]} \ \mathrm{SQRT}\ [5N1'(x-5).5N2'(x-5)] \qquad (2.2.6b)$$

Thus,

$$N(x) = \frac{t}{5} \ \mathrm{SQRT}\ [5N(x).5N(x-5)] \qquad (2.2.6c)$$

Substituting (2.2.6a) and (2.2.6b) into (2.2.6c) gives:

$$N(x) = \frac{t}{5\mathrm{SQRT}\ [k1.k2]} \ \text{4TH ROOT OF } (5N1'x.5N2'x.5N1'x\text{-}5.5N2'x\text{-}5)$$

$$\text{i.e} \quad N(x) = \frac{1}{\mathrm{SQRT}\ [k1.k2]} \ .\ N'(x)$$

$$\text{Where} \quad N'(x) = \frac{t}{5} \ \text{4TH ROOT OF } (5N1'x.5N2'x.5N1'x\text{-}5.5N2'x\text{-}5) \qquad (2.2.7)$$

It should be noted that in Hill's (1987) work, t.5N(x-5) is denoted by PYL (x-5,x) and t.5N(x) is denoted by PYL (x,x+5), where t is the intercensal period and PYL (x-5,x) and PYL (x.x+5) are the intercensal person years lived by the age groups (x-5,x) and (x,x+5) respectively.

Equations (2.2.5a) and (2.2.5b) imply that:

$$\frac{N(x)}{N(x+)} = \frac{N'(x)}{N'(x+)} \qquad (2.2.8)$$

and using (2.2.3a) and (2.2.5b), we have:

$$\frac{D(x+)}{N(x+)} = \frac{\mathrm{SQRT}\ [k1.k2]}{k} \ .\ \frac{D'(x+)}{N'(x+)} \qquad (2.2.9)$$

Substituting equations (2.2.8). (2.2.4b), and (2.2.9) into (2.2.2) gives:

$$\frac{N'(x)}{N'(x+)} = \frac{1}{t2 - t1} \log \frac{k1}{k2} + r'(x+) + \frac{SQRT\ [k1.k2]}{k} \cdot \frac{D'(x+)}{N'(x+)}$$

Thus:

$$\frac{N'(x)}{N'(x+)} - r'(x+) = \frac{1}{t} \log \frac{k1}{k2} + \frac{SQRT\ [k1.k2]}{k} \cdot \frac{D'(x+)}{N'(x+)} \qquad (2.2.10)$$

Where, t = t2 - t1

Equation (2.2.10) is Hill's estimation equation.

2.2.2 APPLICATION OF HILL'S TECHNIQUE TO KENYA'S DATA

step 1: The reported intercensal deaths for those aged x years and above, D'(x+), are obtained by cumulating recorded deaths by age group across the entire interval. The total deaths reported for those aged x to x+5 years during the intercensal period are obtained by estimating average annual intercensal deaths and multiplying by 10, the intercensal period. Average annual inter-censal deaths are estimated by averaging registered deaths for 1969, 1974 and 1979 as shown in table 2:1 for Kenyan females.

TABLE 2:1: KENYA: CUMULATING INTERCENSAL REPORTED DEATHS OF FEMALES

age, x	(registered deaths) 1969 (1)	1974 (2)	1979 (3)	(average) 1969-79 (4)	5D'x 1969-79 (5)	CUMULATED D'(x+) (6)
0	9136	13047	11395	11192.67	111926.7	185810
5	579	1196	935	903.3333	9033.333	73883.33
10	185	522	456	387.6667	3876.667	64850
15	210	392	489	363.6667	3636.667	60973.33
20	246	445	488	393	3930	57336.67
25	249	489	495	411	4110	53406.67
30	225	450	473	382.6667	3826.667	49296.67
35	206	501	449	385.3333	3853.333	45470
40	198	452	398	349.3333	3493.333	41616.67
45	261	467	423	383.6667	3836.667	38123.33
50	223	517	463	401	4010	34286.67
55	136	352	366	284.6667	2846.667	30276.67
60	249	638	629	505.3333	5053.333	27430
65	161	448	491	366.6667	3666.667	22376.67
70+	882	2064	2667	1871	18710	18710

step 2: The recorded populations of 1969 and 1979, $5N1'(x)$ and $5N2'(x)$, are entered into columns (1) and (2) as shown in table 2:2, and these are cumulated from down to give columns (3) and (4) respectively.

step 3: The $r'(x+)$ values in column (5) of table 2.2.2a are calculated from formula (2.2.4b).

$$\text{i.e } r'(x+) = \frac{1}{t} \log \left[\frac{N2'(x+)}{N1'(x+)}\right]$$

e.g for x = 0,

$$r'(0+) = \frac{1}{10} \log \left[\frac{7719947}{5460324}\right] = 0.034629$$

step 4: The $N'(x+)$ values in column (6) are calculated from formula (2.2.5c).

i.e $N'(x+) = t.\mathrm{SQRT}\,[N1'(x+).N2'(x+)]$

e.g for x = 0,

$N'(0+) = 10.[5460324 * 7719947] = 64925658$

step 5: The N'(x) values in column (7) are calculated from formula (2.2.7).

$$\text{i.e } N'(x) = \frac{t}{5} \text{ 4TH ROOT OF } (5N1'x-5.5N2'x-5.5N1'x.5N2'x)$$

e.g for x = 5.

$$N'(5) = \frac{10}{5} \text{ 4TH ROOT OF } [5N1'(0).5N2'(0).5N1'(5).5N2'(5)]$$

$$= 2270108$$

TABLE 2:2: KENYA: ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR FEMALES

age,x	5N1'(x) (1)	5N2'(x) (2)	N1'(x+) (3)	N2'(x+) (4)	r(x+) (5)	N'(x+) (6)	N'(x) (7)
0	1046380	1423936	5460324	7719947	.0346299	64925659	-
5	893359	1246983	4413944	6296011	.0355148	52716449	2270108.
10	663808	1025677	3520585	5049028	.0360569	42161039	1866444.
15	544847	889316	2856777	4023351	.0342421	33902532	1515744.
20	450096	687234	2311930	3134035	.0304239	26917781	1244415.
25	411245	542233	1861834	2446801	.0273219	21343705	1024953.
30	299241	413432	1450589	1904568	.0272286	16621508	815094.5
35	264819	325951	1151348	1491136	.0258605	13102734	642927.0
40	201936	274193	886529	1165185	.0273321	10163515	525863.3
45	163852	222363	684593	890992	.0263511	7810038.	423863.6
50	139072	191365	520741	668629	.0249977	5900699.	352926.4
55	102235	134776	381669	477264	.0223516	4267984.	276763.4
60	94508	109715	279434	342488	.0203470	3093587.	218658.7
65	63307	83370	184926	232773	.0230108	2074748.	172020.0
70+	121619	149403	121619	149403	.0205754	1347970.	-

step 6: The estimation equation is:

$$\frac{N'(x)}{N'(x+)} - r'(x+) = \frac{1}{t} \log \frac{k1}{k2} + \frac{SQRT\ [k1.k2]}{k} \cdot \frac{D'(x+)}{N'(x+)}$$

Which is of the form: Y = a + bX

Where Y = N'(x)/N'(x+) - r'(x+)

and X = D'(x+)/N'(x+)

The values of X and Y are given in columns (2) and (3) of table 2.3. respectively.

step 7: Columns (4), (5), (6) and (7) are used in obtaining least square estimates of a and b.

$$\text{where } \hat{a} = \frac{1}{t} \log \frac{k1}{k2} = \bar{Y} - \hat{b}\bar{X}$$

$$\text{and } \hat{b} = \frac{\text{SQRT}[k1.k2]}{k} = \frac{\sum (Xi-\bar{X})(Yi-\bar{Y})}{\sum (Xi-\bar{X})^2}$$

TABLE 2:3: KENYA: ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR FEMALES

age, x	D'(x+) (1)	Xi (2)	Yi (3)	$\bar{Xi}$ (4)	$\bar{Yi}$ (5)	$\bar{Xi}\bar{Yi}$ (6)	$(\bar{Xi})^2$ (7)
0	185810	-	-	-	-	-	-
5	73883.33	.0014015	.0075479	-.003009	-.019192	.0000578	.0000091
10	64850	.0015381	.0082125	-.002873	-.018528	.0000532	.0000083
15	60973.33	.0017985	.0104668	-.002612	-.016273	.0000425	.0000068
20	57336.67	.0021301	.0158063	-.002281	-.010934	.0000249	.0000052
25	53406.67	.0025022	.0206994	-.001908	-.006041	.0000115	.0000036
30	49296.67	.0029658	.0218100	-.001445	-.004930	.0000071	.0000021
35	45470	.0034703	.0232077	-.000940	-.003532	.0000033	.0000009
40	41616.67	.0040947	.0244082	-.000316	-.002332	.0000007	.0000001
45	38123.33	.0048813	.0279205	.0004706	.0011804	.0000006	.0000002
50	34286.67	.0058106	.0348133	.0013999	.0080731	.0000113	.0000020
55	30276.67	.0070939	.0424948	.0026832	.0157546	.0000423	.0000072
60	27430	.0088667	.0503342	.0044560	.0235941	.0001051	.0000199
65	22376.67	.0107852	.0599005	.0063745	.0331603	.0002114	.0000406
70+	18710	-	-	-	-	-	-
.0573391	.3476221			.0005718	.0001059		

$\bar{X}$ = .0044107 $\bar{Y}$ = .0267402

NB: $Xi-X = \bar{Xi}$ and $Yi-Y = \bar{Yi}$.

Setting k1=1,

b^= 5.398336=1/k*SQRT(k2)

a^= .0029297=-1/10*lnk2. Therefore:

lnk2= -.029297, k2= .9711277 and k= .1825485

The foregoing procedure is repeated for Kenyan males and combined sexes to obtain tables given in appendices 1a and 1b.

Results from Hill's technique show that the relative coverage of the 1979 census with respect to the 1969 census is 97.11 percent for females. 98.79 percent for males and 98.11 percent for combined sexes. The degree of intercensal death registration completeness with respect to the 1969 census coverage is 18.25 percent for females, 26.18 percent for males and 22.37 percent for combined sexes.

2.3. THE PALLONI - KOMINSKI METHOD

2.3.1. THE THEORY

The Palloni-Kominski(1984) method relies on corrected (population-based) intercensal survival ratios and their linear relation with intercensal cohort specific death rates. The correction of the survival ratios depends on results obtained from foward and backward projections of two population censuses separated by five or ten years. Palloni and Kominski (1984) showed how foward and backward projections can be used to correct the set of observed survival ratios to yield estimates of completeness of death registration and census coverage.

ESTIMATION OF ADULT MORTALITY USING FORWARD PROJECTIONS.

The technique presented by Coale and Demeny (1964), is based on the assumptions that the: (i) population is closed to migration during the intercensal period. (ii) reported population in the various age categories is not severely distorted by age mis-statement; and (iii) The age pattern of adult mortality conforms to a known (or assumed) pattern of mortality.

If the first two assumptions hold, then:

$$S(x) = \frac{5L(x+10)}{5L(x)} = \frac{5N2(x+10)}{5N1(x)} \qquad (2.3.1)$$

where [5L(x+10)]/[5L(x)] is the ten - year survival ratio in a life table and [5N2(x+10)]/[5N1(x)] is the ratio of the actual population in the age group x+10, x+15 at the time of the second census to the actual population in the age group x to x+5 at the first census. If age misreporting is mild, then the mortality level determined by the observed survival ratios will be in the neighbourhood of the "true" level of mortality applicable to the intercensal period. However, if age misreporting is severe, Coale and Demeny (1964) suggested the use of forward survival of the observed population aged x and above in the second census. A level of mortality within the assumed family is then selected so as to match the observed population aged x+10 and above in the second census. The procedure may be repeated for several ages, x. and the median of the set of levels used as a final estimate of the life table applicable for the intercensal period. With the cumulation procedure, errors of age mis-statement will seriously affect the selection of a level of mortality only if they represent substantial transfer across the pivotal ages used in the cumulation. Biases in the foward projections will however still occur when there is a high rate of population growth or when there exists differential completeness in the census enumeration.

ESTIMATION OF ADULT MORTALITY USING BACKWARD PROJECTIONS.

If there is no age misreporting and the completeness of enumeration in the two censuses is similar, then the reversal of the foward projection ought to identify exactly the same level of mortality.

$$\text{i.e} \sum_{y=x}^{w} 5N2(y+10)\ S(y)^{-1} \text{ should equal } \sum_{y=x}^{w} 5N1(y)\ S(y)$$

where S(y) is the schedule of ten - year survivorship ratios for the mortality level and w is the latest year to which one can survive. When the coverage of the first census is more complete than the second, foward projections will give a lower mortality level than the backward projections. The opposite occurs when enumeration in the second census is more complete.

UTILIZATION OF FORWARD AND BACKWARD PROJECTIONS TO ESTIMATE COMPLETENESS OF DEATH REGISTRATION AND RELATIVE CENSUS COVERAGE.

If the completeness of census enumeration in the two censuses is different, then the foward or backward projections cannot by themselves retreive the correct level of mortality to which the population was exposed during the intercensal period. However, joint information provided by both types of projections on one hand. and the observed values of intercensal death rate on the other hand may produce good estimates of death registration completeness and relative coverage of censuses.
Preston and Hill (1980) suggested that in the absence of age misreporting, the intercensal survival ratios constructed from enumerated populations are related to the cohort intercensal death ratios as follows:

$$\frac{5N2'(x+10)}{5N1'(x)} = \frac{k2}{k1} - \frac{k2}{k} d'(x) \qquad (2.3.2)$$

where [5N2'(x+10)]/[5N1'(x)] is the ratio of the observed population in the age group x+10 to x+15 at the time of the second census to the observed population in the age group x to x+5 at the time of the first census. d'(x) is the observed intercensal death rate for the cohort aged x to x+5 at the first census in terms of the initial population, and the completeness factors k1, k2 and k denote the completeness of enumeration of first census, enumeration of second census and intercensal death registration respectively.

Formula (2.3.2) can also be applied when populations are cumulated above some pivoting ages. Preston's procedure is however very sensitive to age misreporting. In order to obtain reliable estimates of k2/k1 and k2/k from equation (2.3.2), Palloni and Kominski showed how the observed survivorship ratios, [5N2'(x+10)]/[5N1(x)] can be adjusted to obtain improved estimates of k2/k1 and k2/k.

For every pivotal age of cumulation, x*, one obtains an estimated level of mortality within some model of mortality schedule. This estimated level may be derived from the backward projection procedure, or in cases with age misreporting, as an arithmetic mean of the levels corresponding to foward and backward projections. Let {S^(y)} denote the survival ratios associated to the level of mortality thus estimated when x* is the pivotal age of cumulation. The reconstructed population based survival ratios,

$$CSR(x) = \frac{\sum_{y=x}^{w} 5N1'(y).S\hat{}(y)}{\sum_{y=x}^{w} 5N1'(y)},$$

when regressed on D'(x), the cumulated cohort based intercensal death rates, yield an estimate of k2/k1 and k2/k. Both of them however will be in error in so far as k1 is not equal to k2 or there are errors of age misreporting. When k1 is not equal to k2, but no errors of age misreporting exist. one can still arrive at correct estimatess of k2/k1 and k2/k. The estimated values of k2^/k1 can be used to generate an artificial network of survival ratios, (k2^/k1).S(x), within the selected model and foward and backward projections repeated, new values of CSR(x) calculated and finally new estimates of k2/k1 obtained. The iteration procedure should converge rapidly in the sense that after no more than 3 or 4 iterations, the value of the constant in the regression will differ little from the value used to generate the artificial network, (k2^/k1).S(x), employed in the corresponding iteration stage. The reciprocal of the value of the slope in the final iteration is a good estimate of the completeness of adult death registration relative to the completeness of the second census. If k2 is not equal to k1 and age misreporting exists, the above described procedure can still be employed, but with the following modifications, that the:

(i) average level generated by both foward and backward projections is taken as the best estimate corresponding to the case when a pivotal age, x*, is the initial age of cumulation.

(ii) median of the levels estimated for each pivotal age, x*, may be taken as the best estimate of the level of mortality, and the cumulated survival ratios constructed using this estimated level.

(iii) Convergence towards a constant, k2/k1, cannot any longer be guaranteed. The best alternative then is to use the constant estimated in the regression equation, in which the CSR(x) have reconstructed using the median level of mortality and then apply foward/backward projections once more to attempt a final correction when k2/k1 is within the range of 0.98 - 1.02, and age misreporting is not too serious. This one iteration routine will be sufficient to produce an accurate estimate of death registration completeness and relative coverage of censuses.

2.3.2 APPLICATION OF THE PALLONI - KOMINSKI METHOD TO KENYA'S DATA

Step 1: estimating the mortality level corresponding to the foward projections

(a) The observed 1969 population aged x to x+4, 5N1(x), is entered into column (1) and the ten - year survival ratios for various mortality levels from the North model, 10S(x,x+4), entered into column (2) as shown in table 2:4 for Kenyan females.

(b) The projected 1979 population aged x+10 to x+14 years, 5N2*(x+10), is obtained by multiplying columns (1) and (2). These are entered into column (3).

i.e 5N1(x).10Sx,x+4 = 5N2*(x+10) e.g for x=0,

5N1(0).10S0,4 = 5N2*(10)

i.e 1046380*0.82791 = 866308.4, for level 8, North Model - females

(c) The projected 1979 population aged x+10 years and above, N2*(x+10)+, is obtained by cumulating column (3) from down. This is entered into column (4).

The above three steps are repeated for several mortality levels within which the mortality level of the study population can possibly lie as shown in table 2:4 below for Kenyan females.

TABLE 2:4: FOWARD PROJECTION OF THE 1969 FEMALE POPULATION TO 1979 USING DIFFERENT MORTALITY LEVELS

		LEVEL 8			LEVEL 10		
x	5N1x (1)	10Sx.x+4 (2)	5N2*x+10 (3)	N2*x+10+ (4)	10Sx,x+4 (5)	5N2*x+10 (6)	N2*x+10+ (7)
0	1046380	.82791	866308.5	4644726.	.85981	899688.0	4758928.
5	893359	.91561	817968.4	3778418.	.93075	831493.9	3859240.
10	663808	.92682	615230.5	2960449.	.93915	623415.3	3027746.
15	544847	.91779	500055.1	2345219.	.93112	507317.9	2404331.
20	450096	.90512	407390.9	1845164.	.92042	414277.4	1897013.
25	411245	.89061	366258.9	1437773.	.90837	373562.6	1482735.
30	299241	.87668	262338.6	1071514.	.89639	268236.6	1109173.
35	264819	.86516	229110.8	809175.4	.88578	234571.4	840936.0
40	201936	.85016	171677.9	580064.6	.87162	176011.5	606364.6
45	163852	.81913	134216.1	408386.7	.84342	138196.1	430353.2
50	139072	.76249	106041.0	274170.6	.79265	110235.4	292157.1
55	102235	.67484	68992.27	168129.6	.71258	72850.62	181921.7
60	94508	.55405	52362.16	99137.35	.59903	56613.13	109071.1
65	63307	.41072	26001.45	46775.19	.45922	29071.84	52457.96
70+	121619	.17081	20773.74	20773.74	.19229	23386.12	23386.12

TABLE 2:4 (continued)

		LEVEL 12			LEVEL 14		
x	5N1x (1)	10Sx,x+4 (2)	5N2*x+10 (3)	N2*x+10+ (4)	10Sx.x+4 (5)	5N2*x+10 (6)	N2*x+10+ (7)
0	1046380	.88783	929007.6	4860613.	.91578	958253.9	4950947.
5	893359	.9441	843420.2	3931605.	.95676	854730.2	3992693.
10	663808	.95002	630630.9	3088185.	.95963	637010.1	3137963.
15	544847	.9429	513736.2	2457554.	.953	519239.2	2500953.
20	450096	.93395	420367.2	1943818.	.94551	425570.3	1981713.
25	411245	.9241	380031.5	1523451.	.93752	385550.4	1556143.
30	299241	.91386	273464.4	1143419.	.92859	277872.2	1170593.
35	264819	.90407	239414.9	869954.7	.91907	243387.2	892720.6
40	201936	.89068	179860.4	630539.8	.90586	182925.7	649333.4
45	163852	.86505	141740.2	450679.4	.88205	144525.7	466407.6
50	139072	.81972	114000.1	308939.3	.84086	116940.1	321882.0
55	102235	.74679	76348.08	194939.2	.77321	79049.12	204941.9
60	94508	.64037	60520.09	118591.1	.67182	63492.36	125892.8
65	63307	.50585	32023.85	58070.99	.53887	34114.24	62400.39
70+	121619	.21417	26047.14	26047.14	.23258	28286.15	28286.15

TABLE 2:4 (continued)

		LEVEL 16			LEVEL 18		
	5N1x	10Sx,x+4	5N2*x+10	N2*x+10+	10Sx,x+4	5N2*x+10	N2*x+10+
x	(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	1046380	.93983	983419.3	5034617.	.95972	1004232.	5110724.
5	893359	.96799	864762.6	4051198.	.97761	873356.7	4106492.
0	663808	.96879	643090.6	3186435.	.97697	648520.5	3233135.
15	544847	.96289	524627.7	2543345.	.97192	529547.7	2584615.
20	450096	.95676	430633.8	2018717.	.96713	435301.3	2055067.
25	411245	.95046	390871.9	1588083.	.96241	395786.3	1619766.
30	299241	.94277	282115.4	1197211.	.956	286074.4	1223979.
35	264819	.93357	247227.1	915095.8	.94741	250892.2	937905.0
40	201936	.92057	185896.2	667868.7	.93496	188802.1	687012.9
45	163852	.89839	147203.0	481972.5	.9147	149875.4	498210.8
50	139072	.86102	119743.8	334769.5	.88144	122583.6	348335.4
55	102235	.79861	81645.89	215025.7	.82473	84316.27	225751.7
60	94508	.70265	66406.05	133379.8	.7349	69453.93	141435.5
65	63307	.57292	36269.85	66973.78	.60924	38569.16	71981.54
70+	121619	.25246	30703.93	30703.93	.27473	33412.39	33412.39

(d) The projected 1979 population aged x+10 years and above, obtained using different mortality levels are put together as shown below in table 2:5 for computational convenience.

TABLE 2:5: THE PROJECTED 1979 POPULATION AGED x+10 YEARS AND ABOVE OBTAINED USING DIFFERENT MORTALITY LEVELS

	LEVEL 8	LEVEL 10	LEVEL 12	LEVEL 14	LEVEL 16	LEVEL 18
	N2*x+10+	N2*x+10+	N2*x+10+	N2*x+10+	N2*x+10+	N2*x+10+
x	(1)	(2)	(3)	(4)	(5)	(6)
0	4644726.	4758928.	4860613.	4950947.	5034617.	5110724.
5	3778418.	3859240.	3931605.	3992693.	4051198.	4106492.
10	2960449.	3027746.	3088185.	3137963.	3186435.	3233135.
15	2345219.	2404331.	2457554.	2500953.	2543345.	2584615.
20	1845164.	1897013.	1943818.	1981713.	2018717.	2055067.
25	1437773.	1482735.	1523451.	1556143.	1588083.	1619766.
30	1071514.	1109173.	1143419.	1170593.	1197211.	1223979.
35	809175.4	840936.0	869954.7	892720.6	915095.8	937905.0
40	580064.6	606364.6	630539.8	649333.4	667868.7	687012.9
45	408386.7	430353.2	450679.4	466407.6	481972.5	498210.8
50	274170.6	292157.1	308939.3	321882.0	334769.5	348335.4
55	168129.6	181921.7	194939.2	204941.9	215025.7	225751.7
60	99137.35	109071.1	118591.1	125892.8	133379.8	141435.5
65	46775.19	52457.96	58070.99	62400.39	66973.78	71981.54
70+	20773.74	23386.12	26047.14	28286.15	30703.93	33412.39

Source: compiled by the author

(e) The observed 1979 population aged x+10 to x+14 years. 5N2(x+10), is entered into column (1) of table 2.6 and this cumulated from down to obtain column (2), the observed 1979 population aged x+10 years and above, denoted by N2(x+10)+.

(f) The mortality levels corresponding to various pivotal ages of cumulation are estimated through linear interpolation, by obtaining from table 2.5 the level whose projected population corresponds to the observed population in column (2) of table 2.6 The median level for the various pivotal ages of cumulation (In our case, x* is from 10 to 50) is taken as the level corresponding to foward projections.

TABLE 2:6: OBTAINING THE MORTALITY LEVEL CORRESPONDING TO THE FOWARD PROJECTIONS.

x	OBSERVED FEMALE POPULATION 5N2x+10 (1)	N2(x+10)+ (2)	ESTIMATED LEVEL (3)
0	1025677	5049028	
5	889316	4023351	
10	687234	3134035	13.84219
15	542233	2446801	11.59593
20	413432	1904568	10.32284
25	325951	1491136	10.41266
30	274193	1165185	13.60199
35	222363	890992	13.84814
40	191365	668629	16.07943
45	134776	477264	15.39499
50	109715	342488	17.13793
55	83370	232773	
60	149403	149403	
65	-	-	
70+	-	-	

MEDIAN MORTALITY LEVEL = 13.84219

step 2: estimating the mortality level corresponding to the backward projections.

As in the case of foward projections, mortality levels corresponding to the backward projections are obtained by projecting the observed 1979 population aged x+10 to x+14 years, 5N2(x+10), backwards to obtain the projected 1969 population. In the backward projections, the reciprocals of the ten-year survival ratios are used as shown in table 2.7 below:

TABLE 2:7: BACKWARD PROJECTION OF THE 1979 FEMALE POPULATION TO 1969 USING DIFFERENT MORTALITY LEVELS

	LEVEL 8				LEVEL 10		
		reciprcal			reciprcal		
	5N2x+10	10Sx,x+4	5N1*x	N1*x+	10Sx,x+4	5N1*x	N1*x+
x	(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	1025677	1.207861	1238875.	5861712.	1.163048	1192911.	5711600.
5	889316	1.092168	971282.5	4622837.	1.074402	955483.2	4518689.
10	687234	1.078958	741496.7	3651554.	1.064793	731761.7	3563206.
15	542233	1.089574	590802.9	2910057.	1.073975	582344.9	2831444.
20	413432	1.104826	456770.4	2319254.	1.086461	449177.5	2249099.
25	325951	1.122826	365986.2	1862484.	1.100873	358830.7	1799922.
30	274193	1.140667	312762.9	1496498.	1.115586	305885.8	1441091.
35	222363	1.155856	257019.5	1183735.	1.128948	251036.4	1135205.
40	191365	1.176249	225092.9	926715.4	1.147289	219551.0	884169.0
45	134776	1.220807	164535.5	701622.5	1.185649	159797.0	664618.1
50	109715	1.311493	143890.4	537087.0	1.261591	138415.4	504821.0
55	83370	1.481833	123540.4	393196.6	1.403351	116997.4	366405.6
60	149403	1.804891	269656.2	269656.2	1.669365	249408.2	249408.2
65	-	2.434749	-	-	2.177606	-	-
70+	-	5.854458	-	-	5.200478	-	-

TABLE 2:7 (continued)

	LEVEL 12				LEVEL 14		
x	5N2x+10 (1)	reciprcal 10Sx,x+4 (2)	5N1*x (3)	N1*x+ (4)	reciprcal 10Sx,x+4 (5)	5N1*x (6)	N1*x+ (7)
0	1025677	1.126342	1155263.	5586526.	1.091965	1120004.	5481524.
5	889316	1.059210	941972.2	4431263.	1.045194	929507.9	4361521.
10	687234	1.052609	723389.0	3489291.	1.042068	716144.8	3432013.
15	542233	1.060558	575069.5	2765902.	1.049318	568974.8	2715868.
20	413432	1.070721	442670.4	2190833.	1.057630	437258.2	2146893.
25	325951	1.082134	352722.6	1748162.	1.066644	347673.6	1709635.
30	274193	1.094260	300038.3	1395440.	1.076902	295278.9	1361961.
35	222363	1.106109	245957.7	1095401.	1.088056	241943.5	1066683.
40	191365	1.122738	214852.7	849443.7	1.103923	211252.3	824739.1
45	134776	1.156003	155801.4	634591.0	1.133723	152798.6	613486.8
50	109715	1.219929	133844.5	478789.6	1.189259	130479.5	460688.2
55	83370	1.339065	111637.8	344945.1	1.293310	107823.2	330208.7
60	149403	1.561597	233307.3	233307.3	1.488494	222385.5	222385.5
65	-	1.976871	-	-	1.855735	-	-
70+	-	4.669188	-	-	4.299596	-	-

TABLE 2:7 (continued)

	LEVEL 16				LEVEL 18		
x	5N2x+10 (1)	reciprcal 10Sx.x+4 (2)	5N1*x (3)	N1*x+ (4)	reciprcal 10Sx.x+4 (5)	5N1*x (6)	N1*x+ (7)
0	1025677	1.064022	1091343.	5388994.	1.041971	1068725.	5308305.
5	889316	1.033069	918724.4	4297651.	1.022903	909683.8	4239580.
10	687234	1.032215	709373.5	3378927.	1.023573	703434.1	3329896.
15	542233	1.038540	563130.8	2669553.	1.028891	557898.8	2626462.
20	413432	1.045194	432116.7	2106423.	1.033987	427483.4	2068563.
25	325951	1.052122	342940.3	1674306.	1.039058	338682.1	1641080.
30	274193	1.060704	290837.6	1331366.	1.046025	286812.8	1302398.
35	222363	1.071157	238185.7	1040528.	1.055509	234706.2	1015585.
40	191365	1.086283	207876.6	802342.4	1.069564	204677.2	780878.8
45	134776	1.113102	150019.5	594465.7	1.093255	147344.5	576201.6
50	109715	1.161413	127424.5	444446.2	1.134507	124472.5	428857.1
55	83370	1.252176	104393.9	317021.8	1.212518	101087.6	304384.7
60	149403	1.423184	212627.9	212627.9	1.360729	203297.0	203297.0
65	-	1.745444	-	-	1.641389	-	-
70+	-	3.961024	-	-	3.639937	-	-

The projected 1969 population aged x years and above, N1*(x)+. are then put togather as shown in table 2:8 for computational convenience.

TABLE 2:8: THE PROJECTED 1969 POPULATION AGED x YEARS AND ABOVE OBTAINED USING DIFFERENT MORTALITY LEVELS.

	LEVEL 8	LEVEL 10	LEVEL 12	LEVEL 14	LEVEL 16	LEVEL 18
x	Nl*x+ (1)	Nl*x+ (2)	Nl*x+ (3)	Nl*x+ (4)	Nl*x+ (5)	Nl*x+ (6)
0	5861712.	5711600.	5586526.	5481524.	5388994.	5308305.
5	4622837.	4518689.	4431263.	4361521.	4297651.	4239580.
10	3651554.	3563206.	3489291.	3432013.	3378927.	3329896.
15	2910057.	2831444.	2765902.	2715868.	2669553.	2626462.
20	2319254.	2249099.	2190833.	2146893.	2106423.	2068563.
25	1862484.	1799922.	1748162.	1709635.	1674306.	1641080.
30	1496498.	1441091.	1395440.	1361961.	1331366.	1302398.
35	1183735.	1135205.	1095401.	1066683.	1040528.	1015585.
40	926715.4	884169.0	849443.7	824739.1	802342.4	780878.8
45	701622.5	664618.1	634591.0	613486.8	594465.7	576201.6
50	537087.0	504821.0	478789.6	460688.2	444446.2	428857.1
55	393196.6	366405.6	344945.1	330208.7	317021.8	304384.7
60	269656.2	249408.2	233307.3	222385.5	212627.9	203297.0
65	-	-	-	-	-	-
70+	-	-	-	-	-	-

Source: compiled by the author

The levels implied by the observed 1969 population aged x years and above are obtained by interpolating linearly through table 2:8. The median level for the various pivotal ages of cumulation is taken as the estimate of the level corresponding to the backward projections. These are given in table 2:9 below.

TABLE 2:9: ESTIMATING THE MEDIAN MORTALITY LEVEL CORRESPONDING TO THE BACKWARD PROJECTIONS.

x	FEMALE POPULATION 5N1x (1)	N1(x)+ (2)	ESTIMATED LEVEL (3)
0	1046380	5460324	
5	893359	4413944	
10	663808	3520585	11.15325
15	544847	2856777	9.355510
20	450096	2311930	8.208808
25	411245	1861834	8.020783
30	299241	1450589	9.657161
35	264819	1151348	9.334731
40	201936	886529	9.889063
45	163852	684593	8.920404
50	139072	520741	9.013203
55	102235	381669	
60	94508	279434	
65	63307	184926	
70+	121619	121619	

MEDIAN MORTALITY LEVEL = 9.334731

step 3: estimating mortality level for the intercensal period

The estimate of the mortality level for the intercensal period is obtained as the arithmetic mean of the median levels corresponding to foward and backward projections.

i.e MEAN OF MEDIAN LEVELS = 11.58846

step 4: Cumulating cohort deaths from registration data.

The proximate procedure for estimating cohort deaths is too crude to give reasonable results for the cohort initially aged 0 to 4, so we start with that aged 5 to 9. Registered deaths by five - year age groups in 1969, 1974 and 1979 are entered into columns (1). (2) and (3) respectively as shown below in table 2:10 for Kenyan females.

(a) Cohort deaths over the first five years. mid-1969 to mid-1974 are estimated as:

$$\sum_{j=1969}^{1974} D^{j}(5,9) = 2.5[5D^{1969}(5) + 5D^{1974}(10)]$$

$$= 2.5[579 + 522] = 2752.5$$

(b) Cohort deaths over the second five years, mid-1974 to mid-1979.are estimated as:

$$\sum_{j=1974}^{1979} D^{j}(5,9) = 2.5[5D^{1974}(10) + 5D^{1979}(15)]$$

$$= 2.5[522 + 489] = 2527.5$$

(c) Cohort deaths for the ten - year period are then obtained by summing the deaths during the two five - year periods. Thus:

$$\sum_{j=1969}^{1979} D^{j}(5,9) = \sum_{j=1969}^{1974} D^{j}(5,9) + \sum_{j=1974}^{1979} D^{j}(5,9) = 2752.5 + 2527.5$$

$$= 5280.0$$

The results for each cohort are shown in table 2:10

(d) The only age group that requires special treatment is the open-ended interval, 60 years and above. For the period 1969 to 1974, all the yearly deaths over 65 years belong to this cohort, and some of the deaths to persons aged 60 64 years. The total number of deaths over 65 years during the 1969-74 period can be estimated by summing the deaths over 65 in 1969 and 1974 and multiplying the sum by 2.5. i.e

$$\sum_{j=1969}^{1974} (w-65)D^{j}(65) = 2.5[(w-65)D^{1969}(65) + (w-65)D^{1974}(65).$$

$$= 2.5[161 + 882 + 448 + 2064] = 8887.5$$

Where $(w-65)D^{j}(65)$ denotes the number of deaths occuring during year j to persons aged 65 years and over.

For the age group 60-64, the average number of deaths per year between 1969 and 1974 is estimated as: 0.5(249 + 638) = 443.5 and since the cohort averaged 2.5 years of exposure to the risk of dying during the 1969-74 period, the deaths during this period to persons aged 60-64 belonging to that cohort are estimated as: 2.5(443.5) = 1108.75. Hence, the total number of deaths for the cohort aged 60 years and above in 1969 is:

$$\sum_{j=1969}^{1974} 5D^{j}(60) + \sum_{j=1969}^{1974} (w-65)D^{j}(65) = 8887.5 + 1108.75 = 9996.2$$

Between 1974 and 1979, all the deaths at age 70 and above belong to the initial 60+ cohort, as do a proportion of the deaths 65-69.

Deaths at age 70 and over are estimated as:

$$\sum_{j=1974}^{1979} (w-70)D^{j}(70) = 2.5[(w-70)D^{1974}(70) = (w-70)D^{1979}(70).$$

$$= 2.5[2064 + 2667] = 11827.5$$

Deaths occuring to the cohort during the 1974-79 period at ages 65-69 can be estimated from the average annual number of deaths at these ages, 0.5(448 + 491), and the average exposure to risk, 2.5 years, giving (2.5)(0.5)(448 + 491) = 1173.75. Hence, the deaths during the 1974-79 period to the cohort aged 60+ at 1969 are:

$$\sum_{j=1974}^{1979} D^{j}(60,w) = 11827.5 + 1173.75 = 13001.25$$

Column (6) of table 2:10 is obtained by adding columns (4) and (5), and cumulating it upwards, we get column (7), the cumulated cohort deaths for the intercensal period (1969-79).

TABLE 2:10: CUMULATING COHORT DEATHS FROM REGISTRATION DATA - FEMALES

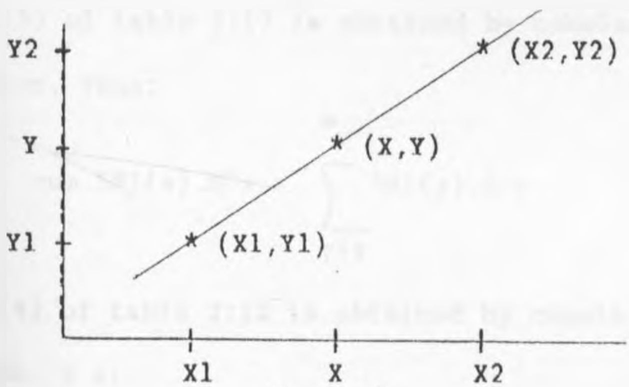
x	deaths by age group, 5dx 1969 (1)	1974 (2)	1979 (3)	cohort deaths, dx 1969-74 (4)	1974-79 (5)	cohort deaths 1969-79 (6)	CUM., Dx (7)
0	9136	13047	11395	-	-	-	-
5	579	1196	935	2752.5	2527.5	5280	68827.5
10	185	522	456	1442.5	2200	3642.5	63547.5
15	210	392	489	1637.5	2350	3987.5	59905
20	246	445	488	1837.5	2405	4242.5	55917.5
25	249	489	495	1747.5	2247.5	3995	51675
30	225	450	473	1815	2247.5	4062.5	47680
35	206	501	449	1645	2187.5	3832.5	43617.5
40	198	452	398	1662.5	2325	3987.5	39785
45	261	467	423	1945	2207.5	4152.5	35797.5
50	223	517	463	1437.5	2452.5	3890	31645
55	136	352	366	1935	2822.5	4757.5	27755
60	249	638	629	9996.25	13001.25	22997.5	22997.5
65	161	448	491			-	-
70+	882	2064	2667			-	-

step 5: obtaining survival ratios for the estimated level.

The survival ratios for the lower and upper levels, for example; levels 10 and 12 for Kenyan females in our case, are entered into columns (1) and (2) respectively of table 2:11.

Let X, the estimated level, lie between levels X1 and X2 and the survival ratio of level X be Y. Then the survival ratios for the estimated level may be obtained by linear interpolation as:

FIG. 1:1: ILLUSTRATION OF LINEAR INTERPOLATION



$$Y = Y1 + \left[\frac{(X - X1)}{(X2 - X1)}\right] * (Y2 - Y1)$$

These values are entered into column (3) of table 2:11 as shown below.

TABLE 2:11: OBTAINING SURVIVAL RATIOS FOR THE ESTIMATED LEVEL

x	LEVEL 10 Sx (1)	LEVEL 12 Sx (2)	ESTIMATED S^x (3)
0	.85981	.88783	.8820643
5	.93075	.9441	.9413530
10	.93915	.95002	.9477833
15	.93112	.9429	.9404760
20	.92042	.93395	.9311659
25	.90837	.9241	.9208632
30	.89639	.91386	.9102652
35	.88578	.90407	.9003065
40	.87162	.89068	.8867580
45	.84342	.86505	.8605992
50	.79265	.81972	.8141498
55	.71258	.74679	.7397506
60	.59903	.64037	.6318635
65	.45922	.50585	.4962550
70+	.19229	.21417	.2096678

step 6: estimating the completeness of death registration and census coverage

(a) The observed 1969 female population. 5N1(x), is entered into column (1) of table 2:12, and its product with column (3) of table 2:11 entered into column (2) of table 2:12.

i.e S^x * 5N1(x) = 5N1(x).S^x

e.g for the 0-4 age group,

0.882064 * 1046380 = 922974.4

(b) Column (3) of table 2:12 is obtained by cumulating column (2) from down. Thus:

$$\text{cum.}5N1(x).S\hat{}x = \sum_{y=x}^{w} 5N1(y).S\hat{}y$$

(c) Column (4) of table 2:12 is obtained by cumulating column (1) from down. i.e:

$$\text{cum.}5N1(x) = \sum_{y=x}^{w} 5N1(y)$$

(d) Column (5), the reconstructed population based survival ratios, denoted by CSR(x), are obtained by dividing column (3) by column (4)

i.e

$$CSR(x) = \frac{\sum_{y=x}^{w} 5N1(y).S\hat{}y}{\sum_{y=x}^{w} 5N1(y)} = Yi$$

e.g for the 0-4 age group, 0.886337 = 4839688/5460324

(e) column (6), the cumulated cohort based intercensal death rates, denoted by D*x, are obtained by dividing column (7) of table 2:10

by column (4). i.e:

$$D^{*}x = \frac{\sum_{y=x}^{w} D(y)}{\sum_{y=x}^{w} 5N1(y)} = Xi$$

TABLE 2:12: ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR KENYAN FEMALES.

x	OBSERVED 5Nlx (1)	5Nlx.S^x (2)	CUM. 5Nlx.S^x (3)	CUM. 5Nlx (4)	(Yi) Slx (5)	(Xi) D*x (6)	(i) (7)
0	1046380	922974.5	4839689.	5460324	.8863373		1
5	893359	840966.2	3916714.	4413944	.8873503	.0155932	2
10	663808	629146.1	3075748.	3520585	.8736469	.0180503	3
15	544847	512415.5	2446602.	2856777	.8564204	.0209694	4
20	450096	419114.1	1934187.	2311930	.8366113	.0241865	5
25	411245	378700.4	1515073.	1861834	.8137528	.0277549	6
30	299241	272388.7	1136372.	1450589	.7833867	.0328694	7
35	264819	238418.3	863983.5	1151348	.7504104	.0378839	8
40	201936	179068.4	625565.3	886529	.7056343	.0448773	9
45	163852	141010.9	446496.9	684593	.6522078	.0522902	10
50	139072	113225.4	305486.0	520741	.5866371	.0607692	11
55	102235	75628.40	192260.6	381669	.5037364	.0727201	12
60	94508	59716.15	116632.2	279434	.4173871	.0823003	13
65	63307	31416.41	56916.00	184926	.3077771		14
70+	121619	25499.58	25499.58	121619	.2096678		15
					8.667182	.4902646	

$\bar{X}$ = .0408554 $\qquad$ $\bar{Y}$ = .7222651

(f) our basic estimation equation is:

$$\frac{\sum_{y=x}^{w} 5Nl(y)\,.\,S\hat{\ }y}{\sum_{y=x}^{w} 5Nl(y)} = \frac{k2}{k1} - \frac{k2}{k} * \frac{\sum_{y=x}^{w} D(y)}{\sum_{y=x}^{w} 5Nl(y)} \qquad (2.3.6a)$$

which is analogous to:

$$Yi = a + bXi \qquad (2.3.6b)$$

where a = k2/k1 and b = -k2/k

The values of a and b are obtained as the least square estimates of the constant and the slope of equation (2.3.6b).

$$\text{i.e } \hat{b} = \frac{\sum_{i=2}^{13} (X_i-\bar{X}).(Y_i-\bar{Y})}{\sum_{i=2}^{13} (X_i-\bar{X})^2} \quad (2.3.7)$$

$$\text{and } \hat{a} = \bar{Y} - \hat{b}\bar{X} \quad (2.3.8)$$

Equations (2.3.7) and (2.3.8) are solved simultanously using table 2:13 below. $\hat{a}$ gives the relative completeness of the 1979 census with respect to the 1969 census where as the negative of the reciprocal of $\hat{b}$ gives degree of completeness of intercensal death registration, relative to 1979 census coverage.

TABLE 2:13: ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR KENYAN FEMALES

age,x	$\bar{X}_i$ (1)	$\bar{Y}_i$ (2)	$\bar{X}_i.\bar{Y}_i$ (3)	$(\bar{X}_i)^2$ (4)	(i) (5)
5	-.025262	.1650852	-.004170	.0006382	2
10	-.022805	.1513818	-.003452	.0005201	3
15	-.019886	.1341553	-.002668	.0003955	4
20	-.016669	.1143461	-.001906	.0002779	5
25	-.013100	.0914877	-.001199	.0001716	6
30	-.007986	.0611216	-.000488	.0000638	7
35	-.002972	.0281453	-.000084	.0000088	8
40	.0040219	-.016631	-.000067	.0000162	9
45	.0114348	-.070057	-.000801	.0001308	10
50	.0199138	-.135628	-.002701	.0003966	11
55	.0318647	-.218529	-.006963	.0010154	12
60	.0414449	-.304878	-.012636	.0017177	13
			-.037135	.0053523	

where $\bar{X}_i = X_i - \bar{X}$ and $\bar{Y}_i = Y_i - \bar{Y}$.

Then, $\hat{b}$ = -6.93806= -k2/k, and $\hat{a}$= 1.005722 = k2/k1

Setting k1=1 then k2=1.005722 and k = 0.1449570

step 7: The iteration procedure.

The estimated values of k2/k1 should be used to generate an artificial set of survival ratios, (k2/k1).10S(x,x+4), within the selected levels from an appropriate model (In our case the North model) and foward and backward projections repeated, new values of CSR(x) calculated and finally new estimates of k2/k1 and k2/k obtained. When there is no age misreporting, the iteration procedure will converge rapidly to give accurate values of k2/k1 and k2/k. However, in our case convergence does not occur.

The foregoing procedure is repeated for the Kenyan males to give the corresponding tables, given in appendix C.

The Palloni - Kominski method does not appear to give reliable results with the Kenyan data. First and foremost, convergence, which is required for optimum accuracy, does not occur, possibly due to considerable age misreporting and/or the high rate of population growth. Secondly, the value of k2/k1, for the Kenyan males, lies outside the range (0.98-1.02) within which the one - iteration routine would be sufficient to produce an accurate estimate of death registration completeness. Futhermore, even though it is not the aim of this study to estimate mortality levels, the inconsistencies in the implied average mortality levels by sex of 11.59 for females and 14.26 for males, raise suspecion on the appropriateness of the method to Kenya's data. For these reasons, the iteration procedure does not help improve on the results. Results from the Palloni - Kominski method imply that the relative coverage of the 1979 census with respect to the 1969 census coverage was 100.57 percent for females and 103.58 percent for males. The degree of intercensal death registration completeness is 14.50 percent and 19.39 percent for females and males, respectively.

CHAPTER 3

DETECTION OF AGE ERRORS

3.1. INTRODUCTION

Age errors may be divided into two categories. The first category takes the form of age heaping on certain prefered digits or ages. The second category consists of systematic age misreporting that transfers persons across age group boundaries and may thus make the population appear older or younger than it actually is. In this chapter, detection of age errors in Kenya is carried out using two techniques, namely; the age ratio technique and the age specific growth rate technique. The age ratio technique not only detects heaping on specific ages, but may also identify systematic age misreporting. The age specific growth rate technique detects systematic age misreporting that carries people across age group boundaries.

3.2 THE AGE RATIO TECHNIQUE

3.2.1 THE THEORY

The commonly used indices of digit preference, namely: the Myers' Index and the Whipple's Index, provide convenient means of determining the overall extent of preference or avoidance for specific terminal digits. However, they do not take into account the possibility that heaping at any given digit may be due to a particular preference for a single age and may may not really reflect any preference for the particular terminal digit. The age ratio technique determines the extent of heaping at specific ages. The age ratio of a particular age is computed by taking the ratio of the number reporting the specific age to the arithmetic mean of the number reporting the five ages immediately below and five ages immediately above the age in question. For example, the age ratio for age 5 would be computed as the number of persons reporting age 5 divided by one-tenth of the sum reporting ages 0, 1, 2, 3, 4, 6, 7, 8, 9 and 10. An age ratio less than one indicates avoidance for that particular age, where as an age ratio greater than one indicates preference for the age in question. 5 is the lowest age for which an age ratio can be computed.

3.2.2 APPLICATION OF THE AGE RATIO TECHNIQUE TO KENYA'S DATA.

step 1: Let N'(x) be the enumerated population aged x years and R(x) be the age ratio for age x.

Then, using the enumerated population by single years of age,

$$R(x) = N'(x)/[(1/10)*(N'(x-5) + N'(x-4) + N'(x-3) + N'(x-2) +N'(x-1) + N'(x+1) +N'(x+2) +N'(x+3) +N'(x+4) + N'(x+5)]$$

e.g for x=5,

$$R(5) = N'(5)/[(1/10)*(N'(0) + N'(1) +N'(2) + N'(3) + N'(4) + N'(6) + N'(7) + N'(8) + N'(9) + N'(10)]$$

Thus using table 3.2.1 for 1969 female data, we have:

$$R(5) = 1.008353$$

We should note that 5 is the lowest age for which an age ratio can be computed. Similarly, the age ratios for the remaining specific ages are worked out upto and including age A-6. A is the age begining the open age interval. In our case, A=70. Table 3:1 below gives the age ratios for females and males separately and togather for the 1969 data.

TABLE 3:1: AGE RATIOS FOR SPECIFIC AGES - 1969

	females		males		combined sexes	
age,x	N'(x)	R(x)	N'(x)	R(x)	N'(x)	R(x)
0	180506		181280		361786	
1	208958		211025		419983	
2	233763		236092		469855	
3	210930		213745		424675	
4	212223		215960		428183	
5	192860	1.008353	199534	1.021971	392394	1.015233
6	200051	1.091150	205164	1.091571	405215	1.091363
7	167003	.9215708	171084	.9139732	338087	.9177104
8	187441	1.120761	190295	1.093473	377736	1.106846
9	146004	.8993794	150522	.8871226	296526	.8931156
10	165744	1.103334	177275	1.124273	343019	1.114057
11	108470	.7330238	113997	.7317299	222467	.7323602
12	154670	1.164156	169287	1.211213	323957	1.188281
13	114489	.8584681	123712	.8834622	238201	.8712699
14	120435	.9757953	130436	1.007271	250871	.9919108
15	110788	.8987871	122766	.9618672	233554	.9308764
16	113136	.9904315	117370	.9906932	230506	.9905647
17	95092	.8335510	100208	.8546772	195300	.8442587
18	131863	1.294775	128153	1.228256	260016	1.261113
19	93968	.9199832	91655	.8924989	185623	.9062039
20	134772	1.398388	124237	1.300199	259009	1.349504
21	77743	.7833735	80275	.8515073	158018	.8165659
22	88942	.9559976	84575	.9611254	173517	.9584901
23	69059	.7267716	68140	.7816605	137199	.7530338
24	79580	.9118524	70788	.8865389	150368	.8997580
25	103596	1.182927	91593	1.159860	195189	1.171990
26	82405	1.032499	66021	.9072844	148426	.9727820
27	62280	.7763282	58888	.8233976	121168	.7985127
28	95067	1.324058	75549	1.155959	170616	1.243958
29	64897	.8986401	57543	.8938205	122440	.8963686
30	121015	1.830009	103674	1.728309	224689	1.781635
31	35933	.5188753	36652	.5907163	72585	.5528247
32	61744	.9924981	60648	1.067532	122392	1.028313
33	37488	.5828268	39614	.6780444	77102	.6281483
34	43061	.7349598	40360	.7334621	83421	.7342344
35	74810	1.301852	72990	1.358087	147800	1.329029
36	49750	.9839989	45180	.9228280	94930	.9539055
37	37806	.7249556	37664	.7528027	75470	.7385906
38	59127	1.269416	53979	1.200496	113106	1.235564
39	43326	.9287659	42323	.9529868	85649	.9405787
40	85393	1.966579	77353	1.817483	162746	1.892778
41	26902	.6069631	27999	.6545676	54901	.6303425
42	39893	.9893925	39871	1.003913	79764	.9965978
43	27352	.6612321	26285	.6427106	53637	.6520241
44	22396	.5791300	22428	.5805264	44824	.5798279
45	52859	1.415579	56886	1.560200	109745	1.487027
46	25321	.7514832	25779	.7592152	51100	.7553640
47	22725	.6775734	26460	.7951056	49185	.7361107
48	35710	1.198153	35893	1.203906	71603	1.201030

	females		males		combined sexes	
N'(x)	R(x)	N'(x)	R(x)	N'(x)	R(x)	
50	60480	2.215612	55049	1.919328	115529	2.063807
51	21393	.7651096	21187	.7400460	42580	.7524298
52	22747	.8516382	21918	.7956439	44665	.8232087
53	15532	.5700319	14656	.5259833	30188	.5477613
54	18920	.7579399	19656	.7709172	38576	.7644973
55	30528	1.201947	36889	1.446378	67417	1.324416
56	20407	.9457887	22503	.9876668	42910	.9672976
57	14165	.6542181	15692	.6773779	29857	.6661892
58	20889	1.047976	22363	1.032351	43252	1.039839
59	16246	.8146748	17222	.7843548	33468	.7987856
60	43209	2.466281	44798	2.275246	88007	2.365195
61	12138	.6619909	13459	.6693056	25597	.6658170
62	15902	.9451131	18194	.9819043	34096	.9643952
63	12280	.7171976	13553	.7132144	25833	.7151023
64	10979	.6732196	12462	.6853391	23441	.6796088
65	21665		24556		46221	
66	7614		9746		17360	
67	9070		11442		20512	
68	13510		15785		29295	
69	11448		13082		24530	
70+	121619		131472		253091	

Step 2: The results from table 3:1 are then put in a summary form as shown in table 3:2 for computational convenience. For example, the age ratio for age 5 is entered in the cell corresponding to age group 5-9 and digit 5. This is done for the ages 5 to A-6.

TABLE 3:2: AGE RATIOS INDICATING PREFERENCE FOR SPECIFIC AGES FOR THE 1969 FEMALES

	terminal digits					mean age
Age group	5/0	6/1	7/2	8/3	9/4	ratio
5-9	1.008353	1.091150	.9215708	1.120761	.8993794	1.008243
10-14	1.103334	.7330238	1.164156	.8584681	.9757953	.9669554
15-19	.8987871	.9904315	.8335510	1.294775	.9199832	.9875056
20-24	1.398388	.7833735	.9559976	.7267716	.9118524	.9552766
25-29	1.182927	1.032499	.7763282	1.324058	.8986401	1.042891
30-34	1.830009	.5188753	.9924981	.5828268	.7349598	.9318337
35-39	1.301852	.9839989	.7249556	1.198153	.9287659	1.027545
40-44	1.966579	.6069631	.9893925	.6612321	.5791300	.9606594
45-49	1.415579	.7514832	.6775734	1.198153	.9137388	.9913056
50-54	2.215612	.7651096	.8516382	.5700319	.7579399	1.032066
55-59	1.201947	.9457887	.6542181	1.047976	.8146748	.9329209
60-64	2.466281	.6619909	.9451131	.7171976	.6732196	1.092760

The last column of table 3:2 is obtained by taking the arithmetic mean of age ratios corresponding to specific age groups. This column may give an indication of age groups that gain or lose persons as a result of age heaping.

Step 3: Absolute deviations of age ratios in table 3:2 from one are entered into table 3:3 as shown below.

TABLE 3:3: ABSOLUTE DEVIATIONS OF AGE RATIOS FROM ONE - 1969 FEMALES

Age group	terminal digits 5/0	6/1	7/2	8/3	9/4	mean dev. from one	mean dev. from one
5-9	.0083534	.0911500	.0784292	.1207610	.1006206	.0798628	
10-14	.1033337	.2669762	.1641560	.1415319	.0242047	.1400405	.1099517
15-19	.1012129	.0095685	.1664490	.2947751	.0800168	.1304045	
20-24	.3983878	.2166265	.0440024	.2732284	.0881476	.2040786	.1672415
25-29	.1829268	.0324992	.2236718	.3240585	.1013599	.1729032	
30-34	.8300087	.4811247	.0075019	.4171732	.2650402	.4001698	.2865365
35-39	.3018518	.0160011	.2750444	.1981533	.0712341	.1724569	
40-44	.9665792	.3930369	.0106075	.3387679	.4208700	.4259723	.2992146
45-49	.4155792	.2485168	.3224266	.1981533	.0862612	.2541874	
50-54	1.215612	.2348904	.1483618	.4299681	.2420601	.4541785	.3541829
55-59	.2019465	.0542113	.3457819	.0479764	.1853252	.1670483	
60-64	1.466281	.3380091	.0548869	.2828024	.3267804	.4937520	.3304001

Sum. of mean dev. from one= 1.547527

The last two columns of table 3:3 are obtained by taking the arithmetic mean of absolute deviations from one for specific age intervals. The second last column is for 5 - year age groups. while the last column is for 10 - year age intervals. These columns are useful in identifying the amount of error in each age interval. The summation of the last column, i.e sum of means of absolute deviations from one, may be used as an index of error resulting from age heaping. The higher the index, the higher the degree of age heaping.

GRAPHS OF AGE RATIO AGAINST AGE

Fig. 3.1 FEMALES 1969

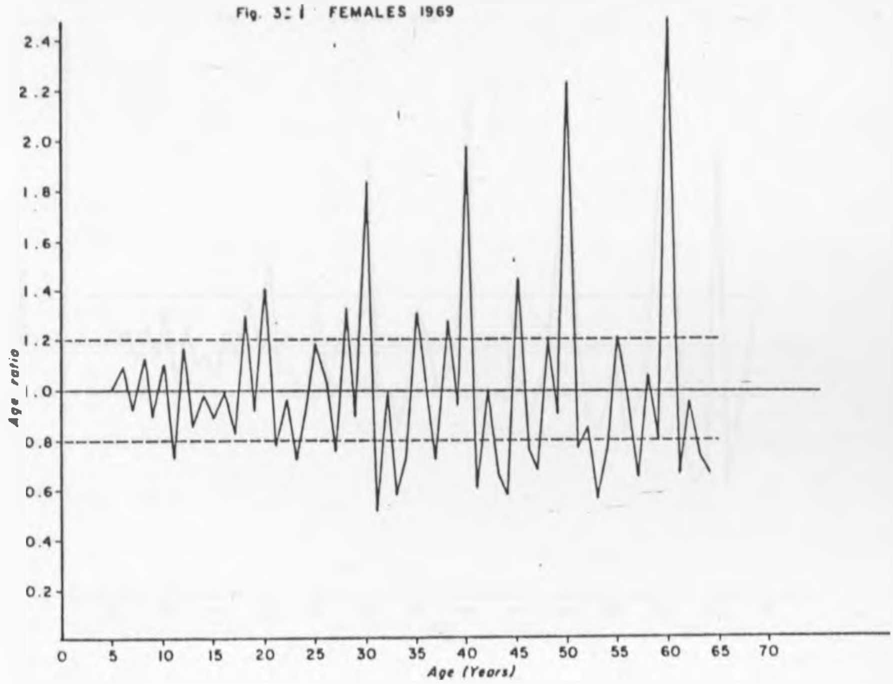
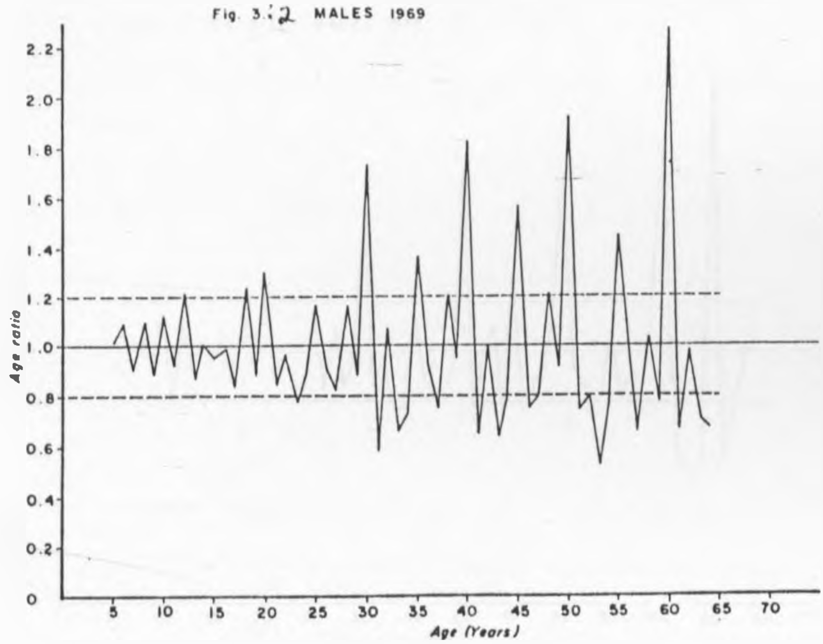


Fig. 3.2 MALES 1969



GRAPHS OF AGE RATIO AGAINST AGE

Fig 3.3 FEMALES 1979

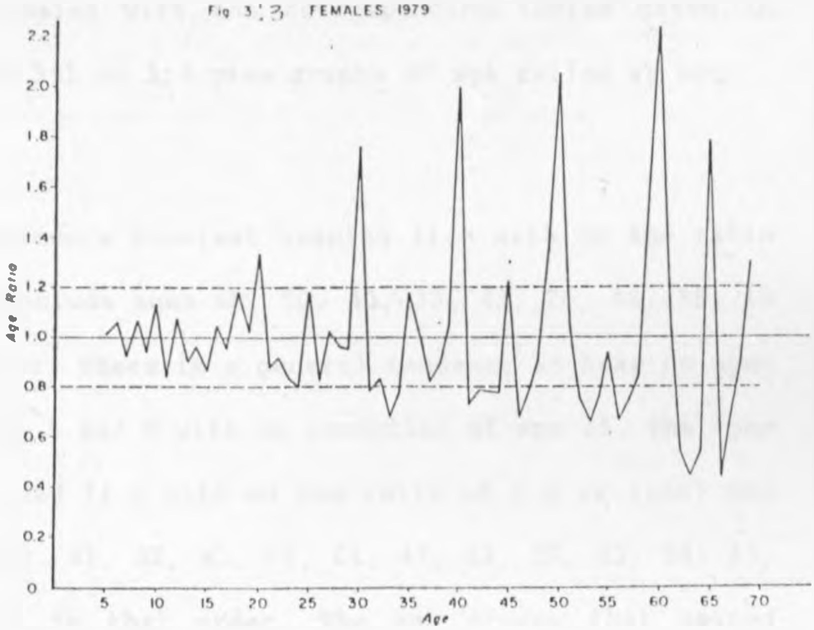
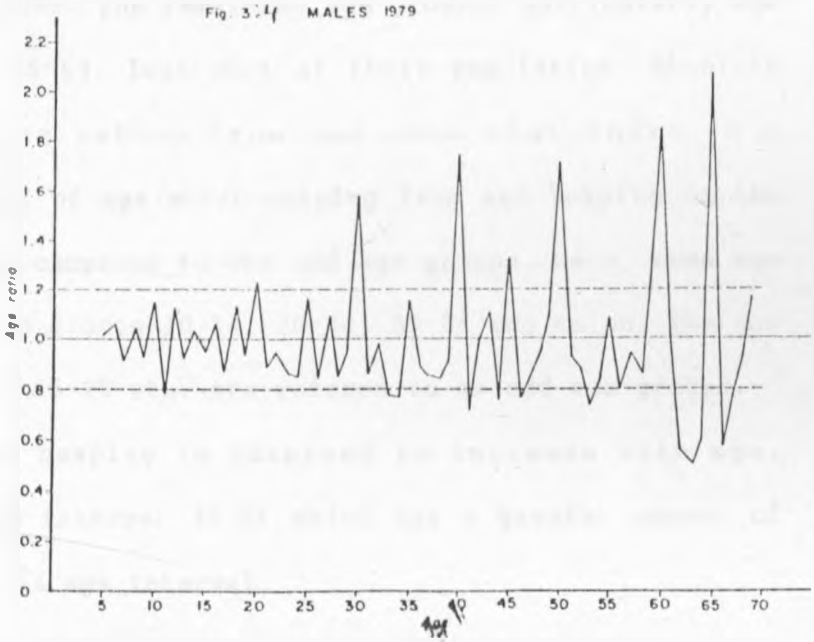


Fig. 3.4 MALES 1979



The foregoing procedure is then repeated for 1969 males, 1979 females and 1979 males with the corresponding tables given in appendix D.Figures 3:1 to 3:4 give graphs of age ratios vs age.

1969 FEMALES

The ages that experience greatest heaping (i.e with an age ratio of 1.2 or above) include ages 60, 50, 40, 30, 45, 20, 28, 35, 18 and 55 in that order. There is a general tendency to heap on ages ending in digits 0, 5 and 8 with an exception of age 15. The ages that are most avoided (i.e with an age ratio of 0.8 or less) are ages 31, 53, 44, 33, 41, 57, 43, 61, 64, 47, 63, 37, 23, 34, 46, 54, 51, 27 and 21 in that order. The age groups that gained persons as a result of age heaping are 60-64, 25-29, 50-54, 35-39 and 5-9 in that order. The remaining age groups, particularly age groups 30-34 and 55-59, lost part of their population. Absolute deviations of age ratios from one show that there is a considerable amount of age error arising from age heaping in the even age groups as compered to the odd age groups. Here, even age groups refer to age groups 10-14, 20-24, 30-34 and so on. The age groups 5-9, 15-19, 25-29 etc. are refered to as odd age groups.
The degree of age heaping is observed to increase with age, except for the age interval 45-54 which has a greater amount of error than the 55-64 age interval.

1969 MALES

The ages that experience greatest heaping are 60, 50, 40, 30, 45, 55, 35, 20, 18, 12, 48 and 38 in that order. Again, there is a tendency to heap on ages with terminal digits 0, 5 and 8 with an exception of age 15. The ages that are most avoided are ages 53, 44, 31, 43, 41, 61, 57, 33, 64, 63, 11, 34, 51, 37, 46, 54, 59, 47 and 52 in that order. The age groups that gained population as a result of age heaping are 60-64, 45, 35-39 and 5-9 in that order. The rest of the age groups, and in particular age groups 40-44, 50-54, 20-24 and 30-34, lost part of their population to the surrounding age groups. There is a greater amount of age error in the even than the odd age groups. The degree of age heaping is observed to increase with age except for the age interval 45-54 which has a greater amount of error than the age interval 55-64.

1979 FEMALES

The ages that experience greatest heaping are 60,50,40,65,30,59, 49, 20, 69 and 45 in that order. There is a tendency to heap on ages with terminal digits 0, 5 and 9 except for ages 15, 55, 19 and 29. The ages that are most avoided are: 66, 63, 62, 64, 53, 56, 67, 33, 46, 41, 57, 52, 54, 44, 34, 42, 43, 31 and 47 in that order. The age groups that gained population as a result of age heaping are: 50-54, 65 69, 15 19 and 40 44. The remaining age groups and in particular 20-24, 60-64 and 30-34, lost part of their population to surrounding age groups. Again, the amount of error arising from age heaping is greater in the even than the odd age groups and the degree of heaping increases with age.

1979 MALES

Greatest amount of heaping is observed in ages 65, 60, 40, 50, 30, 45, 59 and 20 in that order. There is heaping on all ages ending in digits 0 and 5 except for age 15. The ages that are most avoided are ages 63,62. 66, 64, 41. 53, 44, 34, 46, 33, 67, 11 and 56 in that order. The age group that gained population as a result of age heaping are: 65-69, 40-44, 50-54 and 10-14 in that order. The remaining age groups, particularly 60-64, 35-39 and 20-24 lost part of their population to the surrounding age groups. The degree of heaping increases with age and is greater for the even age groups than the odd age groups.

For both males and females, the considerable amount of heaping on digits 0 and 5 could be attributed to universal preference for these terminal digits. Where the respondent is ignorant of his/her age, there is a tendency to round up ages to the nearest multiple of 10 or 5. This was the case for both the 1969 and the 1979 censuses. The marked heaping on terminal digits 8 and 9 is possibly a result of assigning ages ending in these digits to those reporting a year of birth ending in digit 0,since the censuses were conducted in August 1969 and August 1979 respectively. However, the pattern of heaping on terminal digits 8 and 9 was fairly interesting. Heaping on ages ending in digit 8 was only observed in the 1969 census data and was more pronounced in the early ages of 18 and 28, where as heaping on terminal digit 9 was only observed in the 1979 census data and was more pronounced in old ages like 49, 59 and 69. In all the cases considered. their is a general tendency for the degree of age heaping to increase with age. This could be explained in terms of: (i) Due to memory lapse, the older respondents are more likely to be ignorant of their ages, and as a result, their ages are either estimated by themselves or by the enumerator based on external clues with the result that these ages are rounded up to the universally prefered terminal digits of 0 and 5. (ii) Lack of education or proper written records among the older respondents may also lead to rounding up of ages to terminal digits 0 or 5. The greater amount of error in the even age groups than the odd age groups is possibly due to greater heaping on terminal digit 0 than terminal digits 5, 8 or 9. The degree of heaping was observed to be greater for females than males possibly due to better education and better written records for males. Similar reasons may be used to explain why the degree of heaping was greater in the 1969 census than the 1979 census.

3.3 THE AGE SPECIFIC GROWTH RATE TECHNIQUE

3.3.1: THE THEORY

The age specific growth rate technique is an extension of the stable population theory by making the growth rate a function of age. Apart from being useful in the estimation of the degree of completeness of death registration, construction of life tables, estimation of adult mortality from data on ophanhood, estimation of mean age at marriage, estimation of fertility measures and net migration rates, finding out the relative coverage of censuses and making population projections, the age specific growth rate technique can also be used to detect age misreporting as will be shown in this section.

Let $N(x)$ = the number of persons aged x

$u(x)$ = the age specific mortality rate at exact age x

r = the constant growth rate.

In a stable population,

$$N(x) = N(0).p(x) \exp(-rx) \qquad (3.3.1)$$

Where p(x) is the probability of surviving upto age x from birth.

Differentiating (1) with respect to x, we get:

$$\frac{dN}{dx} = N(x)\left[-r + \frac{d}{dx}\log P(x)\right] \qquad (3.3.2)$$

But by definition,

$$u(x) = -\frac{1}{l(x)}\frac{dl}{dx}$$

$$= -\frac{d}{dx}\log p(x) \qquad (3.3.3)$$

Therefore equation (3.3.2) becomes:

$$\frac{1}{N(x)}\frac{dN}{dx} = -r - u(x) \qquad (3.3.4)$$

Thus the relative change in the number of persons at age x diminishes at a rate of r + u(x).

Suppose now that the rate of increase is no longer a constant, but rather a function of age, then equation (3.3.4) can be modified to:

$$\frac{1}{N(x)}\frac{dN}{dx} = -r(x) - u(x)$$

i.e

$$\frac{d}{dx}\log N(x) = -r(x) - u(x) \qquad (3.3.5)$$

If a < x < a+n, then intergrating (3.3.5), we have:

$$N(a+n) = N(a).nPa.\exp\left[-\int_a^{a+n} r(x)\,dx\right] \qquad (3.3.6)$$

where

$$nPa = \exp\left[-\int_a^{a+n} u(x)\,dx\right] \qquad (3.3.7)$$

If 0 < x < a, then we have:

$$N(a) = N(0)\,p(a)\,\exp\left[-\int_0^{a} r(x)\,dx\right] \qquad (3.3.8)$$

where $p(a) = \exp [-\int_0^a u(x)\, dx$ (3.3.9)

is the probability of surviving from birth upto age a.

The birth rate is expressed as:

$$b = \frac{N(0)}{\int_0^\infty N(a)\, da}$$

$$= \frac{1}{p(a) \{ \exp [-\int_0^\infty r(x)\, dx]\}\, da} \qquad (3.3.10)$$

using formular (3.3.8).

The proportion of the population that is aged a is given by:

$$C(a) = \frac{N(a)}{\int_0^\infty N(a)\, da}$$

$$= bp(a) \exp [-\int_0^a r(x)\, dx] \qquad (3.3.11)$$

The proportion of people aged between x and x+5 years is given by:

$$5Cx = \int_x^{x+5} C(a)\, da$$

$$= \int_x^{x+5} bp(a) [\exp [-\int_0^a r(y)\, dy]\}\, da \qquad (3.3.12)$$

The mid - point of x and x+5 is x+2.5. Thus, we can replace

$\int_0^a r(y)\, dy$ by $\int_0^{x+2.5} r(y)\, dy$.

Therefore,

$$5Cx = \int_x^{x+5} bp(a) \{ \exp [-\int_0^{x+2.5} r(y)\, dy] \}\, da.$$

$$= \{ b \exp [-\int_0^{x+2.5} r(y)\, dy] \} \{\int_x^{x+5} p(a)\, da\}$$

0 x

$$= \{ b \exp [- \int_0^{x+2.5} r(y)\, dy] \} \frac{5Lx}{l(0)} \qquad (3.3.13)$$

$$\text{where} \quad 5Lx = \int_x^{x+5} l(a)\, da \qquad (3.3.14a)$$

$$\text{and} \quad p(a) = \frac{l(a)}{l(0)} \qquad (3.3.14b)$$

5Lx is called the person - years lived between ages x and x+5.

But,

$$\int_0^{x+2.5} r(y)\, dy = \int_0^{5} r(y)\, dy + \int_5^{10} r(y)\, dy + \ldots\ldots + \int_{x-5}^{x} r(y)\, dy + \int_x^{x+2.5} r(y)\, dy$$

$$= 5[5r0 + 5r5 + \ldots\ldots + 5r(x-5)] + 2.5[5rx] \qquad (3.3.15)$$

where 5rx is the age specific growth rate between ages x and x+5.

Assuming constant growth rates within the five - year age interval;

$$5Cx = b \frac{5Lx}{l(0)} \exp \{-5[5r0+5r5+\ldots+5rx-5] + 2.5(5rx)\} \qquad (3.3.16)$$

$$\text{and} \quad 5C0 = b \frac{5L0}{l(0)} \exp \{ -2.5[5r0] \} \qquad (3.3.17)$$

To determine b, we sum (3.3.13) over x and noting that

$$\sum_{x=0}^{w} 5Cx = 1$$

we obtain

$$b = \frac{1}{\sum_{x=0}^{\omega} \frac{5Lx}{l(0)} \exp [- \int_0^{x+2.5} r(y)\, dy]} \qquad (3.3.18a)$$

$$= \frac{1}{\displaystyle\sum_{x=0}^{\omega} \frac{{}_5L_x}{l(0)} \exp\{-5[{}_5r_0 + {}_5r_5 + \ldots + {}_5r_{x-5}] - 2.5({}_5r_x)\}} \qquad (3.3.18b)$$

Therfore,

$${}_5C_0 = \frac{{}_5L_0 \exp[-2.5({}_5r_0)]}{\displaystyle\sum_{x=0}^{\omega} {}_5L_x \exp[-\int_0^{x+2.5} r(y)\,dy]} \qquad (3.3.19a)$$

$$= \frac{{}_5L_0 \exp[-2.5({}_5r_0)]}{\displaystyle\sum_{x=0}^{\omega} {}_5L_x \exp\{-5[{}_5r_0 + {}_5r_5 + \ldots + {}_5r_{x-5}] - 2.5({}_5r_x)\}} \qquad (3.3.19b)$$

$${}_5C_x = \frac{{}_5L_x \exp[-\int_0^{x+2.5} r(y)\,dy]}{\displaystyle\sum_{x=0}^{\omega} {}_5L_x \exp[-\int_x^{x+2.5} r(y)\,dy]} \qquad (3.3.20a)$$

$$= \frac{{}_5L_x \exp\{-5[{}_5r_0 + {}_5r_5 + \ldots + {}_5r_{x-5}] - 2.5({}_5r_x)\}}{\displaystyle\sum_{x=0}^{\omega} {}_5L_x \exp\{-5[{}_5r_0 + {}_5r_5 + \ldots + {}_5r_{x-5}] - 2.5({}_5r_x)\}} \qquad (3.3.20b)$$

From formulae (3.3.19b) and (3.3.20b), we have:

$$\frac{{}_5C_x}{{}_5C_o} = \frac{{}_5L_x \exp\{-5[{}_5r_0 + {}_5r_5 + \ldots + {}_5r_{x-5}] - 2.5({}_5r_x)\}}{{}_5L_0 \exp\{-2.5({}_5r_0)\}}$$

$$= \frac{{}_5L_x}{{}_5L_0} \exp -\{2.5({}_5r_0) + 5({}_5r_5 + \ldots {}_5r_{x-5}] + 2.5({}_5r_x)$$

Which implies that

$$\frac{{}_5L_x}{{}_5L_0} = \frac{{}_5C_x}{{}_5C_0} \exp\{2.5({}_5r_0) + 5({}_5r_5 + \ldots + {}_5r_{x-5}) + 2.5({}_5r_x)\} \qquad (3.3.21)$$

For the open interval, say age A and over, we have:

$$C(A+) = b \frac{T(A)}{l(0)} \exp\{-5[5r0+5r5+.....+5rA-5] - (2/3)e(A).r(A+)\} \quad (3.3.22a)$$

$$= \frac{T(A) \exp\{-5[5r0+5r5+.....+5rA-5] - (2/3)e(A).r(A+)\}}{\sum_{x=0}^{\omega} 5Lx \exp\{-5[5r0+5r5+....+5rx-5] - 2.5(5rx)\}} \quad (3.3.22b)$$

where e(A) = Expectation of life at age A

r(A+) = The growth rate for age A and above

T(A) = The total population for those aged A and over

$$= \int_A^w l(x)\, dx$$

From two censuses, the growth rates, 5rx, can be calculated by simply applying the formula:

$$5rx = \frac{1}{t2 - t1} \log \left[\frac{5Nx(t2)}{5Nx(t1)}\right] \quad (3.3.23)$$

where t1 and t2 are the periods the censuses were taken.

Using (3.3.22b) and (3.3.17), we have:

$$\frac{T(A)}{5L0} = \frac{C(A+)}{5C0} \exp\{2.5(5r0)+5(5r5+....+5rA-5) + (2/3)e(A).r(A+)\} \quad (3.3.24)$$

Once we have obtained a column of 5Lx/5L0, it is now a matter of adding these values from down upwards to get T(x)/5L0.

Hence, $$\frac{T(x)}{T(5)} = \left[\frac{T(x)}{5L0}\right] / \left[\frac{T(5)}{5L0}\right] \quad (3.3.25)$$

From the Office of Population Research, Princeton University, computerized tables of T(x)/T(5) against mortality levels have been made for each region (i.e East, West, North and South) and sex. We should note that the tables of T(x)/T(5) are computed from T(x) values for each mortality level of the Coale - Demeny model life tables. A graph of age against mortality levels is then plotted. It is hypothesized that if the graph is rising, then there is an indication of overstatement of age. A graph showing a downward trend implies under-estimation of age. A horizontal graph implies correct age statement.

3.3.2 APPLICATION OF THE AGE SPECIFIC GROWTH RATE TECHNIQUE TO KENYA'S DATA

Step 1: The 1969 and the 1979 female populations, denoted by 5N1(x) and 5N2(x) respectively are entered into columns (1) and (2) of table 3:4, and the geometric mean of the 1969 and 1979 populations, 5N'(x), is entered into column (3).

i.e 5N'(x) = SQRT [5N1(x) * 5N2(x)]

e.g for x = 0,

5N'(0) = SQRT [1046380*1423936] = 1220646: for Kenyan females

Step 2: The proportion of the population aged x to x+4 years, 5C(x), is obtained by dividing the values in column (3) by the total sum of column (3).

$$\text{i.e } 5C(x) = \frac{5N'(x)}{\sum_{x=0} 5N'(x)}$$

e.g for x = 0,

5C(0) = 1220646/6487234 = 0.188161

These values are entered into column (4) of table 3:4.

Step 3: The age specific growth rates, 5rx, are obtained from formula (3.3.23).

i.e 5rx = 1/10 log [5N2(x)/5N1(x)]

e.g for x = 0,

5r0 = 1/10 log [1423936/1046380] = 0.030808.

These values are entered into column (5). The sum of 5rx values, starting from x = 5, are given in column (6).

Step 4: The 5Cx/5C0 values in column (7) are obtained by dividing column (4) with 5C0 = 0.188161.

e.g for x = 5,

5C0/5C5 = 0.162698/0.188161 = 0.864675.

TABLE 3:4: DETECTING AGE MISREPORTING FOR KENYAN FEMALES - ASGRT

age,x	5N1(x) (1)	5N2(x) (2)	5N'(x) (3)	5C(x) (4)	5r(x) (5)	SUM. 5r(x) (6)	5Cx/5Co (7)
0	1046380	1423936	1220647.	.1881613	.0308088		1
5	893359	1246983	1055464.	.1626985	.0333494	.0333494	.8646758
10	663808	1025677	825137.9	.1271941	.0435115	.0768609	.6759843
15	544847	889316	696089.9	.1073015	.0489948	.1258557	.5702633
20	450096	687234	556166.6	.0857325	.0423214	.1681771	.4556328
25	411245	542233	472218.8	.0727920	.0276507	.1958277	.3868596
30	299241	413432	351732.6	.0542192	.0323244	.2281521	.2881527
35	264819	325951	293799.3	.0452888	.0207700	.2489221	.2406915
40	201936	274193	235307.1	.0362723	.0305881	.2795103	.1927725
45	163852	222363	190878.6	.0294237	.0305348	.3100451	.1563750
50	139072	191365	163136.5	.0251473	.0319191	.3419641	.1336476
55	102235	134776	117383.2	.0180945	.0276340	.3695981	.0961648
60	94508	109715	101828.0	.0156967	.0149202	.3845183	.0834214
65	63307	83370	72649.19	.0111988	.0275293	.4120476	.0595170
70+	121619	149403	134797.0	.0207788	.0205754		.1104309
	5460324	7719947	6487235.				

Step 5: The 5Lx/5L0 values in column (1) of table 3:5 are obtained from formula (3.3.22).

i.e
$$\frac{5Lx}{5L0} = \frac{5Cx}{5C0} \exp\{2.5(5r0)+5(5r5+\ldots.5rx-5)+2.5(5rx)\}$$

where 5Lx is the person years lived by those aged x to x+4 year

e.g for x = 5,

$$\frac{5Lx}{5L0} = \frac{5C5}{5C0} \exp\{2.5(5r0)+0+2.5(5r5)$$

$$= 0.864675 \exp\{2.5(0.030808)+2.5(0.033347)\}$$

$$= 1.015107$$

Step 6: The T(x)/5L0 values in column (2) are obtained by cumulating column (1) from down.

$$\text{i.e} \quad \frac{T(x)}{5L0} = \sum_{y=x} \frac{5Ly}{5L0}$$

where Tx is the person years lived by those aged x years and above, and w is the latest age to which one can survive.

e.g for x=5,

$$\frac{T(5)}{5L0} = \sum_{y=5} \frac{5Ly}{5L0} = 11.79196$$

Step 7: The T(x)/T(5) values in column (3) are obtained by dividing column (2) by T(5)/5L0 = 11.79196, as shown in formular (3.3.25)

i.e T(x)/T(5) = [T(x)/5L0] / [T(5)/5L0].

e.g for x = 10,

T(10)/T(5) = 10.77685/11.79196 = 0.913915

Assuming e(70) = 7.612
source: Mudaki,1986

TABLE 3:5: DETECTING AGE MISREPORTING FOR KENYAN FEMALES

age,x	5Lx/5Lo (1)	Tx/5Lo (2)	Tx/T5 (3)	ESTIMATED LEVEL (4)
0	1	12.79197	1.084803	-
5	1.015108	11.79197	1	-
10	.9617145	10.77686	.9139153	13.72102
15	1.022404	9.815145	.8323586	14.38485
20	1.026378	8.792741	.7456552	13.35868
25	1.038046	7.766363	.6586148	12.42886
30	.8982622	6.728317	.5705848	11.42831
35	.8568165	5.830055	.4944090	11.57820
40	.7802497	4.973238	.4217480	11.72539
45	.7374270	4.192989	.3555801	12.17077
50	.7367521	3.455562	.2930437	12.66595
55	.6152269	2.718809	.2305645	12.74004
60	.5936071	2.103583	.1783912	13.61104
65	.4709247	1.509975	.1280512	14.08763
70+		1.039051	.0881151	

Step 8: Mortality levels corresponding to the computed T(x)/T(5) values are then obtained from the computerized tables of T(x)/T(5) against mortality levels for the North model given below by linear interpolation.

TABLE 3:6: Tx/T5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS FOR THE NORTH MODEL - FEMALES

age,x	LEVEL 11 (1)	LEVEL 12 (2)	LEVEL 13 (3)	LEVEL 14 (4)	LEVEL 15 (5)
0	1.07944	1.07666	1.07415	1.07181	1.06962
5	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90781	.91028	.91243	.91449	.91648
15	.81877	.82329	.82719	.83095	.83461
20	.7321	.73838	.74379	.74899	.7541
25	.64799	.65575	.66243	.66884	.67516
30	.56676	.57569	.58339	.59074	.59805
35	.48876	.49853	.50696	.51497	.52297
40	.41432	.42456	.43341	.44177	.45018
45	.34371	.35405	.36301	.37143	.37995
50	.27709	.28719	.29598	.30417	.31254
55	.21485	.2244	.23273	.24045	.2484
60	.15789	.16655	.17412	.18111	.18838
65	.10765	.11504	.12152	.1275	.13379
70+					

Source: Office of Population Research, Princeton University.

DETECTING AGE MISREPORTING : THE ASGR TECHNIQUE.

Fig. 3.5 FEMALES

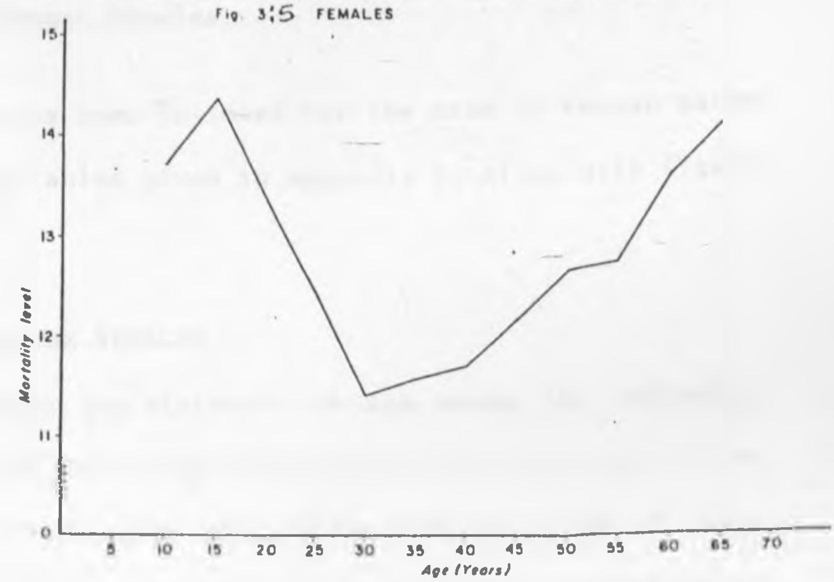
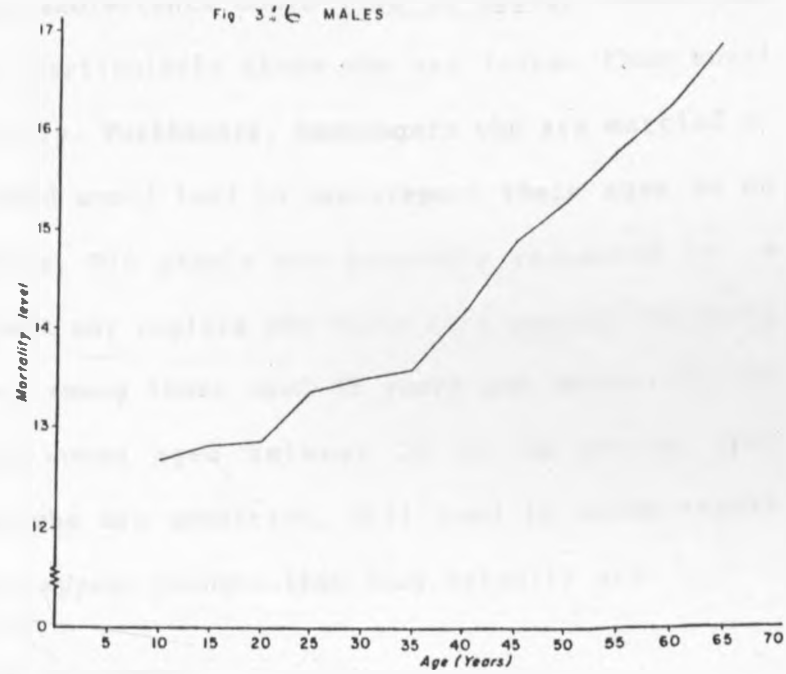


Fig. 3.6 MALES



A graph of age against mortality level is then plotted as shown in figure 3:5 for Kenyan females.

The same procedure has been followed for the case of Kenyan males with corresponding tables given in appendix E, along with figure 3:6.

AGE REPORTING AMONG THE FEMALES

There is considerable overstatement of age among the teenagers and those aged 45-49, 50-54, 60-64 and 65-69 while the age groups 35-39, 40-44 and 55-59 only show mild over-reporting of age. Over-reporting of age among the teenagers could be attributed to the fact that most adolescents would like to appear older than they actually are, particularly those who are faster than usual in maturing physically. Furthemore, teeenagers who are married or have at least a child would tend to over-report their ages so as to be seen as adults. Old people are generally respected in a society and this fact may explain why there is a general tendency to over-report age among those aged 35 years and above. On the other hand, young women aged between 20 to 34 years, and particularly those who are unmarried, will tend to under-report their ages so as to appear younger than they actually are.

AGE REPORTING AMONG THE MALES

For males, there is a tendency to over-report age throughout the age distribution, and in particular, among those in their late twenties and above age 40 years. Generally, men are considered mature and capable of taking care of a family resposibly when they are around 30 years old. For this reason, married men in their late twenties may tend to over-state their ages to appear older. Again, age exaggeration among those aged 40 years and above could be attributed to the respect the society attached to the elderly.

CHAPTER 4

CORRECTION OF AGE ERRORS

4.2. INTRODUCTION

In this chapter, an attempt is made to estimate Kenya's age distribution by correcting for the age misreporting errors. The Demeny - Shorter method is used to detect and correct systematic age misreporting, where as the Saxena - Gogte technique is used to correct for heaping on multiples of five. The two methods are first applied separately, then jointly to Kenya's data. Following the correction of age errors, the efficiency or appropriateness of the correction techniques to Kenyan data is examined by studying the correspondence between the techniques of detecting and of correcting age errors. This will help to identify the method that gives the best estimate of Kenya's age distribution. Finally, the extent to which some of the assumptions made in the study with regard to changes in census coverage, mortality level and life expectancy at old age could have affected the results is examined.

2 THE DEMENY - SHORTER METHOD

2.1 THE THEORY

The Demeny - Shorter method is a cohort survival method of correcting age distributions. It is based on the following assumptions: first, that the pattern of age misreporting is systematic and therefore repeats itself from one census to the next; second, that the population can be assumed to experience mortality according to an appropriately selected model mortality schedule; and third, that the total size of the population was enumerated correctly or at least that the coverage of the two censuses are reasonably close.

The method can be represented mathematically using the following notations:

Let $i = 1,2,\ldots\ldots16$ represent the ith age group. The

The 16 age groups are 0-4, 5-9, ..., 70-74, 75+.

P_i = The known reported populations in age group i in the first census.

Q_i = The known reported population in age group i in the second census.

C_i = The unknown actual population in age group i in the first census.

D_i = The unknown actual population in age group i in the second census.

S_i = The known survivorship rate from age group i to i+1

(For i=15 and i=16, S(15) is the rate from 70-74 to 75-79, and S(16) is the rate from 75+ to 80+.

e_i = The unknown ratio of reported to actual population in age group i.

We note that in terms of nLx, the life table stationary population column,

$$S_i = {}_5L_{5i}/{}_5L_{5(i-1)}, \quad i = 1.......15.$$

$$S_{16} = L_{80}/L_{75}.$$

From the above assumptions, we can formulate the following equations:

$$P_i = e_iC_i \qquad (4.2.1a)$$

and $$Q_i = e_iD_i. \quad \text{for } i = 1,2,\ldots\ldots16 \qquad (4.2.1b)$$

$$D(i+1) = SiCi \quad \text{for } i = 1,2........14. \qquad (4.2.2a)$$

and $$D(16) = S(15)C(15) + S(16)C(16) \qquad (4.2.2b)$$

$$\sum_{i=1}^{16} Pi = \sum_{i=1}^{16} Ci \qquad (4.2.3a)$$

and

$$\sum_{i=1}^{16} Qi = \sum_{i=1}^{16} Di \qquad (4.2.3b)$$

general, the last (open) age groups could be represented by L. In is case L = 16. It can be seen from the above sets of equations in (4.2.1), (4.2.2) and (4.2.3) that we have 48 unknown parameters (i.e Ci's, 16 Di's and 16 ei's) and 49 independent equations.

From (4.2.1b),

$$Qi = eiDi \quad ==> \quad Q(i+1) = e(i+1)D(i+1).$$

Thus, $$e(i+1) = \frac{Q(i+1)}{D(i+1)}, \qquad \text{for all } i.$$

Using (4.4.2),

$$e(i+1) = \frac{Q(i+1)}{SiCi}, \qquad \text{for } i = 1,2.......14 \qquad (4.2.4a)$$

and $$e(16) = \frac{Q(16)}{D(16)} = \frac{Q(16)}{S(15)C(15) + S(16)C(16)}, \quad \text{for } i = 15. \quad (4.2.4b)$$

$$==> Q(16) = e(16)S(15)C(15) + e(16)S(16)C(16)$$

$$==> C(15) = \frac{Q(16) - S(16)P(16)}{e(16)S(15)} \qquad (4.2.5)$$

$$==> C(15)e(16) = \frac{Q(16) - S(16)P(16)}{S(15)}$$

From (4.2.1a),

$$e(1)C(1) = P(1) \tag{4.2.6a}$$

and $e(1)C(1)e(2)C(2)..........e(i-1)C(i-1)eiCi = P(1)P(2)......Pi$

which implies that:

$$e(1)Ci = \frac{P(1)P(2)............Pi}{C(1)e(2)C(2)e(3)......C(i-1)ei}, \quad \text{for } i = 2,......15$$

but from (4.2.4),

$$C(i)e(i+1) = \frac{Q(i+1)}{Si}, \qquad \text{for } i = 1,2,.......14$$

i.e $C(1)e(2) = Q(2)/S(1)$, $C(2)e(3) = Q(3)/S(2)$ and so on.

Therefore:

$$e(1)C(i) = \frac{P(1)P(2)...........P(i)}{Q(2)/S(1)\ Q(3)/S(2).....Q(i)/S(i-1)}$$

$$= \frac{P(1)P(2).....P(i)S(1)S(2)......S(i-1)}{Q(2)Q(3)......Q(i)}, \tag{4.2.6b}$$

$$\text{for } i = 2,3......15$$

Now consider,

$$e(1)C(1)e(2)C(2)......e(16)C(16) = P(1)P(2).......P(16)$$

$$\Rightarrow e(1)C(1) = \frac{P(1)P(2).........P(16)}{C(1)e(2)C(2)e(3).............C(15)e(16)}$$

$$= \frac{P(1)P(2)..........P(16)}{Q(2)/S(1)\ Q(3)/S(2)........Q(15)/S(14)\ C(15)e(16)}$$

From (4.2.5),

$$C(15) = \frac{Q(16) - S(16)P(16)}{e(16)S(15)}$$

$$\Rightarrow C(15)e(16) = \frac{Q(16) - S(16)P(16)}{S(15)}$$

$$\Longrightarrow \quad e(1)C(16) = \frac{P(1)P(2)\ldots\ldots\ldots P(16)}{\frac{Q(2)}{S(1)}\frac{Q(3)}{S(2)}\ldots\ldots\frac{Q(15)}{S(14)}\left[\frac{Q(16) - S(16)P(16)}{S(15)}\right]}$$

$$= \frac{P(1)P(2)\ldots\ldots P(16)S(1)S(2)\ldots\ldots S(15)}{Q(2)Q(3)\ldots\ldots Q(15)[Q(16) - S(16)P(16)]} \qquad (4.2.6c)$$

Summing up both sides of the equations (4.2.6a) to (4.2.6c), we get:

$$e(1)\sum_{i=1}^{16} Ci = e(1)C(1) + \sum_{i=2}^{15} e(1)C(i) + e(1)C(16)$$

$$= P(1) + \sum_{i=2}^{15} \frac{P(1)P(2)\ldots\ldots P(i)S(1)S(2)\ldots\ldots S(i-1)}{Q(2)Q(3)\ldots\ldots\ldots Q(i)}$$

$$+ \frac{P(1)P(2)\ldots\ldots P(16)S(1)S(2)\ldots\ldots S(15)}{Q(2)Q(3)\ldots Q(15)[Q(16) - S(16)P(16)]}$$

$$e(1) = \frac{1}{\sum_{i=1} P(i)}\Bigg[P(1) + \sum_{i=2}^{15} \frac{P(1)P(2)\ldots P(i)S(1)S(2)\ldots S(i-1)}{Q(2)Q(3)\ldots\ldots Q(i)}$$

$$+ \frac{P(1)P(2)\ldots\ldots P(16)S(1)S(2)\ldots\ldots S(15)}{Q(2)Q(3)\ldots\ldots Q(15)[Q(16) - S(16)P(16)]}\Bigg] \qquad (4.2.7)$$

With this value of e(1) in equation (4.2.7) we can calculate C's from equations (4.2.6) and then D's and other e's from equations (4.2.1).

Alternatively, we can eliminate equation (4.2.3b) to solve the 48 knowns. Given: eiDi = Qi,
for all i
eiCi = Pi,
and SiCi = D(i+1), for i=1,2.........14

Multiplying (4.2.1a) by Si, we have:

$$eiCiSi = PiSi \implies eiD(i+1) = PiSi \quad (4.2.8)$$

From (4.2.1b), $e1D1 = Q1$ (4.2.9a)

From (4.2.8), $e1D2 = P1S1$ (4.2.9b)

Further,

$$e(1)D(2)e(2)D(3) = P(1)S(1)P(2)S(2)$$

$$\implies e(1)Q(2)D(3) = P(1)P(2)S(1)S(2)$$

$$\implies e(1)D(3) = [P(1)P(2)S(1)S(2)]/Q(2)$$

Thus, $e(1)D(2)e(2)D(3)e(3)D(4) = P(1)S(1)P(2)S(2)P(3)S(3)$

$$\implies e(1)Q(2)Q(3)D(4) = P(1)P(2)P(3)S(1)S(2)S(3)$$

$$\implies e(1)D(4) = [P(1)P(2)P(3)S(1)S(2)S(3)]/[Q(2)Q(3)]$$

general,

$$e(1)D(2)e(2)D(3)\ldots e(i-1)D(i) = P(1)S(1)P(2)S(2)\ldots.(i-1)S(i-1)$$

for $i = 2,3.........15$

$$e(1)Q(2)Q(3)\ldots Q(i-1)D(i) = P(1)P(2)\ldots P(i-1)S(1)S(2)\ldots S(i-1)$$

$$\implies e(1)D(i) = \frac{P(1)P(2)\ldots P(i-1)S(1)S(2)\ldots S(i-1)}{Q(2)Q(3)..........Q(i-1)} \quad (4.2.9c)$$

Now consider,

$$e(16) = \frac{Q(16)}{D(16)} = \frac{Q(16)}{S(15)C(15) + S(16)C(16)}$$

$$\implies Q(16) = e(16)S(15C(15) + e(16)S(16)C(16)$$

$$\implies C(15) = [Q(16) - S(16)P(16)]/[e(16)S(15)]$$

Therefore,

$$e(15) = P(15)/C(15) = [P(15)e(16)S(15)]/[Q(16) - S(16)P(16)]$$

Multiplying both sides by D(16), we have:

$$e(15)D(16) = \frac{P(15)e(16)S(15)D(16)}{Q(16) - S(16)P(16)}, \text{ but } D(16) = \frac{Q(16)}{e(16)}$$

$$\Longrightarrow \quad e(15)D(16) = \frac{P(15)e(16)S(15)[Q(16)/e(16)]}{Q(16) - S(16)P(16)} = \frac{P(15)S(15)Q(16)}{Q(16) - S(16)P(16)}$$

Therefore,

$$e(1)D(2)e(2)D(3)........e(14)D(15)e(15)D(16)$$

$$= P(1)P(2).....P(14)S(1)S(2).....S(14)\left[\frac{P(15)S(15)Q(16)}{Q(16) - S(16)P(16)}\right]$$

$$\Longrightarrow \quad e(1)Q(2)Q(3)...Q(15)D(16) = \frac{P(1)P(2)...P(15)S(1)S(2)..S(15)Q(16)}{Q(16) - S(16)P(16)}$$

$$\Longrightarrow \quad e(1)D(16) = \frac{P(1)P(2)....P(15)S(1)S(2)....S(15)Q(16)}{[Q(2)Q(3)......Q(15)][Q(16) - S(16)P(16)]} \qquad (4.2.9d)$$

Summing up both sides of the equations in (4.4.9), we have:

$$(1) \sum_{i=1}^{16} D(i) = e(1)D(1) + e(1)D(2) + \sum_{i=3}^{15} e(1)D(i) + e(1)D(16)$$

$$= Q(1) + P(1)S(1) + \sum_{i=3}^{15} \frac{P(1)P(2)....P(i-1)S(1)S(2)....S(i-1)}{Q(2)Q(3).........Q(i-1)}$$

$$+ \frac{P(1)P(2).......P(15)S(1)S(2).....S(15)Q(16)}{Q(2)Q(3).....Q(15)[Q(16) - S(16)P(16)]}$$

Theerefore,

$$e(1) = \frac{1}{\sum_{i=1} Q(i)}\left[Q(1) + P(1)S(1) + \sum_{i=2}^{14} \frac{P(1)P(2)...P(15)S(1)S(2)...S(15)Q(16)}{Q(2)Q(3)........Q(i)}\right.$$

$$\left. + \frac{P(1)P(2)......P(15)S(1)S(2).....S(15)Q(16)}{Q(2)Q(3)....Q(15)[Q(16) - S(16)P(16)]}\right] \qquad (4.2.10)$$

With this value of e(1) in equation (4.2.10), we can calculate D's from equations (4.2.9) and then C's and remaining e's from equations (4.2.1). a practical solution, the average of the two ratios is taken as the best estimate.

2.2: APPLICATION OF THE DEMENY - SHORTER METHOD TO KENYA'S DATA

Since the censuses used in this study are ten and not five years apart, and we intend to obtain correction factors for five year age groups, the 1974 population has been estimated as the geometric mean of the 1969 and the 1979 populations to enable us work with sets of population data separated by five years. The survival ratios for mortality level 14.10164 - females, North model are worked out by linear interpolation.

for this application, let

Pi = 5N1(x) be the enumerated 1969 population,

Qi = 5N2(x) be the enumerated 1979 population,

Ci = 5N1*(x) be the corrected 1969 population,

Di = 5N2*(x) be the corrected 1979 population and

5N'(x) be the estimated 1974 population.

TABLE 4:1:THE 1969, 1974 AND 1979 FEMALE POPULATIONS AND THE SURVIVAL RATIOS FOR LEVEL 14.10164 - FEMALES, NORTH MODEL

	POPULATIONS			SURVIVAL RATIOS		
	5N1(x)	5N2(x)	5N'(x)	LEVEL 14	LEVEL 15	*LEVEL*
age,x	(1)	(2)	(3)	(4)	(5)	(6)
0	1046380	1423936	1220647.	.93907	.94852	.9400305
5	893359	1246983	1055464.	.97519	.97879	.9755559
10	663808	1025677	825137.9	.9811	.98345	.9813389
15	544847	889316	696089.9	.97812	.98056	.9783680
20	450096	687234	556166.6	.97432	.97704	.9745965
25	411245	542233	472218.8	.97042	.97358	.9707412
30	299241	413432	351732.6	.9661	.96972	.9664679
35	264819	325951	293799.3	.96118	.96501	.9615693
40	201936	274193	235307.1	.95619	.95998	.9565752
45	163852	222363	190878.6	.94737	.95131	.9477705
50	139072	191365	163136.5	.93104	.93576	.9315197
55	102235	134776	117383.2	.90313	.90929	.9037561
60	94508	109715	101828.0	.85614	.86418	.8569572
65	63307	83370	72649.19	.78471	.79498	.7857538
70+	121619	149403	134797.0	.5537253	.5625247	.5546197
	5460324	7719947	6487235.			

LEVEL* - Mortality level 14.10164- Females, North model (Mudaki,1986)

Step 1: obtaining correction factors for 1969 and 1974.

The 1969 and the 1979 census populations are corrected as follows: (a) The enumerated 1969 and estimated 1974 populations are entered into columns (1) and (2) as shown in table 4.2. for Kenyan females. (b) A mortality level is selected. In this application, the levels come from the analysis by Mudaki (1986). The schedule of cohort survivorship rates comes from the appropriate model (i.e level 14.10164, North model for females and level 14.34975, North model for males). and is entered into column (3). (c) A provisional set of correction factors is calculated on the basis of a provisional assumption, which is dropped later, that the age group 0-4 was enumerated correctly. The selection of the age group 0-4 is purely a computational convenience which does not affect the final results. The 0-4 age group correction factor is written in column (4) as 1.0000 and the enumerated populations entered as corrected populations in columns (5) and (6).

(d) The enumerated population of the 0-4 age group in the 1969 census is multiplied by the survivorship rate for this age group. The answer is the corrected population for the 5-9 age group at the date of the second census. This is given in column (6)

e.g 1046380 * 0.940030 = 983629.1

(e) The ratio which the corrected population for the 5-9 age group bears to the enumerated population is calculated. This gives the correction factor for the 5-9 age group and is entered into column (4) e.g 983629.1/1055463 = 0.93194

(f) The enumerated population at the first census date is multiplied by the correction factor. The result is the corrected population for the 5-9 age group in the first census.

e.g 893359 * 0.93194 = 832557.2

(g) This procedure is repeated for each succeeding age interval until the last and open ended interval is reached. For this interval, let C1 and C2 be the enumerated populations respectively, and star the symbols for the corrected estimates. Since the ratios of the errors to the enumerated populations is assumed to be the same at both census dates, $C1^* = C1/C2 \cdot C2^*$, since the proportions surviving to the last age inteval includes both the cohort entering from the interval below and the survivors who are already in the interval. Thus, $C2^* = a + (p + C1^*)$ where a is the survivors from the next lower age interval calculated as in the previous steps, and p is the proportion surviving from within the open - ended interval to higher ages. The two equations are solved simultanously. The correction factor for the 70+ is the ratio $C2^*/C2 = C1^*/C1$.

(h) Because it was assumed provisionally that the 0-4 age group was enumerated correctly, where as this age group is typically under -reported relative to the rest of the age distribution, the provisional correction factors do not produce the correct total size of the population. The error in each correction factor and in the total population is the proportion to the reporting error for the 0-4 age group. Hence, the assumed correctness of that group is dropped and it is assumed instead that the total population was enumerated correctly.

All the correction factors are then raised by a multiplier which is found by taking the ratios of the totals in columns (1) and (5) and columns (2) and (6) and comparing the results. A trivial difference between the two ratios may arise when the age distributions at the two censuses are different. As a practical solution, an average of the two ratios is used as a multiplier to produce column (7) from column (4).

TABLE 4:2: OBTAINING CORRECTION FACTORS FOR 1969 AND 1974.

age, x	5N1(x) (1)	5N2(x) (2)	SURV. RATIOS (3)	CORRECTION FACTORS (4)	CORRECTED POP. 1969 (5)	CORRECTED POP. 1974 (6)	FINAL CORRECTION FACTORS (7)
0	1046380	1220647.	.9400305	1	1046380	1220647.	1.060380
5	893359	1055464.	.9755559	.9319403	832557.3	983629.1	.9882108
10	663808	825137.9	.9813389	.9843277	653404.6	812206.2	1.043761
15	544847	696089.9	.9783680	.9211617	501892.2	641211.4	.9767813
20	450096	556166.6	.9745965	.8828924	397386.3	491035.3	.9362014
25	411245	472218.8	.9707412	.8201522	337283.5	387291.3	.8696729
30	299241	351732.6	.9664679	.9308634	278552.5	327415.0	.9870689
35	264819	293799.3	.9615693	.9163129	242657.1	269212.1	.9716397
40	201936	235307.1	.9565752	.9916044	200240.6	233331.6	1.051477
45	163852	190878.6	.9477705	1.003493	164424.3	191545.2	1.064083
50	139072	163136.5	.9315197	.9552521	132848.8	155836.5	1.012930
55	102235	117383.2	.9037561	1.054250	107781.3	123751.3	1.117906
60	94508	101828.0	.8569572	.9565931	90405.70	97407.98	1.014352
65	63307	72649.19	.7857538	1.066410	67511.21	77473.81	1.130800
70+	121619	134797.0	.5546197	.7876960	95798.80	106179.1	.8352570
	5460324	6487235.			5149124.	6118172.	

The ratio of enumerated to corrected totals is 1.060380

Step 2: obtaining correction factors for 1974 and 1979.

The 1974 and 1979 populations are entered into columns (1) and (2) of table 4.3 respectively and the same procedure described above followed to obtain correction factors for the 1974 and 1979 populations.

TABLE 4:3: OBTAINING CORRECTION FACTORS FOR 1974 AND 1979.

age, x	5N2(x) (1)	5N3(x) (2)	SURV. RATIOS (3)	CORRECTION FACTORS (4)	CORRECTED POP. 1974 (5)	CORRECTED POP. 1979 (6)	FINAL CORRECTION FACTORS (7)
0	1220647.	1423936	.9400305	1	1220647.	1423936	1.080834
5	1055464.	1246983	.9755559	.9201770	971213.3	1147445.	.9945587
10	825137.9	1025677	.9813389	.9237537	762224.2	947472.9	.9984245
15	696089.9	889316	.9783680	.8410961	585478.5	748000.2	.9090854
20	556166.6	687234	.9745965	.8335057	463568.0	572813.4	.9008814
25	472218.8	542233	.9707412	.8332059	393455.5	451791.7	.9005574
30	351732.6	413432	.9664679	.9238362	324943.3	381943.5	.9985137
35	293799.3	325951	.9615693	.9634800	283069.7	314047.3	1.041362
40	235307.1	274193	.9565752	.9926992	233589.2	272191.2	1.072943
45	190878.6	222363	.9477705	1.004869	191807.9	223445.6	1.086096
50	163136.5	191365	.9315197	.9499639	154973.8	181789.8	1.026753
55	117383.2	134776	.9037561	1.071119	125731.4	144361.1	1.157702
60	101828.0	109715	.8569572	1.035688	105462.1	113630.5	1.119407
65	72649.19	83370	.7857538	1.084041	78754.69	90376.49	1.171668
70+	134797.0	149403	.5546197	.8290490	111753.4	123862.4	.8960645
	6487235.	7719947			6006672.	7137107.	

The ratio of enumerated to corrected totals is 1.080834

Step 3: obtaining correction factors for 1969 and 1979

The average of the correction factors in columns (7) of tables 4:2 and 4:3 (i.e for the periods 1969-74 and 1974-79 respectively) gives the correction factors for the 1969-79 period. The enumerated 1969 and 1979 populations are then multiplied by these correction factors, ei's to obtain the corrected 1969 and 1979 female populations as shown in table 4:4 below. A control chart for the correction factors is given in figure 4:1 for Kenyan females.

The same procedure has been followed for the case of Kenyan males with the corresponding tables given in appendix F as well as table 4.5 given below. The corresponding figures 4:1 and 4:2 for the females and the males are given below.

CONTROL CHARTS FOR CORRECTION FACTORS OBTAINED BY THE DSM

Fig. 4.1 FEMALES

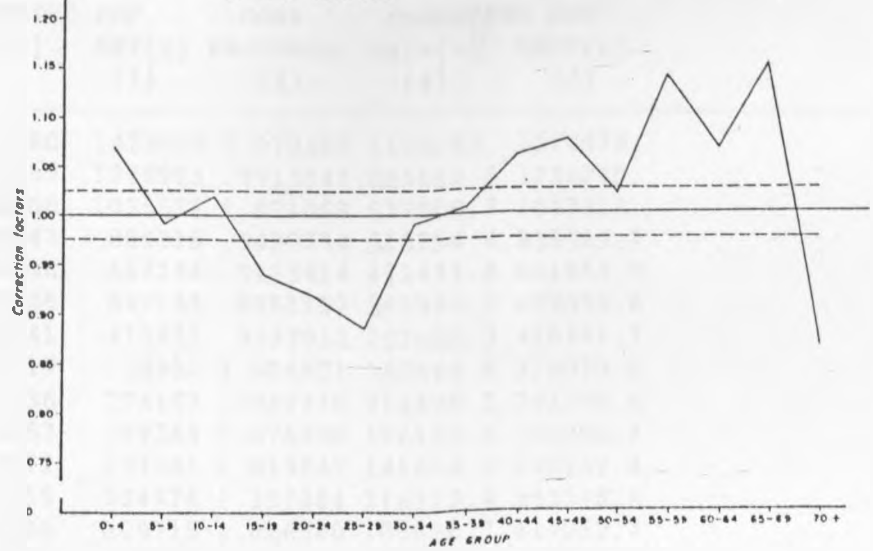


Fig 4.2 MALES

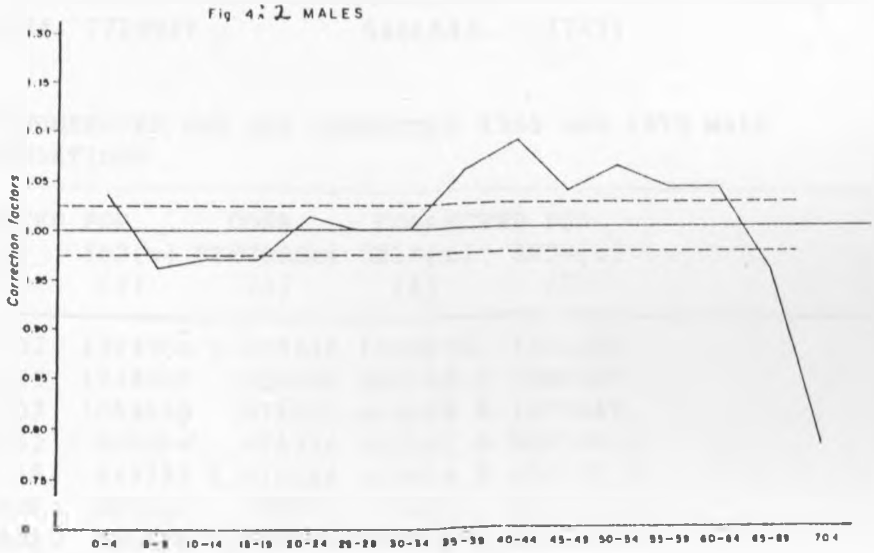


TABLE 4:4: THE ENUMERATED AND THE CORRECTED 1969 AND 1979 FEMALE POPULATIONS

age,x	ENUMERATED POP. 5N1(x) (1)	5N2(x) (2)	CORR. FACTORSei (3)	CORRECTED POP. 5N1*(x) (4)	5N2*(x) (5)
0	1046380	1423936	1.070607	1120262.	1524476.
5	893359	1246983	.9913847	885662.5	1236240.
10	663808	1025677	1.021093	677809.7	1047312.
15	544847	889316	.9429334	513754.4	838565.7
20	450096	687234	.9185414	413431.8	631252.9
25	411245	542233	.8851152	363999.2	479938.6
30	299241	413432	.9927913	297083.9	410451.7
35	264819	325951	1.006501	266540.6	328070.0
40	201936	274193	1.062210	214498.5	291250.6
45	163852	222363	1.075090	176155.6	239060.2
50	139072	191365	1.019842	141831.4	195162.0
55	102235	134776	1.137804	116323.4	153348.6
60	94508	109715	1.066880	100828.7	117052.7
65	63307	83370	1.151234	72881.17	95978.38
70+	121619	149403	.8656607	105280.8	129332.3
TOTAL	5460324	7719947		5466343.	7717491.

TABLE 4:5: THE ENUMERATED AND THE CORRECTED 1969 AND 1979 MALE POPULATIONS

age,x	ENUMERATED POP. 5N1(x) (1)	5N2(x) (2)	CORR. FACTORSei (3)	CORRECTED POP. 5N1*(x) (4)	5N2*(x) (5)
0	1058102	1424954	1.039616	1100020.	1481405.
5	916599	1249662	.960996	880848.0	1200920.
10	714707	1053099	.971083	694039.8	1022647.
15	560152	855884	.973916	545541.0	833559.1
20	428915	642723	1.016318	435914.0	653211.0
25	349594	515512	.997972	348885.0	514466.5
30	280948	406221	1.002719	281711.9	407325.5
35	252136	290825	1.061058	267530.9	308582.2
40	193936	262091	1.090093	211408.3	285703.6
45	172508	219365	1.044597	180201.3	229147.9
50	132466	183285	1.058566	140224.0	194019.3
55	114669	141067	1.038125	119040.8	146445.2
60	102466	107932	1.041240	106691.7	112383.1
65	74611	100112	.9667801	72132.43	96786.28
70+	131472	154453	.782138	102829.2	120803.6
	5483281	7607185		5487018.	7607405.

Note: It is important to note that it is those age groups with correction factors greater than one that lose population, where as those age groups with correction factors less than one gain populations as a result of age misreporting. For this analysis, age groups with correction factors equal to 1 ± 0.025 are considered to be fairly accurately reported.

AGE REPORTING FOR FEMALES

The age groups that suffer deficits are: 0-4, 40-44, 45-59, 55-59, 60-64 and 65-69, where as age groups 15-19, 20-24, 25-29 and 70+ are over - reported. The age group 0-4 is normally under - reported due to omissions. This is so because in certain societies, children are not considered full members of the society and some, particularly those absent from home, might not be included in the enumeration exercise. At older ages, that is; age 40 onwards, it appears that systematic over - reporting of age carries people across age group boundaries to the next higher age groups and this finally leads to the age group 70+ being considerably over - reported. This could be attributed to the fact that the society gives respect to the elderly and thus the desire for most people above age 40 to appear older. The excess in the age group 15-19 is mainly as a result of this age group gaining persons from the age group 10-14. Girls in the age group 10-14 who are past menarche have a tendency to over - state their ages so as to appear older and this carries some to the 15-19 age group. The age groups 20-24 and 25-29 possibly gain persons from the older age groups due to the desire for most young women to appear younger than they actually are.

AGE REPORTING FOR MALES

The age groups that are under - reported include: 0-4, 35-39, 40-44, 45-49, 50-54, 55-59 and 60-64, where as age groups 5-9, 10-14, 15-19, 65-69 and 70+ are over - reported. The deficit in the age group 0-4 could be as a result of omissions of young children as well as over - reporting of age among those under five so as to be included in the school going age. This consequently leads to over - reporting of the 5-9 age group. The excess in the age group 15-19 is possibly as a result of young men in the age group 20-24, who are later than usual in maturing physically, under - reporting their ages and thus falling in the 15-19 age group. Again, it appears that systematic over - reporting of age occurs above age 35 years and this carries people to next higher age groups, finally leading to considerable excesses in the 65-69 and 70+ age groups.

4.3 THE SAXENA - GOGTE TECHNIQUE

4.3.1: THE THEORY

Age distributions obtained from censuses and surveys in most developing countries exhibit heaping on ages that are multiples of five. Feeney (1979) suggested a technique for re-distributing the excess persons at these ages to the surrounding ages. Feeney's procedure involves the transfer of excess persons from a given multiple of five to the eight immediately surrounding ages, the four years on either side of the multiple of five, in such a way that: (i) The adjusted numbers in the surrounding ages are proportional to the original numbers; and (ii) The adjusted numbers at the lower four ages, the central age and the upper four ages form a linear progression.

Feeney's method, which involves an iterative procedure, is somewhat complicated. Saxena and Gogte (1985) showed that a simpler procedure, the nine - point moving average, yields equally effective results as the Feeney's method.

FEENEY'S METHOD

Let $N(x)$ = number of persons aged x in completed years.

$N(x-)$ = number of persons aged x-4 to x-1 years.

$N(x+)$ = number of persons aged x+1 to x+4 years

Where x is a multiple of five. that is; 5, 10, 15........

The first of the two requirements mentioned earlier: that the surrounding ages must be proportional to the existing numbers can be expressed mathematically as follows:

$$N'(x-) = N(x-) * D(x) \qquad (4.3.1)$$

$$N'(x+) = N(x+) * D(x) \qquad (4.3.2)$$

where primes (') indicate adjusted quantities. The constant of proportionality, $D(x)$, is assumed to be the same in both (4.3.1) and (4.3.2), so that the adjustments to the ages on either side of the multiple of five are multiplicatively symmetrical.

The second of the two requirements mentioned earlier: that the adjusted numbers at the lower four ages must form a linear progression, can be expressed mathematically as:

$$N'(x) = 1/2[(1/4)N'(x-) + (1/4)N'(x+)] \qquad (4.3.3)$$

In other words, for the progression to be linear, the middle value must be midway between the average number of persons at the lower four ages.

Substituting (4.3.1) and (4.3.2) into (4.3.3),

we get:

$$N'(x) = 1/8D(x)[N(x-) + N(x+)] \qquad (4.3.4)$$

Equations (4.3.1), (4.3.2) and (4.3.4) are valid for any value of Dx.

Suppose we define Dx as:

$$Dx = 8/9 \frac{N(x-) + N(x) + N(x+)}{N(x-) + N(x+)} \qquad (4.3.5)$$

Then equations (4.3.1), (4.3.2) and (4.3.4) can be re-written as:

$$N'(x-) = N(x-) + (Dx - 1)N(x-) \qquad (4.3.6)$$

$$N'(x+) = N(x+) + (Dx - 1)N(x+) \qquad (4.3.7)$$

$$N'(x) = N(x) - (Dx - 1)[N(x-) + N(x+)] \qquad (4.3.8)$$

Equations (4.3.6) and (4.3.7) follow immediately from (4.3.1) and (4.3.2) regardless of the value of Dx. Equation (4.3.8), though not valid for all values of Dx, is valid for the value of Dx specified by (4.3.5). This may be demonstrated by equating the right hand side of equations (4.3.3) and (4.3.8). Substituting the expression for Dx from (4.3.5), and simplifying, the result is an identity.

Equations (4.3.6) to (4.3.8) are not the final equations however. When all the multiples of five are considered togather, rather than in isolation, the increments to the number of persons intermediate between two successive multiples of five are made independently from the lower and upper multiples of five. That is; ages x-4 and x+4 get a double dose of re-allocation. Thus (4.3.6) and (4.3.7) must be altered somewhat and (4.3.8) re-written in an equivalent but alternative form as:

$$N'(x) = N(x) - (Dx - 1)[N(x-5)+ + N(x+)] \qquad (4.3.9)$$

Equations (4.3.6) and (4.3.7) become one and the same equation, which can be written as:

$$N'(x) = N(x+) + (Dx - 1)[N(x+) + [D(x+5) - 1]N(x+)$$
$$= Dx + D(x+5) - 1 \qquad (4.3.10)$$

Equations (4.3.9) and (4.3.10) are Feeney's basic estimating equations.

They are valid for x = 0, 5, 10,........c-5, where D0 and Dc are taken equal to one, c denoting the age (also a multiple of 5) that begins the open ended age group. The adjustment procedure specified by (4.3.9) and (4.3.10) is iterated until the value of Dx converges to as close to one as desired. It is found empirically that convergence always occurs. The number of persons at single years of age are found by interpolating linearly the final adjusted numbers of persons at ages that are multiples of five.

SIMILARITIES OF FEENEY'S METHOD TO A NINE-POINT MOVING AVERAGE

Let us consider the implications of Feeney's requirement that Dx converges to one. If Dx = 1, equation (4.3.5) implies that:

$$1/9[N(x-) + N(x) + N(x+)] = 1/8[N(x-) + N(x+)] \qquad (4.3.11)$$

The quantity on the left hand side is a nine - point moving average. The quantity on the right hand side is an eight - point moving average that includes the same numbers except for N(x).

For the two quantities to be equal, the final adjusted value of N(x) must be equal to a nine - point moving average of the final adjusted value of N(x-), N(x) and N(x+). This suggests that a nine - point moving average procedure, or its repeated application, might yield approximately the same results as the Feeney's procedure.

4.3.2 APPLICATION OF THE NINE - POINT MOVING AVERAGE PROCEDURE (THE SAXENA - GOGTE TECHNIQUE) TO KENYA'S DATA.

Step 1: The age distribution, derived by the nine - point moving average, is obtained by adding the observed four adjascent single year values on the extremes to the respective average of the nine terms centered at the middle. That is; the adjusted number at 0-4 is obtained by adding the recorded numbers at 0, 1, 2 and 3 to the nine - point moving average at age 4. (4 being the earliest age for which a nine - point moving average can be computed). The adjusted numbers at 65-69 for 1969, and 70-74 for 1979, is similarly obtained by adding the recorded numbers at ages 66, 67, 68 and 69 to the nine - point moving average at age 65. (The latest age for which a nine - point moving average can be computed is 65 for the 1969 census and 70 for the 1979 census). These adjusted values, denoted by 5N'(x), are entered into columns (2), (4) and (6) of table 4:6 for females, males and the combined sexes respectively.

TABLE 4:6: ADJUSTING FOR AGE HEAPING ON MULTIPLES OF FIVE - 1969

	females		males		combined sexes	
	Nx	5N'x	Nx	5N'x	Nx	5N'x
age, x	(1)	(2)	(3)	(4)	(5)	(6)
0	180506	1033461.	181280	1044829.	361786	2078289.
1	208958		211025		419983	
2	233763		236092		469855	
3	210930		213745		424675	
4	212223		215960		428183	
5	192860	895969.3	199534	916334	392394	1812303.
6	200051		205164		405215	
7	167003		171084		338087	
8	187441		190295		377736	
9	146004		150522		296526	
10	165744	649653.7	177275	696517.8	343019	1346171.
11	108470		113997		222467	
12	154670		169287		323957	
13	114489		123712		238201	
14	120435		130436		250871	
15	110788	549938	122766	559339.8	233554	1109278.
16	113136		117370		230506	
17	95092		100208		195300	
18	131863		128153		260016	
19	93968		91655		185623	
20	134772	413563.4	124237	399933.7	259009	813497.1
21	77743		80275		158018	
22	88942		84575		173517	
23	69059		68140		137199	
24	79580		70788		150368	
25	103596	385045.6	91593	330597.9	195189	715643.4
26	82405		66021		148426	
27	62280		58888		121168	
28	95067		75549		170616	
29	64897		57543		122440	
30	121015	245324.9	103674	237157.2	224689	482482.1
31	35933		36652		72585	
32	61744		60648		122392	
33	37488		39614		77102	
34	43061		40360		83421	
35	74810	239236.2	72990	226858.2	147800	466094.4
36	49750		45180		94930	
37	37806		37664		75470	
38	59127		53979		113106	
39	43326		42323		85649	
40	85393	160092.4	77353	158036.6	162746	318129
41	26902		27999		54901	
42	39893		39871		79764	
43	27352		26285		53637	
44	22396		22428		44824	
45	52859	142148	56886	147743.2	109745	289891.2
46	25321		25779		51100	
47	22725		26460		49185	

age,x	females Nx (1)	females 5N'x (2)	males Nx (3)	males 5N'x (4)	combined sexes Nx (5)	combined sexes 5N'x (6)
48	35710		35893		71603	
49	27237		27490		54727	
50	60480	106377	55049	104982.3	115529	211359.3
51	21393		21187		42580	
52	22747		21918		44665	
53	15532		14656		30188	
54	18920		19656		38576	
55	30528	91798.89	36889	99122.89	67417	190921.8
56	20407		22503		42910	
57	14165		15692		29857	
58	20889		22363		43252	
59	16246		17222		33468	
60	43209	69767.33	44798	77695.33	88007	147462.7
61	12138		13459		25597	
62	15902		18194		34096	
63	12280		13553		25833	
64	10979		12462		23441	
65	21665	54376	24556	64752.67	46221	119128.7
66	7614		9746		17360	
67	9070		11442		20512	
68	13510		15785		29295	
69	11448		13082		24530	
70+	121619	121619	131472	131472	253091	253091

Step 2: The adjusted populations for 5 - year age groups are put summary from as in table 4.7. The totals of these adjusted populations is generally lower than the enumerated totals. The ratio of the enumerated to the adjusted totals is worked out for the females and males, first; separately, then for the two sexes combined.

TABLE 4:7: ADJUSTED 5-YEAR AGE GROUPS - 1969 CENSUS

age,x	female 5N'x (1)	male 5N'x (2)	COMBINED 5N'x (3)
0	1033461.	1044829.	2078289.
5	895969.3	916334	1812303.
10	649653.7	696517.8	1346171.
15	549938	559339.8	1109278.
20	413563.4	399933.7	813497.1
25	385045.6	330597.9	715643.4
30	245324.9	237157.2	482482.1
35	239236.2	226858.2	466094.4
40	160092.4	158036.6	318129
45	142148	147743.2	289891.2
50	106377	104982.3	211359.3
55	91798.89	99122.89	190921.8
60	69767.33	77695.33	147462.7
65	54376	64752.67	119128.7
70+	121619	131472	253091
	5158371.	5195372.	10353743

The ratio of enumerated to estimated totals is:1. 1.058537-females

2. 1.055416- males

3. 1.056971-combined

Step 3: To obtain the final adjusted populations, the adjusted populations in table 4:7 are multiplied by the appropriate ratios of the enumerated to the adjusted totals obtained in step 2 above. the results are entered into table 4:8.

TABLE 4:8: THE FINAL ADJUSTED 5-YEAR AGE GROUPS - 1969 CENSUS

age,x	female 5N'x (1)	male 5N'x (2)	COMBINED 5N'x (3)
0	1093956	1102729	2196685
5	948416.3	967113.9	1915530.
10	687682.1	735116.2	1422798.
15	582129.4	590336.3	1172466.
20	437772	422096.5	859868.5
25	407584.8	348918.4	756503.2
30	259685.3	250299.6	509984.9
35	253240.2	239429.8	492670
40	169463.7	166794.3	336258
45	150468.8	155930.6	306399.4
50	112603.9	110800	223403.9
55	97172.48	104615.9	201788.4
60	73851.27	82000.93	155852.2
65	57558.98	68341.02	125900
70+	128738.1	138757.7	267495.8
	5460323.	5483280.	10943603

The same procedure has been followed for the case of the 1979 census with the corresponding tables given in appendix G and table 4:9 given below.

TABLE 4:9: THE FINAL ADJUSTED 5 YEAR AGE GROUPS - 1979 CENSUS

age,x	female 5N'x (1)	male 5N'x (2)	COMBINED 5N'x (3)
0	1485751.	1477948.	2963699.
5	1305756.	1299669.	2605425.
10	1048152.	1067302.	2115454.
15	950144.4	893635.1	1843779.
20	671583.3	637199.1	1308782.
25	536075.5	511594.8	1047670.
30	364613.2	372508.3	737121.5
35	316588.8	283634.3	600223.1
40	232132.2	232426.7	464558.9
45	213619.3	207850.5	421469.8
50	162518.7	164011.9	326530.6
55	136862.0	139849.1	276711.1
60	86932.39	90285.37	177217.8
65	69125.37	81466.48	150591.9
70	48971.31	55921.76	104893.1
75+	91119.42	91881.41	183000.8
	7719945.	7607184.	15327129

4.4 THE DEMENY-SHORTER AND THE SAXENA-GOGTE METHODS COMBINED.

The Demeny - Shorter method is used to correct data that has already been adjusted by the Saxena - Gogte technique in order to correct for both heaping on multiples of five as well as systematic age mireporting. It would be useful to compare the results obtained by applying the Saxena - Gogte technique followed by the Demeny - Shorter method and that obtained when the Demeny - Shorter method is applied first, followed by the Saxena - Gogte technique. However, the second case is not possible since the Saxena - Gogte technique utilizes data on population by single years of age, where as data adjusted by the Demeny - Shorter method is in five - year age groups. The 1969 and 1979 census age distributions that have been corrected by both the Demeny - Shorter and the Saxena - Gogte methods combined are given in tables 4:10 and 4:11 for the females and males, respectively.

TABLE 4:10: CORRECTING THE 1969 AND 1979 FEMALE AGE DISTRIBUTIONS BY THE DSM AND THE SGT COMBINED

age,x	CORR. BY SGT. 5N1(x) (1)	5N2(x) (2)	CORR. FACTORSei (3)	CORR. BY SGT+DSM 5N1*(x) (4)	5N2*(x) (5)
0	1093956	1485751.	1.023747	1119934.	1521033.
5	948416.3	1305756.	.942785	894152.7	1231047.
10	687682.1	1048152.	1.001801	688920.6	1050040.
15	582129.4	950144.4	.894033	520442.9	849460.4
20	437772	671583.3	.953326	417339.4	640237.8
25	407584.8	536075.5	.90424	368554.5	484740.9
30	259685.3	364613.2	1.14367	296994.3	416997.2
35	253240.2	316588.8	1.044075	264401.8	330542.5
40	169463.7	232132.2	1.252343	212226.7	290709.1
45	150468.8	213619.3	1.122221	168859.2	239728.1
50	112603.9	162518.7	1.178192	132669.0	191478.2
55	97172.48	136862.0	1.07819	104770.4	147563.3
60	73851.27	86932.39	1.237241	91371.82	107556.3
65	57558.98	69125.37	1.234886	71078.78	85361.95
70+	128738.1	140090.7	.911365	117327.4	127673.8
	5460323.	7719945.		5469044.	7714170.

TABLE 4:11: CORRECTING THE 1969 AND 1979 MALE AGE DISTRIBUTIONS BY THE DSM AND THE SGT COMBINED

age,x	CORR. BY SGT. 5N1(x) (1)	5N2(x) (2)	CORR. FACTORSei (3)	CORR. BY SGT+DSM 5N1*(x) (4)	5N2*(x) (5)
0	1102729	1477948.	1.001318	1104182.	1479896.
5	967113.9	1299669.	.923086	892729.3	1199706.
10	735116.2	1067302.	.963961	708623.3	1028838.
15	590336.3	893635.1	.946652	558843.0	845961.4
20	422096.5	637199.1	1.049714	443080.6	668876.8
25	348918.4	511594.8	1.022521	356776.4	523116.4
30	250299.6	372508.3	1.124835	281545.8	419010.4
35	239429.8	283634.3	1.102095	263874.4	312591.9
40	166794.3	232426.7	1.230244	205197.7	285941.6
45	155930.6	207850.5	1.092334	170328.3	227042.2
50	110800	164011.9	1.149506	127365.3	188532.7
55	104615.9	139849.1	.987095	103265.8	138044.3
60	82000.93	90285.37	1.114412	91382.82	100615.1
65	68341.02	81466.48	1.0003	68361.52	81490.92
70+	138757.7	147803.2	.771664	107074.3	114054.4
	5483280.	7607184.		5482631.	7613718.

4.5: CORRESPONDANCE BETWEEN THE TECHNIQUES OF DETECTING AND OF CORRECTING AGE ERRORS

It is important to study the correspondence between the techniques of detecting and those of correcting age errors so as to determine the method that is most appropriate and efficient in correcting age errors age errors in Kenyan data. That is; based on the assumption that the techniques of detecting age errors are accurate enough in identifying the types of errors existing, it would be logical to expect that very little, if any amount of error will be detected in the sufficiently corrected data.

In this section, the correspondence between the age specific growth rate technique and the two techniques of correcting age distributions, namely; the Saxena - Gogte technique and the Demeny - Shorter method, is examined. In the first case, the two methods are considered separately and then the second case looks at the result of combining the two methods. This will help to identify the method that gives the most accurate estimate of Kenya's age distribution. It is not possible to study the correspondence between the age ratio technique and the techniques of correcting age misreporting because the application of the age ratio technique requires data on population by single years of age where as the corrected data by the techniques considered here are in five - year age groups. However, this is not a very serious limitation because the age ratio technique only identifies age heaping where as of more concern to a demographic analyst is age mireporting that carries people across age group boundaries. This type of error is sufficiently detected by the age specific growth rate technique.

4.5.1: CORRESPONDENCE BETWEEN THE AGE SPECIFIC GROWTH RATE TECHNIQUE AND THE SAXENA - GOGTE TECHNIQUE

The age specific growth rate technique is used to detect age misreporting in the data already adjusted by the Saxena - Gogte technique by entering the 1969 and 1979 female populations adjusted by the Saxena - Gogte technique into columns (1) and (2) of table 4:12 and then working out the mortality levels corresponding to the various age groups as explained earlier in section 3.1 of chapter 3. Figure 4:3 gives the graph of mortality levels against age for the females.

TABLE 4:12: CORRESPONDENCE BETWEEN THE ASGRT AND THE SGT - FEMALES

age,x	5N1(x) (1)	5N2(x) (2)	5N'(x) (3)	5C(x) (4)	5r(x) (5)	SUM. 5r(x) (6)	5Cx/5Co (7)
0	1093956	1485751	1274891.	.1892643	.0306120		1
5	948416.3	1305756	1112834.	.1652062	.0319744	.0319744	.8728861
10	687682.1	1048152	848996.7	.1260381	.0421457	.0741201	.6659369
15	582129.4	950144.4	743711.6	.1104080	.0489921	.1231122	.5833533
20	437772.0	671583.3	542218.0	.0804952	.0427940	.1659062	.4253055
25	407584.8	536075.5	467435.8	.0693933	.0274026	.1933088	.3666478
30	259685.3	364613.2	307708.8	.0456810	.0339367	.2272455	.2413609
35	253240.2	316588.8	283148.4	.0420349	.0223265	.2495720	.2220962
40	169463.7	232132.2	198338.0	.0294443	.0314668	.2810388	.1555726
45	150468.8	213619.3	179284.8	.0266158	.0350440	.3160828	.1406276
50	112603.9	162518.7	135278.4	.0200828	.0366917	.3527745	.1061098
55	971772.5	136862.0	364689.9	.0541402	-.196015	.1567596	.2860558
60	73851.27	86932.39	80125.32	.0118950	.0163077	.1730674	.0628488
65	57558.98	69125.37	63077.62	.0093642	.0183112	.1913785	.0494769
70+	128738.1	140090.7	134294.5	.0199367	.0084510		.1053380
	6334923.	7719945.	6736033.				

Assume e(70) = 7.612

Source: Mudaki (1986)

TABLE 4:13: CORRESPONDENCE BETWEEN THE ASGRT AND THE SGT - FEMALES

age,x	5Lx/5Lo (1)	Tx/5Lo (2)	Tx/T5 (3)	ESTIMATED LEVEL (4)
0	1	11.06033	1.099400	-
5	1.020728	10.06033	1	-
10	.9372603	9.039604	.8985394	10.7572
15	1.031123	8.102344	.8053754	11.23419
20	.9456607	7.071221	.7028815	9.974351
25	.9716242	6.125560	.6088825	9.925686
30	.7456148	5.153936	.5123028	9.698164
35	.7897247	4.408321	.4381884	10.71723
40	.6328096	3.618596	.3596896	10.7879
45	.6754974	2.985787	.2967881	11.51255
50	.6098100	2.310290	.2296435	11.96648
55	1.103842	1.700480	.1690282	12.7608
60	.1547528	.5966373	.0593059	12.9338
65	.1328407	.4418845	.0439235	14.17273
70+		.3090439	.0307191	

The same procedure has been followed for the case of the males as shown in tables 4:14 and 4:15 along with figure 4:4 given below.

TABLE 4:14: CORRESPONDANCE BETWEEN THE ASGRT AND THE SGT - MALES

age,x	5N1(x) (1)	5N2(x) (2)	5N'(x) (3)	5C(x) (4)	5r(x) (5)	SUM. 5r(x) (6)	5Cx/5Co (7)
0	1102729	1477948	1276627.	.1978205	.0292867		1
5	967113.9	1299669	1121128.	.1737251	.0295549	.0295549	.8781955
10	735116.2	1067302	885771.4	.1372553	.0372861	.0668409	.6938374
15	590336.3	893635.0	726323.1	.1125478	.0414605	.1083014	.5689392
20	422096.5	637199.0	518613.0	.0803620	.0411848	.1494862	.4062370
25	348918.4	511594.8	422498.3	.0654685	.0382695	.1877557	.3309490
30	250299.6	372508.3	305350.1	.0473157	.0397601	.2275158	.2391851
35	239429.8	283634.3	260596.4	.0403809	.0169425	.2444583	.2041289
40	166794.3	232426.7	196894.5	.0305099	.0331814	.2776397	.1542303
45	155930.6	207850.5	180028.5	.0278964	.0287408	.3063805	.1410189
50	110800.0	164011.9	134805.5	.0208889	.0392212	.3456017	.1055951
55	104615.9	139849.1	120956.3	.0187429	.0290268	.3746285	.0947468
60	82000.93	90285.37	86043.50	.0133329	.0096245	.3842530	.0673991
65	68341.02	81466.48	74615.70	.0115621	.0175681	.4018212	.0584475
70+	138757.7	147803.1	143209.0	.0221910	.0063152		.1121777
	5483280.	7607184.	6453460.				

assume e(70)=7.4165 (Mudaki,1986)

TABLE 4:15: CORRESPONDENCE BETWEEN THE ASGRT AND THE SGT - MALES

age,x	5Lx/5Lo (1)	Tx/5Lo (2)	Tx/T5 (3)	ESTIMATED LEVEL (4)
0	1	11.34065	1.096706	-
5	1.017367	10.34065	1	-
10	.9499826	9.323285	.9016148	10.34594
15	.9484662	8.373302	.8097461	10.91407
20	.8326576	7.424836	.7180240	10.79229
25	.8273979	6.592178	.6375012	11.66721
30	.7267867	5.764780	.5574871	11.98077
35	.7147292	5.037994	.4872027	12.98897
40	.6121079	4.323264	.4180843	13.70347
45	.6533813	3.711157	.3588900	15.11784
50	.5798583	3.057775	.2957043	15.64963
55	.6170811	2.477917	.2396287	16.57429
60	.4835004	1.860836	.1799534	16.55956
65	.4487795	1.377335	.1331962	17.54802
70+		.9285559	.0897967	

There appears to be very poor correspondence between the age specific growth rate technique and the Saxena - Gogte technique. In fact, with respect to the age specific growth rate technique, the Saxena-Gogte technique appears to worsen the data as far as age misreporting is concerned. The Saxena - Gogte technique therefore is not by itself appropriate in correcting errors identified by the age specific growth rate technique.

It should be noted that the age specific growth rate graph should be horizontal when there is no age misreporting.

CORRESPONDENCE BETWEEN THE ASGRT AND SGT

Fig 4.3 FEMALES

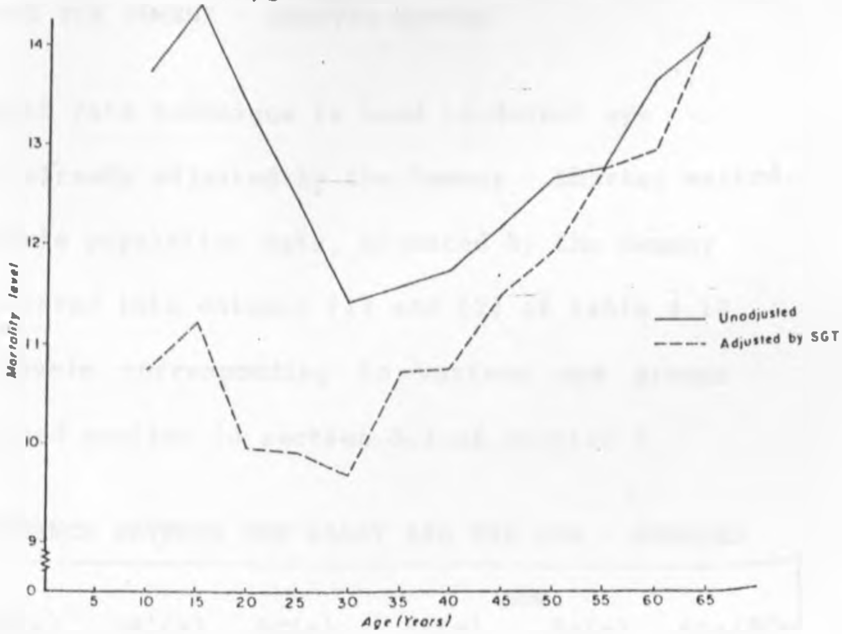
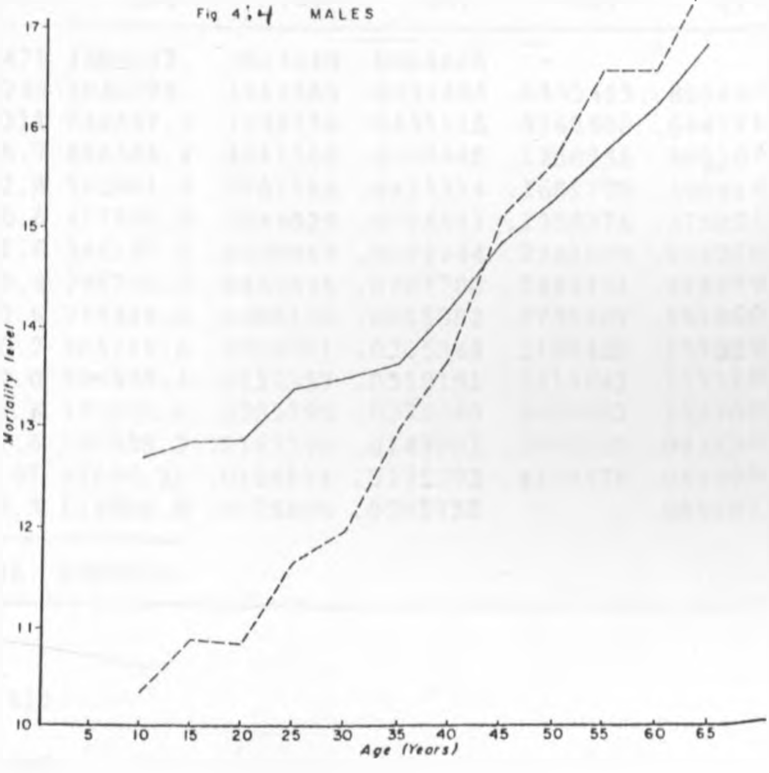


Fig 4.4 MALES



4.5.2: CORRESPONDENCE BETWEEN THE AGE SPECIFIC GROWTH RATE TECHNIQUE AND THE DEMENY - SHORTER METHOD

The age specific growth rate technique is used to detect age misreporting in data already adjusted by the Demeny - Shorter method. The 1969 and 1979 female population data, adjusted by the Demeny - Shorter method are entered into columns (1) and (2) of table 4.16 and the mortality levels corresponding to various age groups worked out as explained earlier in section 3.1 of chapter 3.

TABLE 4:16: CORRESPONDENCE BETWEEN THE ASGRT AND THE DSM - FEMALES

age,x	5N1(x) (1)	5N2(x) (2)	5N'(x) (3)	5C(x) (4)	5r(x) (5)	SUM. 5r(x) (6)	5Cx/5Co (7)
0	1120261	1524475	1306832.	.2013640	.0308088	-	1
5	885662.4	1236239	1046370.	.1612306	.0333493	.0333493	.8006921
10	677809.6	1047311	842542.3	.1298236	.0435115	.0768608	.6447212
15	513754.4	838565.7	656366.4	.1011366	.0489948	.1258556	.5022577
20	413431.7	631252.8	510861.9	.0787165	.0423214	.1681770	.3909163
25	363999.1	479938.6	417968.0	.0644028	.0276507	.1958276	.3198330
30	297083.8	410451.6	349197.0	.0538062	.0323244	.2281520	.2672088
35	266540.5	328069.9	295709.2	.0455645	.0207700	.2489221	.2262794
40	214498.4	291250.6	249945.6	.0385130	.0305882	.2795102	.1912607
45	176155.6	239060.2	205211.6	.0316201	.0305348	.3100450	.1570298
50	141831.4	195162.0	166373.4	.0256357	.0319191	.3419641	.1273105
55	116323.3	153348.6	133559.0	.0205795	.0276340	.3695982	.1022006
60	100828.6	117052.6	108638.2	.0167396	.0149201	.3845183	.0831309
65	72881.16	95978.37	83636.21	.0128871	.0275293	.4120476	.0639992
70+	105280.7	129332.3	116688.5	.0179800	.0205755		.0892911
	5466342.	7717488.	6489899.				

Assume e(70) = 7.612

source: Mudaki, 1986

TABLE 4:17: CORRESPONDENCE BETWEEN THE ASGRT AND THE DSM - FEMALES

age,x	5Lx/5Lo (1)	Tx/5Lo (2)	Tx/T5 (3)	ESTIMATED LEVEL (4)
0	1	11.94336	1.091380	-
5	.9399925	10.94336	1	-
10	.9172364	10.00337	.9141039	13.81256
15	.9004784	9.086135	.8302872	13.82372
20	.8805942	8.185656	.7480018	13.80997
25	.8581960	7.305062	.6675335	13.79618
30	.8329732	6.446866	.5891119	13.77849
35	.8055118	5.613893	.5129952	13.75345
40	.7741303	4.808381	.4393879	13.71505
45	.7405150	4.034251	.3686481	13.66961
50	.7018176	3.293736	.3009802	13.61052
55	.6538418	2.591918	.2368484	13.53347
60	.5915404	1.938076	.1771006	13.42640
65	.5063901	1.346536	.1230459	13.25516
70+		.8401457	.0767722	

The same procedure has been followed for the case of males as shown in tables 4:18 and 4:19.

TABLE 4:18: CORRESPONDENCE BETWEEN THE ASGRT AND THE DSM - MALES

age,x	5N1(x) (1)	5N2(x) (2)	5N'(x) (3)	5C(x) (4)	5r(x) (5)	5r(x) (6)	5Cx/5Co (7)
0	1100020	1481405	1276548.	.1977322	.0297663		1
5	880848.8	1200921	1028509.	.1593119	.0309958	.0309958	.8056951
10	694040.2	1022647	842471.4	.1304955	.0387620	.0697578	.6599606
15	545541.4	833559.8	674345.1	.1044534	.0423927	.1121505	.5282567
20	435914.3	653211.3	533614.2	.0826547	.0404455	.1525960	.4180134
25	348885.1	514466.7	423662.3	.0656236	.0388388	.1914348	.3318812
30	281712.1	407325.8	338745.6	.0524704	.0368728	.2283075	.2653606
35	267530.9	308582.2	287324.3	.0445054	.0142753	.2425829	.2250791
40	211408.2	285703.5	245764.2	.0380679	.0301164	.2726992	.1925225
45	180437.5	229448.3	203472.5	.0315171	.0240293	.2967286	.1593928
50	140224.0	194019.3	164942.9	.0255490	.0324716	.3292002	.1292101
55	119040.8	146445.3	132034.0	.0204515	.0207186	.3499188	.1034305
60	106691.7	112383.1	109500.4	.0169612	.0051970	.3551158	.0857785
65	72132.44	96786.30	83554.96	.0129423	.0294002	.3845160	.0654538
70+	102829.2	120803.5	111454.6	.0172639	.0161096		.0873094
	5487257.	7607708.	6455943.				

TABLE 4:19: CORRESPONDENCE BETWEEN THE ASGRT AND THE DSM - MALES

age,x	5Lx/5Lo (1)	Tx/5Lo (2)	Tx/T5 (3)	ESTIMATED LEVEL (4)
0	1	11.49247	1.095306	-
5	.9378692	10.49247	1	-
10	.9145935	9.554600	.9106150	14.14806
15	.8967424	8.640007	.8234484	14.15956
20	.8728775	7.743264	.7379830	14.16026
25	.8449433	6.870387	.6547922	14.15524
30	.8163648	6.025443	.5742636	14.14467
35	.7868941	5.209079	.4964588	14.13034
40	.7520734	4.422185	.4214627	14.10135
45	.7129110	3.670111	.3497853	14.07523
50	.6655923	2.957200	.2818402	14.03767
55	.6085704	2.291608	.2184050	13.98890
60	.5384911	1.683037	.1604043	13.91227
65	.4480210	1.144546	.1090826	13.77706
70+		.6965254	.0663834	

Figures 4:5 and 4:6 give graphs of mortality levels against age for the Kenyan females and males, respectively.

There is a very close correspondence between the age specific growth rate technique and the Demeny - Shorter method. The age specific growth rate graph is almost horizontal but starts declining slightly at the older ages.

CORRESPONDENCE BETWEEN THE ASGRT AND DSM

Fig. 4.5 FEMALES

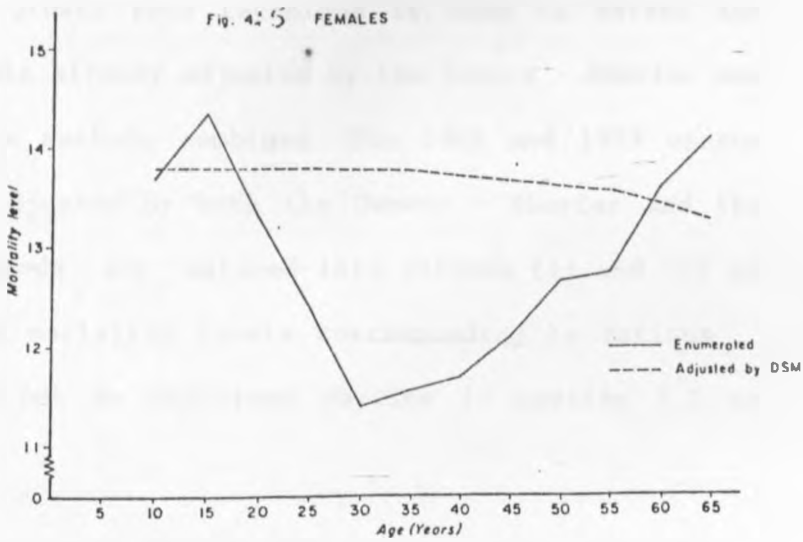
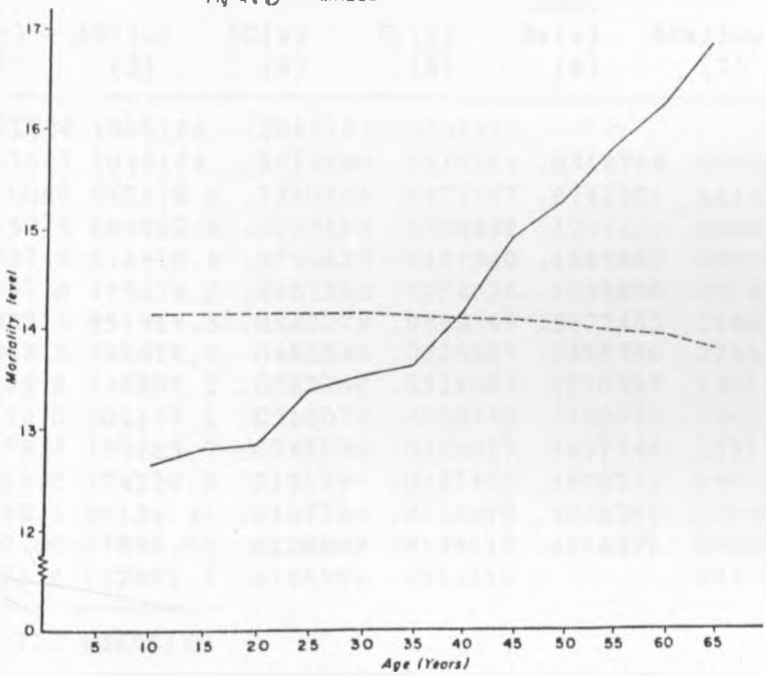


Fig 4.6 MALES



4.5.3: CORRESPONDENCE BETWEEN THE AGE SPECIFIC GROWTH RATE TECHNIQUE AND THE DEMENY - SHORTER AND SAXENA - GOGTE METHODS COMBINED.

The age specific growth rate technique is used to detect age misreporting in data already adjusted by the Demeny - Shorter and the Saxena - Gogte methods combined. The 1969 and 1979 census population data, adjusted by both the Demeny - Shorter and the Saxena - gogte methods are entered into columns (1) and (2) of table 4.20 and the mortality levels corresponding to various age groups worked out as explained earlier in section 3.1 of chapter 3.

TABLE 4:20: CORRESPONDENCE BETWEEN THE ASGRT AND THE DSM + SGT

age,x	5N1(x) (1)	5N2(x) (2)	5N'(x) (3)	5C(x) (4)	5r(x) (5)	SUM. 5r(x) (6)	5Cx/5Co (7)
0	1119935	1521034	1305166.	.2011161	.0306120	-	1
5	894152.8	1231047	1049164.	.1616680	.0319744	.0319744	.8038543
10	688920.8	1050040	850526.0	.1310595	.0421457	.0741201	.6516610
15	520442.9	849460.5	664902.8	.1024564	.0489921	.1231122	.5094391
20	417339.5	640237.9	516910.6	.0796520	.0427940	.1659062	.3960496
25	368554.5	484741.0	422674.2	.0651308	.0274026	.1933088	.3238470
30	296994.3	416997.3	351917.3	.0542278	.0339367	.2272455	.2696341
35	264401.8	330542.5	295628.2	.0455540	.0223265	.2495720	.2265061
40	212226.6	290709.1	248387.2	.0382746	.0314669	.2810389	.1903108
45	168859.2	239728.0	201197.1	.0310029	.0350440	.3160828	.1541544
50	132669.0	191478.3	159383.9	.0245598	.0366917	.3527746	.1221177
55	104770.4	147563.3	124339.3	.0191597	.0342486	.3870232	.0952670
60	91371.88	107556.4	99134.41	.0152759	.0163078	.4033309	.0759554
65	71078.82	85362.00	77893.71	.0120028	.0183112	.4216421	.0596811
70+	117327.4	127673.8	122391.3	.0188596	.0084510		.0937745
	5469045.	7714171.	6489616.				

Assume e(70) = 7.612

source: Mudaki, 1986

TABLE 4:21: CORRESPONDENCE BETWEEN THE ASGRT AND THE DSM + SGT COMBINED - FEMALES

age,x	5Lx/5Lo (1)	Tx/5Lo (2)	Tx/T5 (3)	ESTIMATED LEVEL (4)
0	1	11.97314	1.091132	-
5	.9400037	10.97314	1	-
10	.9171678	10.03314	.9143360	13.92521
15	.9004737	9.115970	.8307530	13.94757
20	.8806104	8.215496	.7486914	13.94256
25	.8582012	7.334886	.6684399	13.93757
30	.8329566	6.476685	.5902307	13.93069
35	.8054054	5.643728	.5143220	13.91909
40	.7741112	4.838323	.4409241	13.89880
45	.7404727	4.064212	.3703781	13.87506
50	.7018073	3.323739	.3028977	13.84463
55	.6537389	2.621932	.2389408	13.80449
60	.5914405	1.968193	.1793646	13.75027
65	.5067294	1.376752	.1254656	13.65979
70+		.8700228	.0792866	

The same procedure has been followed for the case of males as shown in tables 4:22 and 4:23 as shown below.

TABLE 4:22: CORRESPONDENCE BETWEEN THE ASGRT AND THE DSM + SGT COMBINED - MALES

age,x	5N1(x) (1)	5N2(x) (2)	5N'(x) (3)	5C(x) (4)	5r(x) (5)	SUM. 5r(x) (6)	5Cx/5Co (7)
0	1104183	1479897	1278310.	.1980040	.0292867		1
5	892730.0	1199707	1034898.	.1603006	.0295548	.0295548	.8095830
10	708623.4	1028837	853848.9	.1322570	.0372860	.0668409	.6679512
15	558843.6	845962.2	687575.9	.1065021	.0414605	.1083014	.5378787
20	443080.8	668877.1	544395.6	.0843242	.0411848	.1494862	.4258713
25	356776.4	523116.5	432013.5	.0669168	.0382695	.1877557	.3379566
30	281545.9	419010.7	343468.7	.0532016	.0397601	.2275158	.2686896
35	263874.4	312591.9	287202.0	.0444862	.0169425	.2444583	.2246732
40	205197.7	285941.6	242228.3	.0375200	.0331814	.2776397	.1894910
45	170328.3	227042.1	196651.2	.0304603	.0287408	.3063804	.1538368
50	127365.3	188532.7	154959.7	.0240025	.0392212	.3456016	.1212223
55	103265.9	138044.4	119395.5	.0184938	.0290268	.3746285	.0934010
60	91382.83	100615.1	95887.92	.0148526	.0096245	.3842529	.0750115
65	68361.55	81490.96	74638.12	.0115611	.0175682	.4018211	.0583881
70+	107074.4	114054.5	110509.4	.0171174	.0063152		.0864496
	--------	--------	--------				
	5482633.	7613721.	6455983.				

TABLE 4:23: CORRESPONDENCE BETWEEN THE ASGRT AND THE DSM + SGT COMBINED - MALES

age,x	5Lx/5Lo (1)	Tx/5Lo (2)	Tx/T5 (3)	ESTIMATED LEVEL (4)
0	1	11.51086	1.095140	-
5	.9378811	10.51086	1	-
10	.9145399	9.572977	.9107703	14.22344
15	.8966856	8.658437	.8237612	14.24299
20	.8729015	7.761752	.7384508	14.24920
25	.8449175	6.888850	.6554032	14.24896
30	.8164390	6.043933	.5750180	14.24539
35	.7866620	5.227494	.4973422	14.23808
40	.7520503	4.440832	.4224994	14.22177
45	.7127705	3.688781	.3509496	14.20891
50	.6656728	2.976011	.2831368	14.19021
55	.6083158	2.310338	.2198049	14.16498
60	.5381090	1.702022	.1619299	14.13042
65	.4483230	1.163913	.1107344	14.06583
70+		.7155904	.0680811	

Figures 4:7 and 4:8 give graphs of mortality levels against age for the Kenyan females and males, respectively.

The correspondence between the age specific growth rate technique and the two methods combined appears to be better than the correspondence with either of the individual methods. The Saxena - Gogte technique corrects for heaping on multiples of five where as the Dememny - Shorter method mainly corrects systematic age misreporting that carry people across age group boundaries. A combination of the two methods appears to give the most accurate estimate of Kenya's age distribution.

CORRESPONDENCE BETWEEN ASGRT AND DSM AND DSM + SGT

Fig 4.7 FEMALES

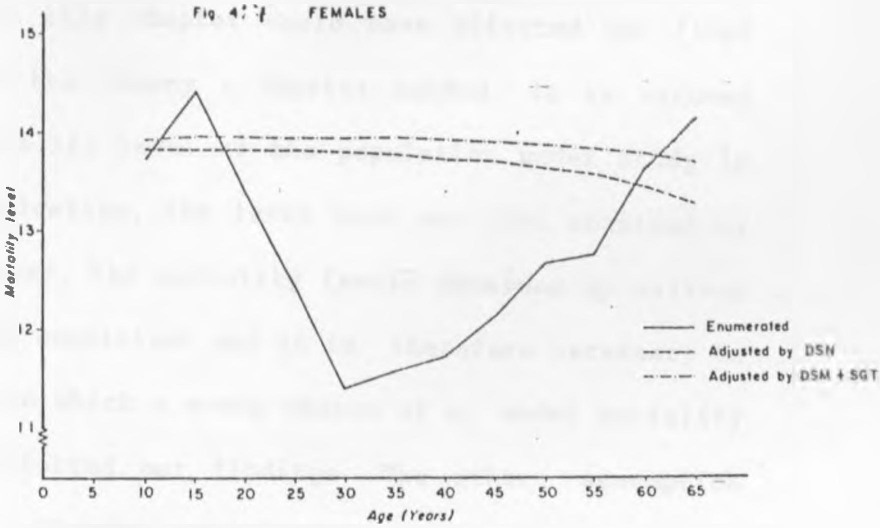
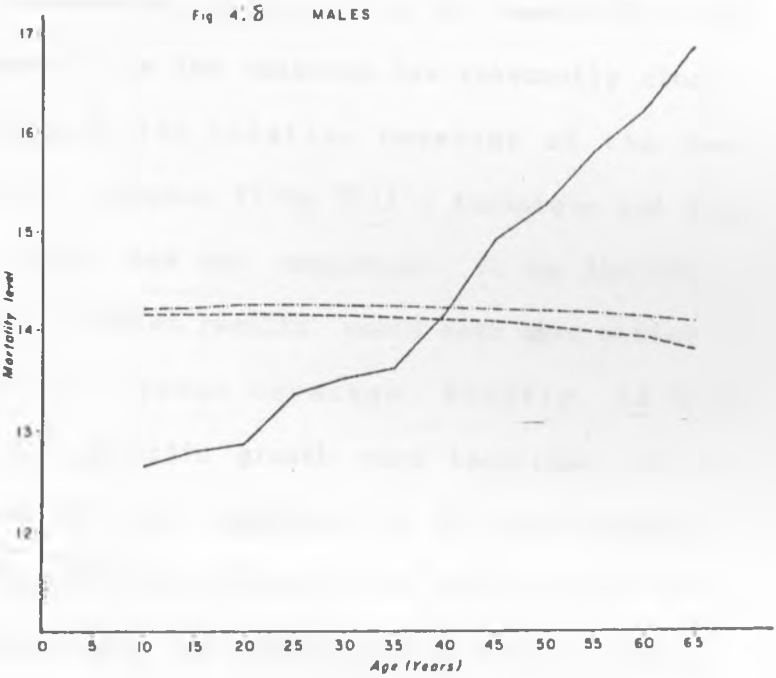


Fig 4.8 MALES



4.6 THE EFFECT OF CHANGES IN ASSUMPTIONS REGARDING CENSUS COVERAGE, KENYA'S MODEL MORTALITY LEVEL AND LIFE EXPECTANCY AT OLD AGE.

It is important to study the extent to which some of the assumptions made in this chapter could have affected our final results. First, in the Demeny - Shorter method, it is assumed that the model mortality level of the population under study is Known. In this application, the level used was that obtained by Mudaki (1986). However, the mortality levels obtained by various methods are not very consistent and it is therefore necessary to examine the extent to which a wrong choice of a model mortality level might have affected our findings. The other assumption made in the Demeny - Shorter method was that the total size of the population was enumerated correctly, or at least that the degree of of coverage of the two censuses was reasonably close. Again, the estimates of the relative coverage of the two censuses as obtained in chapter II by Hill's technique and the Palloni - Kominski method are not consistent. It is therefore necessary to find out if better results would have been achieved if we had adjusted for census coverage. Finally, in the application of the age specific growth rate technique, it is required that we know the life expectancy at the age beginning the open age interval, that is; e(70) in this case. Several life tables have been constructed for Kenya and different methods appear to give different values of e(70). In this study, the values of e(70) used are from the analysis by Mudaki (1986). There is however no reason to suppose that these particular values are the most accurate and thus it is necessary to find out if using an alternative value could have affected our results.

4.6.1 THE EFFECT OF CHANGES IN RELATIVE CENSUS COVERAGE

Before applying the Demeny - Shorter method, the enumerated 1979 population is adjusted for census coverage so that the enumeration completeness in the two censuses is similar. First, it will be assumed that the 1979 census coverage was 95% complete with respect to the 1969 census coverage. In the second case, it will be assumed that the 1979 census coverage was 105% complete with respect to the 1969 census coverage. This has been shown in tables given in appendix H. Figures 4:9 and 4:10 on the next page give corresponding graphs for the females and males respectively.

4.6.2 THE EFFECT OF CHANGES IN MODEL MORTALITY LEVEL

In the application of the Demeny - Shorter method, it requires that we know the model mortality level of the population under study. First, it is assumed that the mortality level is 14, North model, then that the level is 15. This is done for both females and males as shown in tables given in appendix I, along with figures 4:11 and 4:12 given below for for the females and males, respectively.

4.6.3 THE EFFECT OF CHANGES IN LIFE EXPECTANCY AT OLD AGE

In the application of the age specific growth rate technique, it is required that we know the value of e(A), where A is the age beginning the open age interval. In our case A = 70. First, will assume that e(70) = 5, then that e(70) = 10. The values of e(70) that would give ideal cases (that is; horizontal graphs) are also considered.

EFFECT OF CHANGES IN CENSUS COVERAGE

Fig 4:9 FEMALES

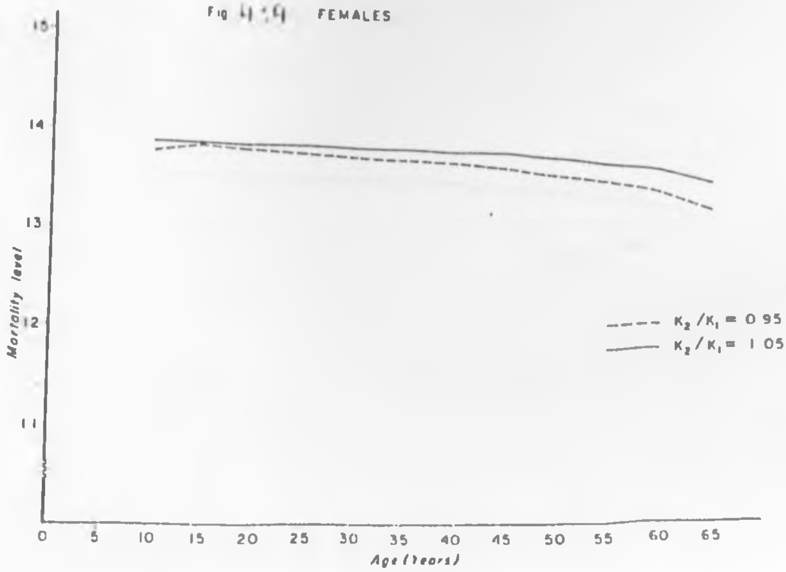
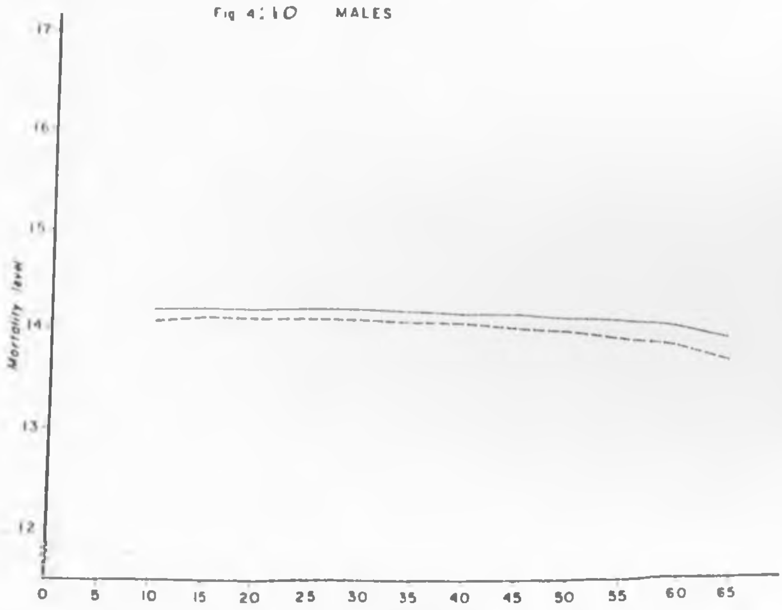


Fig 4:10 MALES



EFFECT OF CHANGE IN MORTALITY LEVEL (Used in the DSM)

Fig 4.11 FEMALES

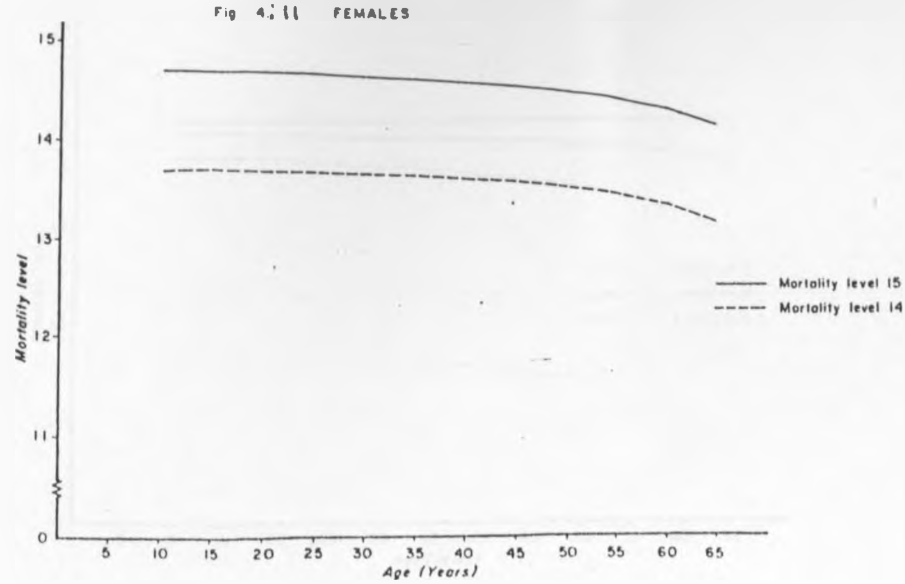
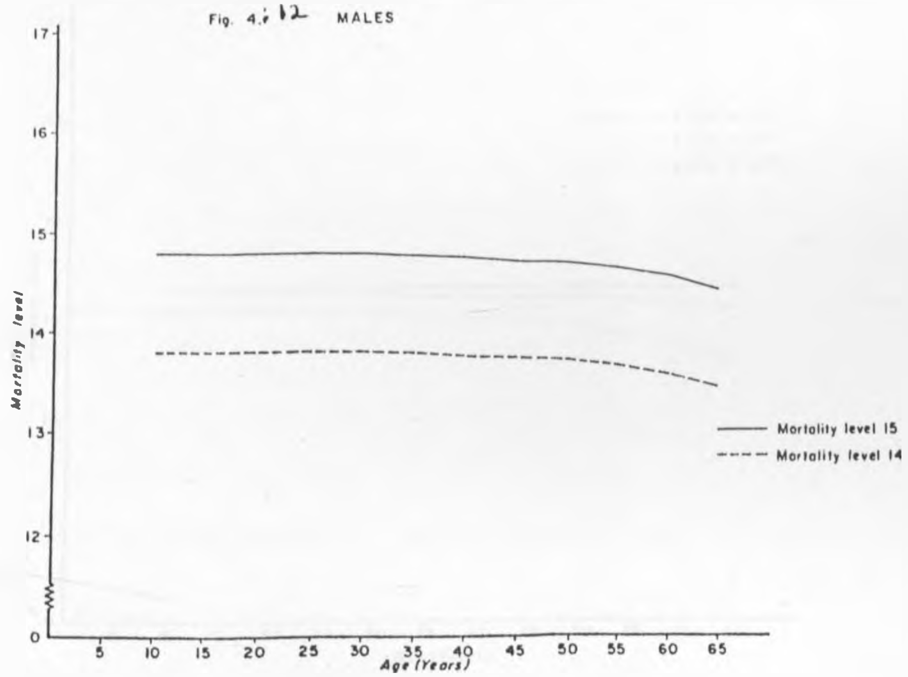


Fig. 4.12 MALES



EFFECT OF CHANGES IN LIFE EXPECTANCY (Value of e(70))

Fig. 4.13 FEMALES

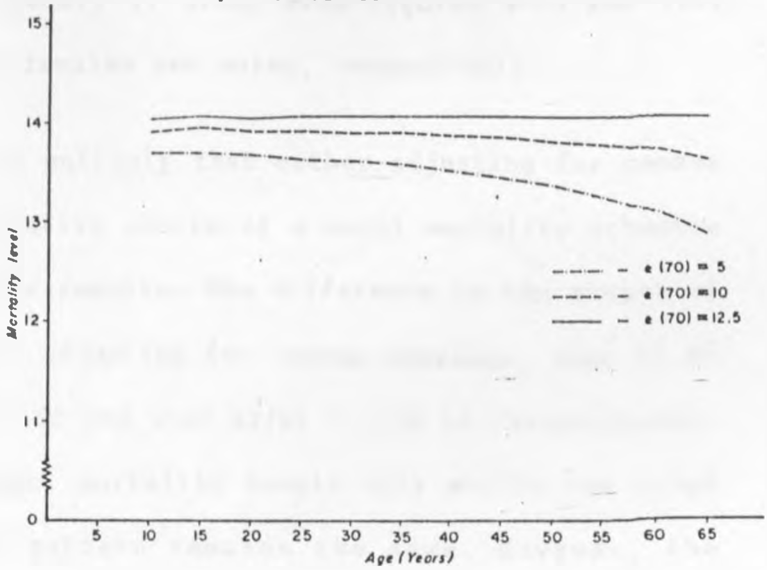
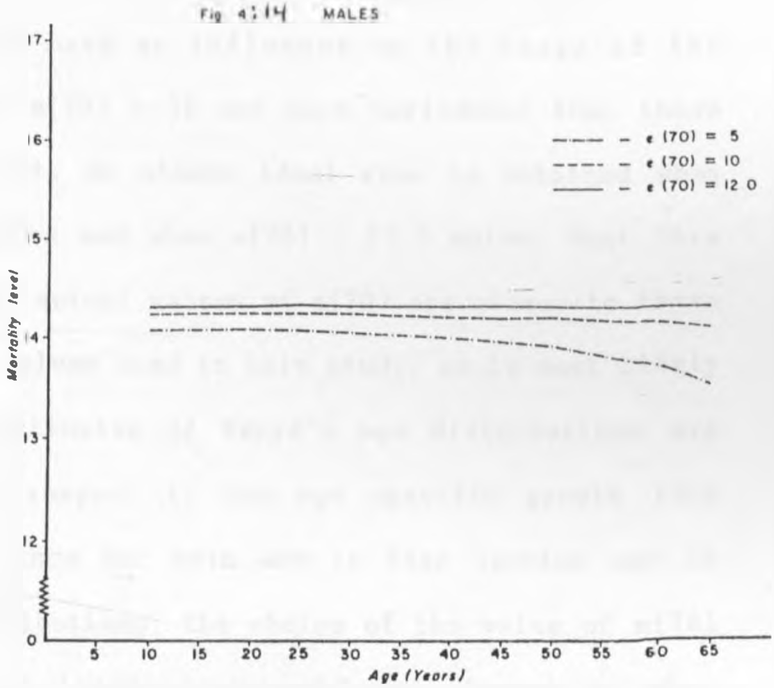


Fig 4.14 MALES



Illustrations of the effect of changes in life expectancy at old age are given in appendix J, along with figures 4:13 and 4:14 given above for the females and males, respectively.

From the graphs, it is unlikely that either adjusting for census coverage, or an alternative choice of a model mortality schedule could have affected our results. The difference in the shapes of graphs obtained after adjusting for census coverage, when it is assumed that k2/kl = 0.95 and when k2/kl = 1.05 is insignificant. Also, choosing different mortality levels only shifts the graph up and down, but the pattern remains the same. However, the choice of the value of e(70) used in the age specific growth rate technique, appears to have an influence on the shape of the graph. The graphs for e(70) = 10 are more horizontal than those for e(70) = 5. In fact, an almost ideal case is obtained when e(70) = 12.5 for females and when e(70) = 12.0 males. What this implies is that if the actual values of e(70) are closer to these ideal cases than the values used in this study, as is most likely the case, then our estimates of Kenya's age distributions are fairly accurate with respect to the age specific growth rate technique. However, since our main aim in this section was to estimate the age distributions, the choice of the value of e(70) is not a very crucial limitation as it only comes in when detecting age misreporting. We can therefore be fairly confident that the estimates of the age distributions obtained in this study are reasonably accurate with respect to the assumptions considered above.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1: INTRODUCTION

The main objective of this study was to estimate Kenya's age distribution, census coverage and death registration completeness. Specifically, the study set out to:

(i) Estimate the relative coverage of the 1979 census with respect to the 1969 census coverage.

(ii) Estimate the intercensal death registration completeness in Kenya.

(iii) Identify the nature and extent of age misreporting in Kenya.

(iv) Make appropriate corrections for age misreporting and thus attempt to estimate Kenya's age distribution.

To achieve the first two objectives, namely; to estimate the relative coverage of the 1979 census and the intercensal death registration completeness, Hill's extension of the generalised growth balance equation and the Palloni - Kominski method have been used. Both methods have used the 1969 and 1979 census population data by five year age groups and by sex, as well as the 1969, 1974 and 1979 registered deaths by five year age groups and by sex. To realise the third objective, the age ratio technique has been used to detect age heaping on specific ages, where as the age specific growth rate technique has been used to detect systematic age misreporting that carry people across age group boundaries. The age ratio technique has utilized the 1969 and 1979 census data on population by single - year age distributions and by sex. The age specific growth rate technique has used the 1969 and the 1979 census data on population by five - year age groups. Finally, to achieve the last objective, the Demeny - Shorter method and the Saxena - Gogte technique have been applied separately, then jointly to correct for age misreporting. Following the correction of age errors, the correspondance between one of the techniques of detecting age misreporting, namely; the age specific growth rate technique and the techniques of correcting age errors has been studied to identify the method that is most efficient in correcting age misreporting in Kenya. The extent to which some of the assumptions made in the study with regard to relative census coverage, Kenya's model mortality level and life expectancy at old age, would have affected the estimate of Kenya's age distribution has also been looked into.

The two methods employed in this study to estimate the relative coverage of the 1979 census and intercensal death registration completeness do not give consistent results. Where as Hill's technique gives the relative coverage of the 1979 census with respect to the 1969 census coverage to be 97.11 percent for females and 98.79 percent for males, results from the Palloni - Kominski method indicate that the 1979 census coverage was 100.57 percent and 103.58 percent for females and males respectively. The estimates of the intercensal death registration are not consistent either. Results from Hill's technique show that the completeness of intercensal death registration, relative to the 1969 census coverage was 18.25 percent for females and 26.18 percent for males, while the Palloni - Kominski method gives much lower estimates of 14.50 percent and 19.39 percent for females and males respectively.

The pattern of age heaping in the two censuses was observed to be quite similar with a fairly large component of digit preference. The terminal digits 0, 5, 8 and 9 were the most prefered in that order. There was heaping in all the ages ending in digit 0 and 5 with an exception of age 15. This was observed to be the case for both males and females. In both censuses, the degree of age heaping for both sexes was observed to increase with age. However, the pattern of systematic age misreporting among the females was observed to be quite different from males'. Among the females, considerable overstatement of age was observed for teenagers and those aged 45 years and above, while women aged 10 to 34 years tended to understate their ages. For the males, there was a tendency to over-report ages throughout the age distribution and in particular, among those in their late twenties and those aged over 40 years.

An examination of the correspondance between the age specific growth rate technique and the techniques of correcting age errors, namely; the Demeny - Shorter method and the Saxena - Gogte technique, first applied separately then jointly indicate that a combination of the two methods is more efficient in correcting age errors in Kenyan data than either of the individual methods. In fact, the Saxena - Gogte technique in itself appears to worsen the data with regard to systematic age misreporting. Finally, a study of the effects of the assumptions made in the study regarding Kenya's model mortality level, relative census coverage and life expectancy at old age showed that it is unlikely that our estimate of Kenya's age distribution would have been significantly affected by these assumptions.

5.2: CONCLUSIONS

There are clearly many biases in Kenya's demographic data arising from both content and coverage errors. Even though no conclusions can be made from this study on the exact estimates of relative census coverage and death registration completeness, what is clear is that the relative coverage of the two censuses with respect to each other was fairly close and within the range of 95% - 105%, and that the average death registration for the intercensal period less than 25%. It would have been useful to compare the estimates of relative census coverage and death registration completeness obtained in this study with those already obtained by other sources to establish consistent estimates. Unfortunately, no study has ever been done in Kenya to estimate the relative coverage of the censuses. Furthermore, comparison of estimates of death registration completeness with those obtained by Nyokangi (1984) is not possible because Nyokangi's data on death registration was incomplete and the study estimated death registration completeness for a particular year, 1979, and not the intercensal period.

With regard to age misreporting, the observed pattern of digit preference on terminal digits 0 and 5 appears to be consistent with what had already been observed in other developing coutries, indicating ignorance of age, particularly among the elderly. Observed heaping on terminal digits 8 and 9 could have been a result of assigning ages ending in these digits to those reporting a year of birth with terminal digit 0, since the censuses were conducted in August 1969 and August 1979 respectively. However, the pattern of systematic age misreporting observed, and the fact that age 15 was being avoided despite the fact that there is a universal preference for terminal digit 5, could best be explained in terms of socio - cultural or biological factors influencing the importance the society attatches to various ages or age groups.

In general, both death registration data and age data appear to be better fo males than females possibly due to better education and better written records. The same reasons could be used to explain why the degree of age heaping in the 1979 census was slightly lower than that observed in the 1969 census. From the above conclusions, the following recommendations can be made.

5.3 RECOMENDATIONS

5.3.1: POLICY MAKERS

(1) Improvements should be made on education in general, and the population need to be informed of the importance of knowledge on age through formal or non-formal education. Equal opportunities should be given to both sexes.(2) The vital registration system should be intensified. This will not only help improve the completeness of death registration, but also the registration of births will help facilitate knowledge on age through provision of written records.

(3) Sufficient funds should be made available for the census operations,particularly for better training of enumerators. A properly trained enumerator has knowledge on the importance of accurate age reporting and will use every available information to obtain as accurate ages as possible even from the ignorant respondents.

5.3.2 FURTHER RESEARCH

(1) Further work should be carried out on the estimation of relative coverage of censuses and death registration completeness in Kenya using other appropriate techniques to establish consistent estimates.

(2) The cultural, socio - economic, demographic and environmental determinants of age misreporting should be researched into so as to identify factors that have significant influence on age misreporting and thus be in a better position to make recommendations for policy makers.

(3) Further work should be carried out to examine other aspects of the quality of demographic data in Kenya, particularly those relating to fertility measures.

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APPENDICES

APPENDIX A

HILL'S TECHNIQUE - MALES

CUMULATING INTERCENSAL REPORTED DEATHS - KENYAN MALES

age,x	1969 (1)	1974 (2)	1979 (3)	(average) 1969-79 (4)	5D'x 1969-79 (5)	CUMULATED D'(x+) (6)
0	10024	14686	12663	12457.67	124576.7	241643.3
5	573	1469	1129	1057	10570	117066.7
10	287	718	621	542	5420	106496.7
15	235	482	582	433	4330	101076.7
20	303	559	604	488.6667	4886.667	96746.67
25	359	703	795	619	6190	91860
30	398	793	747	646	6460	85670
35	449	792	790	677	6770	79210
40	442	808	805	685	6850	72440
45	422	824	833	693	6930	65590
50	474	933	988	798.3333	7983.333	58660
55	354	654	846	618	6180	50676.67
60	465	1101	1042	869.3333	8693.333	44496.67
65	374	806	925	701.6667	7016.667	35803.33
70+	1356	3159	4121	2878.667	28786.67	28786.67

ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR KENYAN MALES

age,x	5N1'(x) (1)	5N2'(x) (2)	N1'(x+) (3)	N2'(x+) (4)	r(x+) (5)	N'(x+) (6)	N'(x) (7)
0	1058102	1424954	5483281	7607185	.0327390	64585086	-
5	916599	1249662	4425179	6182231	.0334368	52304377	2292741.
10	714707	1053099	3508580	4932569	.0340649	41600857	1927180.
15	560152	855884	2793873	3879470	.0328270	32922252	1550099.
20	428915	642723	2233721	3023586	.0302775	25988166	1205894.
25	349594	515512	1804806	2380863	.0277010	20729196	944233.6
30	280948	406221	1455212	1865351	.0248298	16475683	757404.3
35	252136	290825	1174264	1459130	.0217199	13089705	604914.1
40	193936	262091	922128	1168305	.0236625	10379435	494167.6
45	172508	219365	728192	906214	.0218711	8123409.	418843.5
50	132466	183285	555684	686849	.0211915	6177953.	348202.6
55	114669	141067	423218	503564	.0173823	4616463.	281550.1
60	102466	107932	308549	362497	.0161136	3344370.	231302.5
65	74611	100112	206083	254565	.0211277	2290448.	190671.0
70+	131472	154453	131472	154453	.0161096	1425000.	-

ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR KENYAN MALES

age, x	D'(x+)	Xi	Yi	$\bar{X}i$	$\bar{Y}i$	$\bar{X}i\bar{Y}i$	$(\bar{X}i)^2$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	241643.3	-	-	-	-	-	-
5	117066.7	.0022382	.0103978	-.004818	-.017610	.0000849	.0000232
10	106496.7	.0025600	.0122606	-.004497	-.015747	.0000708	.0000202
15	101076.7	.0030702	.0142567	-.003986	-.013751	.0000548	.0000159
20	96746.67	.0037227	.0161242	-.003334	-.011884	.0000396	.0000111
25	91860	.0044314	.0178499	-.002625	-.010158	.0000267	.0000069
30	85670	.0051998	.0211413	-.001857	-.006867	.0000128	.0000034
35	79210	.0060513	.0244931	-.001005	-.003515	.0000035	.0000010
40	72440	.0069792	.0239477	-.000077	-.004060	.0000003	5.994e-9
45	65590	.0080742	.0296890	.0010176	.0016810	.0000017	.0000010
50	58660	.0094951	.0351707	.0024384	.0071627	.0000175	.0000059
55	50676.67	.0109774	.0436059	.0039208	.0155980	.0000612	.0000154
60	44496.67	.0133049	.0530482	.0062483	.0250403	.0001565	.0000390
65	35803.33	.0156316	.0621185	.0085750	.0341105	.0002925	.0000735
70+	28786.67	-	-	-	-	-	-
		.0917359	.3641035			.0008227	.0002167

$\bar{X}$ = .0070566 $\bar{Y}$ = .0280080

NB: $Xi-\bar{X} = \bar{X}i$ and $Yi-\bar{Y} = \bar{Y}i$.

b^= 3.795842=1/k*SQRT(k2)

a^= .0012222=-1/10*lnk2. Therefore:

lnk2= -.012222, k2= .9878525 and k= .2618412

APPENDIX B

HILL'S TECHNIQUE - COMBINED SEXES

CUMULATING INTERCENSAL REPORTED DEATHS - COMBINED SEXES

age,x	1969 (1)	1974 (2)	1979 (3)	(average) 1969-79 (4)	5D'x 1969-79 (5)	CUMULATED D'(x+) (6)
0	19160	27733	24058	23650.33	236503.3	427453.3
5	1152	2665	2064	1960.333	19603.33	190950
10	472	1240	1077	929.6667	9296.667	171346.7
15	445	874	1071	796.6667	7966.667	162050
20	549	1004	1092	881.6667	8816.667	154083.3
25	608	1192	1290	1030	10300	145266.7
30	623	1243	1220	1028.667	10286.67	134966.7
35	655	1293	1239	1062.333	10623.33	124680
40	640	1260	1203	1034.333	10343.33	114056.7
45	683	1291	1256	1076.667	10766.67	103713.3
50	697	1450	1451	1199.333	11993.33	92946.67
55	490	1006	1212	902.6667	9026.667	80953.33
60	714	1739	1671	1374.667	13746.67	71926.67
65	535	1254	1416	1068.333	10683.33	58180
70+	2238	5223	6788	4749.667	47496.67	47496.67

ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR COMBINED SEXES

age,x	5N1'(x) (1)	5N2'(x) (2)	N1'(x+) (3)	N2'(x+) (4)	r(x+) (5)	N'(x+) (6)	N'(x) (7)
0	2104482	2848890	10943675	15327132	.0336863	1.2951e8	-
5	1809958	2496645	8839193	12478242	.0344791	1.0502e8	4562906.
10	1378515	2078776	7029235	9981597	.0350665	83763352	3793946.
15	1104999	1745200	5650720	7902821	.0335437	66825615	3066455.
20	879011	1329957	4545721	6157621	.0303504	52906358	2450698.
25	760839	1057745	3666710	4827664	.0275068	42073322	1969729.
30	580189	819653	2905871	3769919	.0260320	33098185	1573071.
35	516955	616776	2325682	2950266	.0237882	26194237	1248030.
40	395872	536284	1808727	2333490	.0254742	20544212	1020146.
45	336360	441728	1412855	1797206	.0240621	15934841	842863.4
50	271538	374650	1076495	1355478	.0230444	12079591	701267.8
55	216974	275843	804957	980828	.0197608	8885518.	558677.9
60	196974	217647	587983	704985	.0181478	6438317.	450129.8
65	137918	183482	391009	487338	.0220227	4365244.	362972.7
70+	253091	303856	253091	303856	.0182805	2773143.	-

ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR COMBINED SEXES

age, x	D'(x+) (1)	X_i (2)	Y_i (3)	$\bar{X}_i$ (4)	$\bar{Y}_i$ (5)	$\bar{X}_i\bar{Y}_i$ (6)	$(\bar{X}_i)^2$ (7)
0	427453.3	-	-	-	-	-	-
5	190950	.0018182	.0089678	-.003940	-.018433	.0000726	.0000155
10	171346.7	.0020456	.0102271	-.003713	-.017173	.0000638	.0000138
15	162050	.0024250	.0123437	-.003333	-.015057	.0000502	.0000111
20	154083.3	.0029124	.0159710	-.002846	-.011429	.0000325	.0000081
25	145266.7	.0034527	.0193098	-.002306	-.008091	.0000187	.0000053
30	134966.7	.0040778	.0214954	-.001680	-.005905	.0000099	.0000028
35	124680	.0047598	.0238570	-.000998	-.003543	.0000035	.0000010
40	114056.7	.0055518	.0241820	-.000206	-.003218	.0000007	4.262e-8
45	103713.3	.0065086	.0288323	.0007504	.0014320	.0000011	.0000006
50	92946.67	.0076945	.0350096	.0019363	.0076092	.0000147	.0000037
55	80953.33	.0091107	.0431143	.0033525	.0157140	.0000527	.0000112
60	71926.67	.0111717	.0517664	.0054135	.0243660	.0001319	.0000293
65	58180	.0133280	.0611279	.0075698	.0337276	.0002553	.0000573
70+	47496.67	-	-	-	-	-	-
		.0748567	.3562041			.0007076	.0001599

$\bar{X}$ = .0057582 $\bar{Y}$ = .0274003

NB: $X_i - \bar{X} = \bar{X}_i$ and $Y_i - \bar{Y} = \bar{Y}_i$.

b^= 4.426398=1/k*SQRT(k2)

a^= .0019122=-1/10*lnk2. Therefore:

lnk2= -.019122, k2= .9810596 and k= .2237676

APPENDIX C

THE PALLONI - KOMINSKI METHOD: MALES

FOWARD PROJECTION OF THE 1969 MALE POPULATION TO 1979 USING DIFFERENT MORTALITY LEVELS.

		LEVEL 8			LEVEL 10		
x	5N1x	10Sx,x+4	5N2*x+10	N2*x+10+	10Sx,x+4	5N2*x+10	N2*x+10+
0	1058102	.82224	870013.8	4576497.	.85472	904380.9	4695959.
5	916599	.91521	838880.6	3706483.	.92977	852226.3	3791578.
10	714707	.92066	658002.1	2867603.	.93294	666778.7	2939351.
15	560152	.90298	505806.1	2209601.	.91741	513889.0	2272573.
20	428915	.89112	382214.7	1703795.	.90732	389163.2	1758684.
25	349594	.88249	308513.2	1321580.	.90005	314652.1	1369520.
30	280948	.86698	243576.3	1013067.	.88688	249167.2	1054868.
35	252136	.84367	212719.6	769490.3	.86678	218546.4	805701.1
40	193936	.81347	157761.1	556770.7	.83974	162855.8	587154.7
45	172508	.77251	133264.2	399009.6	.80228	138399.7	424298.9
50	132466	.71304	94453.56	265745.5	.74762	99034.23	285899.1
55	114669	.62778	71986.90	171291.9	.66769	76563.34	186864.9
60	102466	.50962	52218.72	99305.00	.55497	56865.56	110301.6
65	74611	.36526	27252.41	47086.28	.41366	30863.59	53436.01
70+	131472	.15086	19833.87	19833.87	.17169	22572.43	22572.43

FOWARD PROJECTION OF THE 1969 MALE POPULATION TO 1979 USING DIFFERENT MORTALITY LEVELS.

		LEVEL 12			LEVEL 14		
x	5N1x	10Sx,x+4	5N2*x+10	N2*x+10+	10Sx,x+4	5N2*x+10	N2*x+10+
0	1058102	.88319	934505.1	4802619.	.91033	963222.0	4893231.
5	916599	.94258	863967.9	3868114.	.95403	874462.9	3930009.
10	714707	.94376	674511.9	3004146.	.95278	680958.5	3055546.
15	560152	.93016	521031.0	2329634.	.94058	526867.8	2374588.
20	428915	.92166	395313.8	1808603.	.93334	400323.5	1847720.
25	349594	.91561	320091.8	1413289.	.92823	324503.6	1447397.
30	280948	.90454	254128.7	1093198.	.91884	258146.3	1122893.
35	252136	.88733	223727.8	839069.0	.90396	227920.9	864746.7
40	193936	.8632	167405.6	615341.1	.88196	171043.8	636825.9
45	172508	.82922	143047.1	447935.6	.85004	146638.7	465782.1
50	132466	.77941	103245.3	304888.5	.80321	106398.0	319143.4
55	114669	.70465	80801.51	201643.2	.73195	83931.97	212745.4
60	102466	.59734	61207.04	120841.7	.62853	64402.95	128813.4
65	74611	.45977	34303.90	59634.61	.49363	36830.23	64410.42
70+	131472	.19267	25330.71	25330.71	.20978	27580.20	27580.20

FOWARD PROJECTION OF THE 1969 MALE POPULATION TO 1979 USING DIFFERENT MORTALITY LEVELS.

		LEVEL 16			LEVEL 18		
x	5N1x	10Sx,x+4	5N2*x+10	N2*x+10+	10Sx,x+4	5N2*x+10	N2*x+10+
0	1058102	.93368	987928.7	4977659.	.95404	1009472.	5057657.
5	916599	.96436	883931.4	3989730.	.97367	892464.9	4048186.
10	714707	.96149	687183.6	3105799.	.9697	693051.4	3155721.
15	560152	.9509	532648.5	2418615.	.96075	538166.0	2462669.
20	428915	.94492	405290.4	1885967.	.95599	410038.5	1924503.
25	349594	.94066	328849.1	1480676.	.95259	333019.7	1514465.
30	280948	.93273	262048.6	1151827.	.94613	265813.3	1181445.
35	252136	.91978	231909.7	889778.5	.93522	235802.6	915631.8
40	193936	.89957	174459.0	657868.8	.91704	177847.1	679829.2
45	172508	.86974	150037.1	483409.8	.8896	153463.1	501982.1
50	132466	.82603	109420.9	333372.7	.84942	112519.3	348519.0
55	114669	.75853	86979.88	223951.8	.78618	90150.47	235999.7
60	102466	.65945	67571.20	136972.0	.69212	70918.77	145849.2
65	74611	.52781	39380.43	69400.75	.56455	42121.64	74930.48
70+	131472	.22834	30020.32	30020.32	.24955	32808.84	32808.84

FOWARD PROJECTION OF THE 1969 MALE POPULATION TO 1979 USING DIFFERENT MORTALITY LEVELS.

		LEVEL 20			LEVEL 22		
x	5N1x	10Sx,x+4	5N2*x+10	N2*x+10+	10Sx,x+4	5N2*x+10	N2*x+10+
0	1058102	.97163	1028084.	5132398.	.98706	1044410.	5200679.
5	916599	.98202	900118.5	4104315.	.98947	906947.2	4156269.
10	714707	.9773	698483.2	3204196.	.98428	703471.8	3249321.
15	560152	.96994	543313.8	2505713.	.97846	548086.3	2545850.
20	428915	.96634	414477.7	1962399.	.97591	418582.4	1997763.
25	349594	.96376	336924.7	1547921.	.97414	340553.5	1579181.
30	280948	.95876	269361.7	1210997.	.97052	272665.7	1238627.
35	252136	.94989	239501.5	941635.0	.96337	242900.3	965961.7
40	193936	.9339	181116.8	702133.5	.94906	184056.9	723061.4
45	172508	.90911	156828.7	521016.7	.92658	159842.5	539004.5
50	132466	.87268	115600.4	364187.9	.89372	118387.5	379162.1
55	114669	.81408	93349.74	248587.5	.83984	96303.61	260774.6
60	102466	.72563	74352.40	155237.7	.75734	77601.60	164471.0
65	74611	.6029	44982.97	80885.35	.64009	47757.75	86869.36
70+	131472	.27308	35902.37	35902.37	.29749	39111.61	39111.61

THE PROJECTED 1979 MALE POPULATION AGED x+10 YEARS AND ABOVE OBTAINED USING DIFFERENT MORTALITY LEVELS

	LEVEL 8	LEVEL 10	LEVEL 12	LEVEL 14	LEVEL 16	LEVEL 18	LEVEL 20
x	N2*x+10+	N2*x+10+	N2*x+10+	N2*x+10+	N2*x+10+	N2*x+10+	N2*x+10+
0	4576497.	4695959.	4802619.	4893231.	4977659.	5057657.	5132398.
5	3706483.	3791578.	3868114.	3930009.	3989730.	4048186.	4104315.
10	2867603.	2939351.	3004146.	3055546.	3105799.	3155721.	3204196.
15	2209601.	2272573.	2329634.	2374588.	2418615.	2462669.	2505713.
20	1703795.	1758684.	1808603.	1847720.	1885967.	1924503.	1962399.
25	1321580.	1369520.	1413289.	1447397.	1480676.	1514465.	1547921.
30	1013067.	1054868.	1093198.	1122893.	1151827.	1181445.	1210997.
35	769490.3	805701.1	839069.0	864746.7	889778.5	915631.8	941635.0
40	556770.7	587154.7	615341.1	636825.9	657868.8	679829.2	702133.5
45	399009.6	424298.9	447935.6	465782.1	483409.8	501982.1	521016.7
50	265745.5	285899.1	304888.5	319143.4	333372.7	348519.0	364187.9
55	171291.9	186864.9	201643.2	212745.4	223951.8	235999.7	248587.5
60	99305.00	110301.6	120841.7	128813.4	136972.0	145849.2	155237.7
65	47086.28	53436.01	59634.61	64410.42	69400.75	74930.48	80885.35
70+	19833.87	22572.43	25330.71	27580.20	30020.32	32808.84	35902.37

OBTAINING THE MORTALITY LEVEL CORRESPONDING TO THE FOWARD PROJECTIONS

x	OBSERVED MALE 5N2x+10	N2(x+10)+	LOWER LEVEL	ESTIMATED LEVEL
0	1053099	4932569		
5	855884	3879470		
10	642723	3023586	12	12.75641
15	515512	2380863	14	14.28505
20	406221	1865351	14	14.92196
25	290825	1459130	14	14.70514
30	262091	1168305	16	17.11269
35	219365	906214	16	17.27144
40	183285	686849	18	18.62946
45	141067	503564	18	18.16621
50	107932	362497	18	19.78417
55	100112	254565		
60	154453	154453		
65	-	-		
70+	-	-		

MEDIAN MORTALITY LEVEL = 17.11269

BACKWARD PROJECTION OF THE 1979 MALE POPULATION TO 1969 DIFFERENT MORTALITY LEVELS

		LEVEL 8			LEVEL 10		
		reciprcl			reciprcl		
x	5N2x+10	10Sx,x+4	5N1*x	N1*x+	10Sx,x+4	5N1*x	N1*x+
0	1053099	1.216190	1280768.	5854514.	1.169974	1232098.	5689622.
5	855884	1.092645	935177.7	4573745.	1.075535	920533.0	4457524.
10	642723	1.086177	698111.1	3638568.	1.071880	688922.1	3536991.
15	515512	1.107444	570900.8	2940457.	1.090025	561921.1	2848069.
20	406221	1.122183	455854.4	2369556.	1.102147	447715.2	2286147.
25	290825	1.133157	329550.5	1913701.	1.111049	323120.9	1838432.
30	262091	1.153429	302303.4	1584151.	1.127548	295520.3	1515311.
35	219365	1.185298	260012.8	1281847.	1.153695	253080.4	1219791.
40	183285	1.229302	225312.5	1021835.	1.190845	218264.0	966710.7
45	141067	1.294482	182608.6	796522.1	1.246448	175832.6	748446.7
50	107932	1.402446	151368.8	613913.5	1.337578	144367.5	572614.0
55	100112	1.592915	159469.9	462544.7	1.497701	149937.8	428246.6
60	154453	1.962246	303074.8	303074.8	1.801899	278308.7	278308.7
65	-	2.737776	-	-	2.417444	-	-
70+	-	6.628662	-	-	5.824451	-	-

BACKWARD PROJECTION OF THE 1979 MALE POPULATION TO 1969 DIFFERENT MORTALITY LEVELS

		LEVEL 12			LEVEL 14		
		reciprcl			reciprcl		
x	5N2x+10	10Sx,x+4	5N1*x	N1*x+	10Sx,x+4	5N1*x	N1*x+
0	1053099	1.132259	1192381.	5552568.	1.098503	1156832.	5443726.
5	855884	1.060918	908022.7	4360187.	1.048185	897124.8	4286893.
10	642723	1.059591	681023.8	3452164.	1.049560	674576.5	3389769.
15	515512	1.075084	554218.6	2771140.	1.063174	548078.8	2715192.
20	406221	1.084999	440749.3	2216921.	1.071421	435233.7	2167113.
25	290825	1.092168	317629.8	1776172.	1.077319	313311.4	1731880.
30	262091	1.105534	289750.6	1458542.	1.088329	285241.2	1418568.
35	219365	1.126976	247219.2	1168792.	1.106244	242671.1	1133327.
40	183285	1.158480	212332.0	921572.6	1.133838	207815.5	890656.0
45	141067	1.205953	170120.1	709240.6	1.176415	165953.4	682840.4
50	107932	1.283022	138479.1	539120.5	1.245004	134375.8	516887.1
55	100112	1.419144	142073.4	400641.4	1.366214	136774.4	382511.2
60	154453	1.674088	258568.0	258568.0	1.591014	245736.9	245736.9
65	-	2.175001	-	-	2.025809	-	-
70+	-	5.190222	-	-	4.766899	-	-

BACKWARD PROJECTION OF THE 1979 MALE POPULATION TO 1969 DIFFERENT MORTALITY LEVELS

		LEVEL 16			LEVEL 18		
x	5N2x+10	reciprcl 10Sx,x+4	5N1*x	N1*x+	reciprcl 10Sx,x+4	5N1*x	N1*x+
0	1053099	1.071031	1127901.	5347376.	1.048174	1103831.	5260037.
5	855884	1.036957	887515.0	4219475.	1.027042	879028.8	4156206.
10	642723	1.040052	668465.6	3331960.	1.031247	662806.0	3277177.
15	515512	1.051635	542130.6	2663494.	1.040853	536572.5	2614371.
20	406221	1.058291	429899.9	2121364.	1.046036	424921.8	2077799.
25	290825	1.063083	309171.2	1691464.	1.049770	305299.2	1652877.
30	262091	1.072122	280993.4	1382292.	1.056937	277013.7	1347578.
35	219365	1.087217	238497.2	1101299.	1.069267	234559.8	1070564.
40	183285	1.111642	203747.3	862801.8	1.090465	199865.9	836004.0
45	141067	1.149769	162194.4	659054.5	1.124101	158573.5	636138.1
50	107932	1.210610	130663.5	496860.0	1.177274	127065.5	477564.6
55	100112	1.318339	131981.6	366196.5	1.271973	127339.8	350499.1
60	154453	1.516415	234214.9	234214.9	1.444836	223159.3	223159.3
65	-	1.894621	-	-	1.771322	-	-
70+	-	4.379434	-	-	4.007213	-	-

THE PROJECTED 1969 MALE POPULATION AGED x YEARS AND ABOVE OBTAINED USING DIFFERENT MORTALITY LEVELS

	LEVEL 8	LEVEL 10	LEVEL 12	LEVEL 14	LEVEL 16	LEVEL 18
x	N1*x+	N1*x+	N1*x+	N1*x+	N1*x+	N1*x+
0	5854514.	5689622.	5552568.	5443726.	5347376.	5260037.
5	4573745.	4457524.	4360187.	4286893.	4219475.	4156206.
10	3638568.	3536991.	3452164.	3389769.	3331960.	3277177.
15	2940457.	2848069.	2771140.	2715192.	2663494.	2614371.
20	2369556.	2286147.	2216921.	2167113.	2121364.	2077799.
25	1913701.	1838432.	1776172.	1731880.	1691464.	1652877.
30	1584151.	1515311.	1458542.	1418568.	1382292.	1347578.
35	1281847.	1219791.	1168792.	1133327.	1101299.	1070564.
40	1021835.	966710.7	921572.6	890656.0	862801.8	836004.0
45	796522.1	748446.7	709240.6	682840.4	659054.5	636138.1
50	613913.5	572614.0	539120.5	516887.1	496860.0	477564.6
55	462544.7	428246.6	400641.4	382511.2	366196.5	350499.1
60	303074.8	278308.7	258568.0	245736.9	234214.9	223159.3
65	-	-	-	-	-	-
70+	-	-	-	-	-	-

ESTIMATING THE MEDIAN MORTALITY LEVEL CORRESPONDING TO THE BACKWARD PROJECTIONS FOR KENYAN MALES

x	OBSERVED MALE 5N1x	N1(x)+	LOWER LEVEL	ESTIMATED LEVEL
0	1058102	5483281		
5	916599	4425179		
10	714707	3508580	10	10.66985
15	560152	2793873	10	11.40899
20	428915	2233721	10	11.51465
25	349594	1804806	10	11.08019
30	280948	1455212	12	12.16663
35	252136	1174264	10	11.78540
40	193936	922128	10	11.97539
45	172508	728192	10	11.03324
50	132466	555684	10	11.01094
55	114669	423218		
60	102466	308549		
65	74611	206083		
70+	131472	131472		

MEDIAN MORTALITY LEVEL = 11.40899

MEAN OF MEDIAN LEVELS = 14.26084

CUMULATING COHORT DEATHS FROM REGISTRATION DATA - MALES

x	deaths by age group,5dx 1969	1974	1979	cohort deaths,dx 1969-74	1974-79	cohort deaths 1969-79	CUM.,Dx
0	9136	14686	12663	-	-	-	-
5	579	1469	1129	3242.5	3250	6492.5	105593.8
10	185	718	621	1667.5	2715	4382.5	99101.25
15	210	482	582	1922.5	3385	5307.5	94718.75
20	246	559	604	2372.5	3625	5997.5	89411.25
25	249	703	795	2605	3957.5	6562.5	83413.75
30	225	793	747	2542.5	3992.5	6535	76851.25
35	206	792	790	2535	4102.5	6637.5	70316.25
40	198	808	805	2555	4530	7085	63678.75
45	261	824	833	2985	4447.5	7432.5	56593.75
50	223	933	988	2192.5	4240	6432.5	49161.25
55	136	654	846	3092.5	5065	8157.5	42728.75
60	249	1101	1042	14207.5	20363.75	34571.25	34571.25
65	161	806	925			-	-
70+	882	3159	4121			-	-

OBTAINING SURVIVAL RATIOS FOR THE ESTIMATED LEVEL - MALES

x	LEVEL 14 Sx	LEVEL 16 Sx	ESTIMATED S^x
0	.91033	.93368	.9133753
5	.95403	.96436	.9553772
10	.95278	.96149	.9539160
15	.94058	.9509	.9419259
20	.93334	.94492	.9348503
25	.92823	.94066	.9298511
30	.91884	.93273	.9206515
35	.90396	.91978	.9060232
40	.88196	.89957	.8842567
45	.85004	.86974	.8526093
50	.80321	.82603	.8061862
55	.73195	.75853	.7354166
60	.62853	.65945	.6325626
65	.49363	.52781	.4980877
70+	.20978	.22834	.2122006

ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR KENYAN MALES

x	OBSERVED 5N1x	5N1x.S^x	CUM. 5N1x.S^x	CUM. 5N1x	(Yi) S1x	(Xi) D*x
0	1058102	966444.2	4926305.	5513281	.8935342	
5	916599	875697.8	3959861.	4455179	.8888219	.0237013
10	714707	681770.4	3084163.	3538580	.8715821	.0280059
15	560152	527621.7	2402392.	2823873	.8507438	.0335421
20	428915	400971.3	1874771.	2263721	.8281810	.0394975
25	349594	325070.4	1473799.	1834806	.8032454	.0454619
30	280948	258655.2	1148729.	1485212	.7734445	.0517443
35	252136	228441.1	890073.9	1204264	.7391019	.0583894
40	193936	171489.2	661632.8	952128	.6948990	.0668805
45	172508	147081.9	490143.6	758192	.6464637	.0746430
50	132466	106792.3	343061.7	585684	.5857453	.0839382
55	144669	106392.0	236269.4	453218	.5213151	.0942786
60	102466	64816.16	129877.4	308549	.4209296	.1120446
65	74611	37162.82	65061.26	206083	.3157042	
70+	131472	27898.44	27898.44	131472	.2122006	
					8.624473	.7121273

$\bar{X}$ = .0593439 $\bar{Y}$ = .7187061

ESTIMATING THE COMPLETENESS OF DEATH REGISTRATION AND CENSUS COVERAGE FOR KENYAN MALES

age,x	$\bar{X}i$	$\bar{Y}i$	$\bar{X}i\bar{Y}i$	$(\bar{X}i)^2$
5	-.035643	.1701158	-.006063	.0012704
10	-.031338	.1528760	-.004791	.0009821
15	-.025802	.1320377	-.003407	.0006657
20	-.019846	.1094749	-.002173	.0003939
25	-.013882	.0845393	-.001174	.0001927
30	-.007600	.0547384	-.000416	.0000578
35	-.000955	.0203958	-.000019	.0000009
40	.0075365	-.023807	-.000179	.0000568
45	.0152991	-.072242	-.001105	.0002341
50	.0245942	-.132961	-.003270	.0006049
55	.0349346	-.197391	-.006896	.0012204
60	.0527007	-.297776	-.015693	.0027774
			-.045186	.0084570

b^= -5.34307 = -k2/k

a^= 1.035785 =k2/k1

let k1=1, then k2=1.035785 and k= .1938557

APPENDIX D

THE AGE RATIO TECHNIQUE

AGE RATIOS FOR SPECIFIC AGES - 1969

	females		males		combined sexes	
age,x	Nx	age ratio	Nx	age ratio	Nx	age ratio
0	180506		181280		361786	
1	208958		211025		419983	
2	233763		236092		469855	
3	210930		213745		424675	
4	212223		215960		428183	
5	192860	1.008353	199534	1.021971	392394	1.015233
6	200051	1.091150	205164	1.091571	405215	1.091363
7	167003	.9215708	171084	.9139732	338087	.9177104
8	187441	1.120761	190295	1.093473	377736	1.106846
9	146004	.8993794	150522	.8871226	296526	.8931156
10	165744	1.103334	177275	1.124273	343019	1.114057
11	108470	.7330238	113997	.7317299	222467	.7323602
12	154670	1.164156	169287	1.211213	323957	1.188281
13	114489	.8584681	123712	.8834622	238201	.8712699
14	120435	.9757953	130436	1.007271	250871	.9919108
15	110788	.8987871	122766	.9618672	233554	.9308764
16	113136	.9904315	117370	.9906932	230506	.9905647
17	95092	.8335510	100208	.8546772	195300	.8442587
18	131863	1.294775	128153	1.228256	260016	1.261113
19	93968	.9199832	91655	.8924989	185623	.9062039
20	134772	1.398388	124237	1.300199	259009	1.349504
21	77743	.7833735	80275	.8515073	158018	.8165659
22	88942	.9559976	84575	.9611254	173517	.9584901
23	69059	.7267716	68140	.7816605	137199	.7530338
24	79580	.9118524	70788	.8865389	150368	.8997580
25	103596	1.182927	91593	1.159860	195189	1.171990
26	82405	1.032499	66021	.9072844	148426	.9727820
27	62280	.7763282	58888	.8233976	121168	.7985127
28	95067	1.324058	75549	1.155959	170616	1.243958
29	64897	.8986401	57543	.8938205	122440	.8963686
30	121015	1.830009	103674	1.728309	224689	1.781635
31	35933	.5188753	36652	.5907163	72585	.5528247
32	61744	.9924981	60648	1.067532	122392	1.028313
33	37488	.5828268	39614	.6780444	77102	.6281483
34	43061	.7349598	40360	.7334621	83421	.7342344
35	74810	1.301852	72990	1.358087	147800	1.329029
36	49750	.9839989	45180	.9228280	94930	.9539055
37	37806	.7249556	37664	.7528027	75470	.7385906
38	59127	1.269416	53979	1.200496	113106	1.235564
39	43326	.9287659	42323	.9529868	85649	.9405787
40	85393	1.966579	77353	1.817483	162746	1.892778
41	26902	.6069631	27999	.6545676	54901	.6303425
42	39893	.9893925	39871	1.003913	79764	.9965978

age,x	females Nx	females age ratio	males Nx	males age ratio	combined sexes Nx	combined sexes age ratio
43	27352	.6612321	26285	.6427106	53637	.6520241
44	22396	.5791300	22428	.5805264	44824	.5798279
45	52859	1.415579	56886	1.560200	109745	1.487027
46	25321	.7514832	25779	.7592152	51100	.7553640
47	22725	.6775734	26460	.7951056	49185	.7361107
48	35710	1.198153	35893	1.203906	71603	1.201030
49	27237	.9137388	27490	.9166022	54727	.9151749
50	60480	2.215612	55049	1.919328	115529	2.063807
51	21393	.7651096	21187	.7400460	42580	.7524298
52	22747	.8516382	21918	.7956439	44665	.8232087
53	15532	.5700319	14656	.5259833	30188	.5477613
54	18920	.7579399	19656	.7709172	38576	.7644973
55	30528	1.201947	36889	1.446378	67417	1.324416
56	20407	.9457887	22503	.9876668	42910	.9672976
57	14165	.6542181	15692	.6773779	29857	.6661892
58	20889	1.047976	22363	1.032351	43252	1.039839
59	16246	.8146748	17222	.7843548	33468	.7987856
60	43209	2.466281	44798	2.275246	88007	2.365195
61	12138	.6619909	13459	.6693056	25597	.6658170
62	15902	.9451131	18194	.9819043	34096	.9643952
63	12280	.7171976	13553	.7132144	25833	.7151023
64	10979	.6732196	12462	.6853391	23441	.6796088
65	21665		24556		46221	
66	7614		9746		17360	
67	9070		11442		20512	
68	13510		15785		29295	
69	11448		13082		24530	
70+	121619		131472		253091	

AGE RATIOS INDICATING PREFERENCE FOR SPECIFIC AGES FOR 1969 MALES

	terminal digits					mean age
Age group	5/0	6/1	7/2	8/3	9/4	ratio
5-9	1.021971	1.091571	.9139732	1.093473	.8871226	1.001622
10-14	1.124273	.7317299	1.211213	.8834622	1.007271	.9915897
15-19	.9618672	.9906932	.8546772	1.228256	.8924989	.9855984
20-24	1.300199	.8515073	.9611254	.7816605	.8865389	.9562062
25-29	1.159860	.9072844	.8233976	1.155959	.8938205	.9880644
30-34	1.728309	.5907163	1.067532	.6780444	.7334621	.9596128
35-39	1.358087	.9228280	.7528027	1.200496	.9529868	1.037440
40-44	1.817483	.6545676	1.003913	.6427106	.5805264	.9398402
45-49	1.560200	.7592152	.7951056	1.203906	.9166022	1.047006
50-54	1.919328	.7400460	.7956439	.5259833	.7709172	.9503836
55-59	1.446378	.9876668	.6773779	1.032351	.7843548	.9856257
60-64	2.275246	.6693056	.9819043	.7132144	.6853391	1.065002

ABSOLUTE DEVIATIONS OF AGE RATIOS FROM ONE - 1969 MALES

	terminal digits					mean dev.	mean dev.
Age group	5/0	6/1	7/2	8/3	9/4	from one	from one
5-9	.0219715	.0915713	.0860268	.0934735	.1128774	.0811841	
10-14	.1242728	.2682701	.2112130	.1165378	.0072706	.1455129	.1133485
15-19	.0381328	.0093068	.1453228	.2282556	.1075011	.1057038	
20-24	.3001989	.1484927	.0388746	.2183395	.1134611	.1638734	.1347886
25-29	.1598602	.0927156	.1766024	.1559594	.1061795	.1382634	
30-34	.7283090	.4092837	.0675322	.3219556	.2665379	.3587237	.2484935
35-39	.3580874	.0771720	.2471973	.2004964	.0470132	.1859933	
40-44	.8174833	.3454324	.0039128	.3572894	.4194736	.3887183	.2873558
45-49	.5602004	.2407848	.2048944	.2039056	.0833978	.2586366	
50-54	.9193275	.2599540	.2043561	.4740167	.2290828	.4173474	.3379920
55-59	.4463779	.0123332	.3226221	.0323513	.2156452	.2058659	
60-64	1.275246	.3306944	.0180957	.2867856	.3146609	.4450965	.3254812

Sum. of mean dev. from one= 1.447460

THE AGE RATIO TECHNIQUE

AGE RATIOS FOR SPECIFIC AGES - 1979

	females		males		combined sexes	
age,x	N(x)	R(x)	N(x)	R(x)	N(x)	R(x)
0	282758		280392		563150	
1	276166		277405		553571	
2	294006		294907		588913	
3	287189		287111		574300	
4	281266		282206		563472	
5	268619	1.014636	271048	1.021005	539667	1.017825
6	268300	1.052590	267311	1.046763	535611	1.049674
7	234942	.9301237	235521	.9280219	470463	.9290703
8	253780	1.059276	251518	1.040350	505298	1.049770
9	219108	.9400767	221693	.9399602	440801	.9400181
10	249927	1.142251	256654	1.153481	506581	1.147913
11	183947	.8460161	175628	.7901458	359575	.8177731
12	219780	1.076382	229806	1.117718	449586	1.097121
13	182710	.8959302	190651	.9341154	373361	.9150305
14	187475	.9647776	198193	1.027676	385668	.9961080
15	169361	.8703068	183670	.9667407	353031	.9179457
16	188890	1.043566	187712	1.063669	376602	1.053490
17	171701	.9673443	154789	.8856133	326490	.9267938
18	195364	1.187671	181316	1.132173	376680	1.160294
19	162406	1.015803	146636	.9478237	309042	.9823722
20	203792	1.344768	178504	1.229887	382296	1.288568
21	133507	.8827715	125567	.8878868	259074	.8852434
22	131688	.9174984	125762	.9399042	257450	.9283084
23	113403	.8223127	110002	.8563486	223405	.8387267
24	103613	.8056641	101566	.8457335	205179	.8250130
25	145511	1.175605	134365	1.159996	279876	1.168059
26	95994	.8319330	93571	.8547654	189565	.8430488
27	110003	1.021063	111714	1.085200	221717	1.052402
28	97196	.9590616	85546	.8647421	182742	.9124713
29	92557	.9591319	89255	.9575206	181812	.9583403
30	156001	1.758521	136836	1.583048	292837	1.671923
31	70388	.7881665	74085	.8727742	144473	.8293966
32	70987	.8344069	78444	.9762751	149431	.9033152
33	54992	.6785475	59428	.7819052	114420	.7285680
34	60323	.7831186	56592	.7770691	116915	.7801787
35	89164	1.175312	81383	1.152814	170547	1.164468
36	65843	.9869961	56076	.8858558	121919	.9377519
37	54281	.8349883	52588	.8592810	106869	.8467682
38	53697	.8655767	49236	.8472750	102933	.8567248
39	62382	1.044907	50944	.9140315	113326	.9817172
40	109747	1.991237	91722	1.751944	201469	1.874664
41	41144	.7315087	38593	.7277030	79737	.7296618
42	41802	.7861745	49582	.9896903	91384	.8849045
43	40683	.7869265	44202	.8964341	84885	.8403848
44	40326	.7789107	37381	.7567663	77707	.7680986
45	61828	1.213680	63559	1.322322	125387	1.266423
46	31865	.6817341	35050	.7770809	66915	.7285581

	females		males		combined sexes	
age,x	N(x)	R(x)	N(x)	R(x)	N(x)	R(x)
47	35761	.7948090	37710	.8536213	73471	.8239458
48	38434	.8965997	39310	.9440102	77744	.9199613
49	54077	1.354512	43285	1.093282	97362	1.224442
50	75587	2.044887	63827	1.706331	139414	1.874602
51	37769	1.031855	33598	.9204705	71367	.9762407
52	27561	.7547650	31971	.8930272	59532	.8232123
53	23207	.6519040	25832	.7391574	49039	.6951282
54	26898	.7625555	27680	.8158213	54578	.7886709
55	32239	.9378564	36065	1.084039	68304	1.009752
56	20401	.6716710	24279	.7981289	44680	.7349482
57	20787	.7473171	26421	.9371974	47208	.8428946
58	22235	.8554160	23043	.8688390	45278	.8621950
59	38872	1.674954	30969	1.263020	69841	1.463325
60	50435	2.222247	45071	1.850471	95506	2.029797
61	23732	1.034904	23549	.9805832	47281	1.007117
62	12575	.5451724	13456	.5613239	26031	.5534036
63	10786	.4795248	11894	.5155144	22680	.4977483
64	11990	.5459405	13740	.6110876	25730	.5788969
65	33338	1.774383	40149	2.064927	73487	1.922143
66	7897	.4571478	11131	.5876173	19028	.5253872
67	10589	.6719548	13752	.7822348	24341	.7301081
68	13268	.8931012	15861	.9441858	29129	.9202109
69	18129	1.298490	19013	1.180917	37142	1.235521
70	28484		26966		55450	
71	9854		11046		20900	
72	11264		12548		23812	
73	6230		7747		13977	
74	6702		8062		14764	
75	86597		87766		174363	
NS	13833		15652		29485	

AGE RATIOS INDICATING PREFERENCE FOR SPECIFIC AGES FOR 1979 FEMALES

Age group	terminal digits 5/0	6/1	7/2	8/3	9/4	mean age ratio
5-9	1.014636	1.052590	.9301237	1.059276	.9400767	.9993405
10-14	1.142251	.8460161	1.076382	.8959302	.9647776	.9850713
15-19	.8703068	1.043566	.9673443	1.187671	1.015803	1.016938
20-24	1.344768	.8827715	.9174984	.8223127	.8056641	.9546029
25-29	1.175605	.8319330	1.021063	.9590616	.9591319	.9893589
30-34	1.758521	.7881665	.8344069	.6785475	.7831186	.9685520
35-39	1.175312	.9869961	.8349883	.8965997	1.044907	.9877607
40-44	1.991237	.7315087	.7861745	.7869265	.7789107	1.014951
45-49	1.213680	.6817341	.7948090	.8965997	1.354512	.9882669
50-54	2.044887	1.031855	.7547650	.6519040	.7625555	1.049193
55-59	.9378564	.6716710	.7473171	.8554160	1.674954	.9774429
60-64	2.222247	1.034904	.5451724	.4795248	.5459405	.9655576
65-69	1.774383	.4571478	.6719548	.8931012	1.298490	1.019015

ABSOLUTE DEVIATIONS OF AGE RATIOS FROM ONE - 1979 FEMALES

Age group	terminal digits 5/0	6/1	7/2	8/3	9/4	mean dev. from one	mean dev. from one
5-9	.0146360	.0525903	.0698763	.0592757	.0599233	.0512603	
10-14	.1422509	.1539839	.0763816	.1040698	.0352224	.1023817	.0768210
15-19	.1296932	.0435664	.0326557	.1876715	.0158032	.0818780	
20-24	.3447676	.1172285	.0825016	.1776873	.1943359	.1833042	.1325911
25-29	.1756052	.1680670	.0210630	.0409384	.0408681	.0893083	
30-34	.7585206	.2118335	.1655931	.3214525	.2168814	.3348562	.2120823
35-39	.1753122	.0130039	.1650117	.1034003	.0449071	.1003271	
40-44	.9912365	.2684913	.2138255	.2130735	.2210893	.3815432	.2409351
45-49	.2136797	.3182659	.2051910	.1034003	.3545121	.2390098	
50-54	1.044887	.0318553	.2452350	.3480960	.2374445	.3815036	.3102567
55-59	.0621436	.3283290	.2526829	.1445840	.6749541	.2925387	
60-64	1.222247	.0349038	.4548276	.5204752	.4540595	.5373026	.4149206
65-69	.7743833	.5428522	.3280452	.1068988	.2984901	.4101339	

Sum of mean dev. from one = 1.387607

AGE RATIOS INDICATING PREFERENCE FOR SPECIFIC AGES FOR 1979 MALES

Age group	terminal digits 5/0	6/1	7/2	8/3	9/4	mean age ratio
5-9	1.021005	1.046763	.9280219	1.040350	.9399602	.9952200
10-14	1.153481	.7901458	1.117718	.9341154	1.027676	1.004627
15-19	.9667407	1.063669	.8856133	1.132173	.9478237	.9992040
20-24	1.229887	.8878868	.9399042	.8563486	.8457335	.9519521
25-29	1.159996	.8547654	1.085200	.8647421	.9575206	.9844449
30-34	1.583048	.8727742	.9762751	.7819052	.7770691	.9982144
35-39	1.152814	.8858558	.8592810	.8472750	.9140315	.9318514
40-44	1.751944	.7277030	.9896903	.8964341	.7567663	1.024508
45-49	1.322322	.7770809	.8536213	.9440102	1.093282	.9980633
50-54	1.706331	.9204705	.8930272	.7391574	.8158213	1.014961
55-59	1.084039	.7981289	.9371974	.8688390	1.263020	.9902449
60-64	1.850471	.9805832	.5613239	.5155144	.6110876	.9037961
65-69	2.064927	.5876173	.7822348	.9441858	1.180917	1.111976

ABSOLUTE DEVIATIONS OF AGE RATIOS FROM ONE - 1979 MALES

Age group	terminal digits 5/0	6/1	7/2	8/3	9/4	mean dev. from one	mean dev. from one
5-9	.0210049	.0467633	.0719781	.0403499	.0600398	.0480272	
10-14	.1534809	.2098542	.1177177	.0658846	.0276762	.1149227	.0814749
15-19	.0332593	.0636687	.1143867	.1321735	.0521763	.0791329	
20-24	.2298873	.1121132	.0600958	.1436514	.1542665	.1400028	.1095679
25-29	.1599960	.1452346	.0852004	.1352579	.0424794	.1136336	
30-34	.5830483	.1272258	.0237249	.2180948	.2229309	.2350049	.1743193
35-39	.1528137	.1141442	.1407190	.1527250	.0859685	.1292741	
40-44	.7519444	.2722970	.0103097	.1035659	.2432337	.2762702	.2027721
45-49	.3223221	.2229191	.1463787	.0559898	.0932819	.1681783	
50-54	.7063305	.0795295	.1069728	.2608426	.1841787	.2675708	.2178746
55-59	.0840389	.2018711	.0628026	.1311610	.2630201	.1485788	
60-64	.8504711	.0194168	.4386761	.4844856	.3889124	.4363924	.2924856
65-69	1.064927	.4123827	.2177652	.0558142	.1809170	.1119764	

Sum of mean dev. from one = 1.078494

APPENDIX E

DETECTING AGE MISREPORTING FOR KENYAN MALES (ASGRT)

age,x	5N1(x) (1)	5N2(x) (2)	5N'(x) (3)	5C(x) (4)	5r(x) (5)	SUM. 5r(x) (6)	5Cx/5Co (7)
0	1058102	1424954	1227903.	.1902729	.0297663		1
5	916599	1249662	1070252.	.1658436	.0309958	.0309958	.8716092
10	714707	1053099	867558.2	.1344347	.0387620	.0697578	.7065362
15	560152	855884	692405.3	.1072934	.0423927	.1121505	.5638924
20	428915	642723	525046.2	.0813599	.0404455	.1525960	.4275957
25	349594	515512	424523.1	.0657831	.0388388	.1914348	.3457301
30	280948	406221	337826.8	.0523488	.0368728	.2283076	.2751249
35	252136	290825	270790.4	.0419610	.0142753	.2425829	.2205307
40	193936	262091	225452.6	.0349356	.0301164	.2726992	.1836078
45	172508	219365	194530.8	.0301440	.0240293	.2967286	.1584251
50	132466	183285	155817.3	.0241451	.0324716	.3292002	.1268970
55	114669	141067	127185.0	.0197083	.0207185	.3499187	.1035790
60	102466	107932	105163.5	.0162959	.0051970	.3551158	.0856448
65	74611	100112	86426.02	.0133924	.0294002	.3845159	.0703850
70+	131472	154453	142500.0	.0220814	.0161096		.1160515
	5483281	7607185	6453380.				

assume e(70) = 7.4165

source: Mudaki,1986

DETECTING AGE MISREPORTING FOR KENYAN MALES (ASGRT)

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.97566	1.091111	-
5	1.014597	10.97566	1	-
10	.9791397	9.961060	.9075594	12.67829
15	.9572359	8.981921	.8183493	12.82378
20	.8928870	8.024685	.7311348	12.86903
25	.8802017	7.131798	.6497832	13.38416
30	.8464042	6.251596	.5695874	13.51713
35	.7709927	5.405192	.4924709	13.63918
40	.7172489	4.634199	.4222252	14.18992
45	.7085832	3.916950	.3568762	14.88934
50	.6536772	3.208367	.2923166	15.26247
55	.6094441	2.554690	.2327596	15.76175
60	.5376512	1.945246	.1772328	16.20987
65	.4817742	1.407595	.1282470	16.83338
70+		.9258204	.0843522	

Tx/T5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS FOR THE NORTH MODEL - MALES

age,x	LEVEL 12	LEVEL 13	LEVEL 14	LEVEL 15	LEVEL 16	LEVEL 17
0	1.08049	1.07786	1.0755	1.07324	1.07111	1.06908
5	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90604	.90828	.91031	.91237	.91438	.91634
15	.81498	.81907	.82285	.8266	.83032	.83399
20	.72619	.73188	.73714	.7424	.74763	.75283
25	.64026	.64729	.65378	.6603	.66682	.67331
30	.55767	.56574	.57318	.58067	.5882	.59574
35	.47848	.4873	.49539	.50359	.51186	.52018
40	.40288	.41214	.42059	.4292	.43794	.44677
45	.33126	.34063	.34913	.35784	.36675	.3758
50	.26417	.27328	.28152	.29002	.29877	.30772
55	.20235	.21083	.21849	.22646	.23473	.24326
60	.14671	.15421	.161	.16813	.1756	.18338
65	.09849	.1047	.11034	.11633	.12268	.12936
70+						

source: Office of Population Research, Princeton University.

APPENDIX F

THE DEMENY - SHORTER METHOD - MALES

Let 5N1(x) - 1969 male population
5N2(x) - 1974 male population (estimated as geometric mean)
5N3(x) - 1979 male population

THE 1969, 1974 AND 1979 MALE POPULATIONS AND THE SURVIVAL RATIOS FOR LEVEL 14.10164 - MALES, NORTH MODEL

	POPULATIONS			SURVIVAL RATIOS		
age,x	5N1(x)	5N3(x)	5N2(x)	LEVEL 14	LEVEL 15	*LEVEL*
	(1)	(2)	(3)	(4)	(5)	(6)
0	1058102	1424954	1227903.	.9347	.94381	.9378862
5	916599	1249662	1070252.	.97392	.97724	.9750812
10	714707	1053099	867558.2	.97958	.98166	.9803075
15	560152	855884	692405.3	.97264	.97507	.9734899
20	428915	642723	525046.2	.96704	.96907	.9680648
25	349594	515512	424523.1	.96515	.96826	.9662377
30	280948	406221	337826.8	.96174	.96513	.9629257
35	252136	290825	270790.4	.95539	.95927	.9567470
40	193936	262091	225452.6	.94617	.95061	.9477229
45	172508	219365	194530.8	.93213	.93704	.9338473
50	132466	183285	155817.3	.91193	.91761	.9139166
55	114669	141067	127185.0	.88078	.88756	.8831513
60	102466	107932	105163.5	.83102	.83936	.8339369
65	74611	100112	86426.02	.75634	.767	.7600683
70+	131472	154453	142500.0	.5289292	.5383947	.5322397
	5483281	7607185	6453380.			

LEVEL -Mortality level 14.34975- Males: North model (Mudaki,1986)

OBTAINING CORRECTION FACTORS FOR 1969 AND 1974 - MALES

age, x	5N1(x) (1)	5N2(x) (2)	SURV. RATIOS (3)	CORRECTION FACTORS (4)	CORRECTED 1969 (5)	POP. 1974 (6)	FINAL CORRECTION FACTORS (7)
0	1058102	1227903.	.9378862	1	1058102	1227903.	1.031890
5	916599	1070252.	.9750812	.9272391	849906.4	992379.3	.9568091
10	714707	867558.2	.9803075	.9552417	682717.9	828727.7	.9857047
15	560152	692405.3	.9734899	.9665920	541438.5	669273.5	.9974170
20	428915	525046.2	.9680648	1.003883	430580.4	527084.9	1.035897
25	349594	424523.1	.9662377	.9818774	343258.5	416829.7	1.013190
30	280948	337826.8	.9629257	.9817730	275827.2	331669.3	1.013082
35	252136	270790.4	.9567470	.9808362	247304.1	265601.0	1.012115
40	193936	225452.6	.9477229	1.049478	203531.5	236607.5	1.082946
45	172508	194530.8	.9338473	.9915730	171054.3	192891.5	1.023195
50	132466	155817.3	.9139166	1.025166	135799.6	159738.6	1.057859
55	114669	127185.0	.8831513	.9758192	111896.2	124109.5	1.006938
60	102466	105163.5	.8339369	.9396920	96286.48	98821.29	.9696591
65	74611	86426.02	.7600683	.9290819	69319.73	80296.85	.9587107
70+	131472	142500.0	.5322397	.7264732	95510.89	103522.4	.7496407
	5483281	6453380.			5312534.	6255456.	

The ratio of enumerated to corrected totals is 1.031890

OBTAINING CORRECTION FACTORS FOR 1969 AND 1974 - MALES

age, x	5N1(x) (1)	5N2(x) (2)	SURV. RATIOS (3)	CORRECTION FACTORS (4)	CORRECTED 1969 (5)	POP. 1974 (6)	FINAL CORRECTION FACTORS (7)
0	1227903.	1424954	.9378862	1	1227903.	1424954	1.047342
5	1070252.	1249662	.9750812	.9215561	986297.1	1151634.	.9651848
10	867558.2	1053099	.9803075	.9132282	792278.6	961719.7	.9564627
15	692405.3	855884	.9734899	.9074555	628327.0	776676.7	.9504167
20	525046.2	642723	.9680648	.9516853	499678.8	611670.0	.9967404
25	424523.1	515512	.9662377	.9383320	398343.7	483721.4	.9827549
30	337826.8	406221	.9629257	.9475007	320091.2	384894.7	.9923576
35	270790.4	290825	.9567470	1.059826	286990.8	308224.0	1.110001
40	225452.6	262091	.9477229	1.047642	236193.7	274577.6	1.097240
45	194530.8	219365	.9338473	1.020428	198504.6	223846.2	1.068737
50	155817.3	183285	.9139166	1.011392	157592.4	185373.0	1.059274
55	127185.0	141067	.8831513	1.020978	129853.0	144026.3	1.069313
60	105163.5	107932	.8339369	1.062520	111738.3	114679.9	1.112822
65	86426.02	100112	.7600683	.9307842	80443.97	93182.67	.9748498
70+	142500.0	154453	.5322397	.7778122	110838.2	120135.4	.8146357
	6453380.	7607185			6165075.	7259315.	

The ratio of enumerated to corrected totals is 1.047342

APPENDIX G

ADJUSTING FOR AGE HEAPING ON MULTIPLES OF FIVE. - 1979: SGT

	females		males		combined sexes	
	Nx	5N'x	Nx	5N'x	Nx	5N'x
age,x	(1)	(2)	(3)	(4)	(5)	(6)
0	282758	1412011.	280392	1411750.	563150	2823761.
1	276166		277405		553571	
2	294006		294907		588913	
3	287189		287111		574300	
4	281266		282206		563472	
5	268619	1240950.	271048	1241456.	539667	2482406.
6	268300		267311		535611	
7	234942		235521		470463	
8	253780		251518		505298	
9	219108		221693		440801	
10	249927	996130.8	256654	1019497.	506581	2015628.
11	183947		175628		359575	
12	219780		229806		449586	
13	182710		190651		373361	
14	187475		198193		385668	
15	169361	902987	183670	853608.7	353031	1756596.
16	188890		187712		376602	
17	171701		154789		326490	
18	195364		181316		376680	
19	162406		146636		309042	
20	203792	638251.4	178504	608658.6	382296	1246910
21	133507		125567		259074	
22	131688		125762		257450	
23	113403		110002		223405	
24	103613		101566		205179	
25	145511	509469.1	134365	488680.2	279876	998149.3
26	95994		93571		189565	
27	110003		111714		221717	
28	97196		85546		182742	
29	92557		89255		181812	
30	156001	346516.8	136836	355823.6	292837	702340.3
31	70388		74085		144473	
32	70987		78444		149431	
33	54992		59428		114420	
34	60323		56592		116915	
35	89164	300876	81383	270930.2	170547	571806.2
36	65843		56076		121919	
37	54281		52588		106869	
38	53697		49236		102933	
39	62382		50944		113326	
40	109747	220611.1	91722	222016.2	201469	442627.3
41	41144		38593		79737	
42	41802		49582		91384	
43	40683		44202		84885	
44	40326		37381		77707	
45	61828	203017	63559	198540.8	125387	401557.8

	females		males		combined sexes	
	Nx	5N'x	Nx	5N'x	Nx	5N'x
age,x	(1)	(2)	(3)	(4)	(5)	(6)
46	31865		35050		66915	
47	35761		37710		73471	
48	38434		39310		77744	
49	54077		43285		97362	
50	75587	154452.7	63827	156665.8	139414	311118.4
51	37769		33598		71367	
52	27561		31971		59532	
53	23207		25832		49039	
54	26898		27680		54578	
55	32239	130069.3	36065	133585.1	68304	263654.4
56	20401		24279		44680	
57	20787		26421		47208	
58	22235		23043		45278	
59	38872		30969		69841	
60	50435	82617.78	45071	86241.44	95506	168859.2
61	23732		23549		47281	
62	12575		13456		26031	
.63	10786		11894		22680	
64	11990		13740		25730	
65	33338	65694.56	40149	77817.56	73487	143512.1
66	7897		11131		19028	
67	10589		13752		24341	
68	13268		15861		29129	
69	18129		19013		37142	
70	28484	46540.78	26966	53417	55450	99957.78
71	9854		11046		20900	
72	11264		12548		23812	
73	6230		7747		13977	
74	6702		8062		14764	
75+	86597	86597	87766	87766	174363	174363
NS	13833		15652		29485	

ADJUSTED 5-YEAR AGE GROUPS - 1979 CENSUS

age,x	female 5N'x (1)	male 5N'x (2)	combined 5N'x (3)
0	1412011.	1411750.	2823761.
5	1240950.	1241456.	2482406.
10	996130.8	1019497.	2015628.
15	902987	853608.7	1756596.
20	638251.4	608658.6	1246910
25	509469.1	488680.2	998149.3
30	346516.8	355823.6	702340.3
35	300876	270930.2	571806.2
40	220611.1	222016.2	442627.3
45	203017	198540.8	401557.8
50	154452.7	156665.8	311118.4
55	130069.3	133585.1	263654.4
60	82617.78	86241.44	168859.2
65	65694.56	77817.56	143512.1
70	46540.78	53417	99957.78
75+	86597	87766	174363
	7336792.	7266455.	14603247

The ratio of enumerated to estimated totals is:1. 1.052224(Females)

2. 1.046891 (males)

3. 1.049570(combined

APPENDIX H

THE EFFECT OF CHANGES IN CENSUS COVERAGE

Let 5N1(x) - 1969 female population
5N2(x) - 1974 female population (estimated as geometric mean)
5N3(x) - 1979 female population
5N3'(x) - 1979 female population adjusted for coverage

ASSUME k2/k1 = 0.95: FEMALES

	FEMALE POPULATIONS				SURVIVAL RATIOS		
age,x	5N1(x)	5N3(x)	5N3'(x)	5N2(x)	LEVEL 14	LEVEL 15	*LEVEL*
0	1046380	1423936	1498880	1252357.	.93907	.94852	.9400305
5	893359	1246983	1312614.	1082883.	.97519	.97879	.9755559
10	663808	1025677	1079660	846573.7	.9811	.98345	.9813389
15	544847	889316	936122.1	714173.2	.97812	.98056	.9783680
20	450096	687234	723404.2	570614.9	.97432	.97704	.9745965
25	411245	542233	570771.6	484486.3	.97042	.97358	.9707412
30	299241	413432	435191.6	360870.0	.9661	.96972	.9664679
35	264819	325951	343106.3	301431.7	.96118	.96501	.9615693
40	201936	274193	288624.2	241420.0	.95619	.95998	.9565752
45	163852	222363	234066.3	195837.3	.94737	.95131	.9477705
50	139072	191365	201436.8	167374.5	.93104	.93576	.9315197
55	102235	134776	141869.5	120432.7	.90313	.90929	.9037561
60	94508	109715	115489.5	104473.3	.85614	.86418	.8569572
65	63307	83370	87757.89	74536.49	.78471	.79498	.7857538
70+	121619	149403	157266.3	138298.9	.5537253	.5625247	.5546197
	5460324	7719947	8126260	6655763.			

LEVEL - Mortality level 14.10164- Females: North model (Mudaki,1986)

OBTAINING CORRECTION FACTORS FOR THE 1969 AND 1974 FEMALE POPULATIONS

age,x	5N1(x)	5N2(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1969	CORRECTED POP. 1974	FINAL CORRECTION FACTORS
0	1046380	1252357.	.9400305	1	1046380	1252357.	1.161415
5	893359	1082883.	.9755559	.9083431	811476.4	983629.1	1.054963
10	663808	846573.7	.9813389	.9351114	620734.4	791640.6	1.086053
15	544847	714173.2	.9783680	.8529455	464724.8	609150.8	.9906239
20	450096	570614.9	.9745965	.7968104	358641.2	454671.9	.9254277
25	411245	484486.3	.9707412	.7214454	296690.8	349530.4	.8378977
30	299241	360870.0	.9664679	.7980990	238824.0	288010.0	.9269244
35	264819	301431.7	.9615693	.7657313	202780.2	230815.7	.8893320
40	201936	241420.0	.9565752	.8076680	163097.2	194987.2	.9380379
45	163852	195837.3	.9477705	.7966552	130533.6	156014.8	.9252475
50	139072	167374.5	.9315197	.7391559	102795.9	123715.8	.8584669
55	102235	120432.7	.9037561	.7951032	81287.38	95756.40	.9234450
60	94508	104473.3	.8569572	.7031838	66456.50	73463.96	.8166884
65	63307	74536.49	.7857538	.7640602	48370.36	56950.37	.8873912
70+	121619	138298.9	.5546197	.5364720	65245.19	74193.47	.6230668
	5460324	6655763.			4698038.	5734088.	

The ratio of enumerated to corrected totals is 1.161415

OBTAINING CORRECTION FACTORS FOR THE 1974 AND 1979 FEMALE POPULATIONS

age,x	5N2(x)	5N3(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1974	CORRECTED POP. 1979	FINAL CORRECTION FACTORS
0	1252357.	1498880	.9400305	1	1252357.	1498880	1.183818
5	1082883.	1312614.	.9755559	.8968776	971213.3	1177254.	1.061740
10	846573.7	1079660	.9813389	.8775660	742924.2	947472.9	1.038878
15	714173.2	936122.1	.9783680	.7788091	556204.6	729060.4	.9219680
20	570614.9	723404.2	.9745965	.7522389	429238.7	544172.8	.8905137
25	484486.3	570771.6	.9707412	.7329281	355093.6	418334.5	.8676532
30	360870.0	435191.6	.9664679	.7920741	285835.8	344704.0	.9376714
35	301431.7	343106.3	.9615693	.8051473	242696.9	276251.1	.9531476
40	241420.0	288624.2	.9565752	.8085597	195202.5	233369.9	.9571873
45	195837.3	234066.3	.9477705	.7977477	156228.7	186725.9	.9443878
50	167374.5	201436.8	.9315197	.7350640	123031.0	148069.0	.8701818
55	120432.7	141869.5	.9037561	.8078255	97288.57	114605.8	.9563181
60	104473.3	115489.5	.8569572	.7613260	79538.27	87925.14	.9012712
65	74536.49	87757.89	.7857538	.7766925	57891.93	68160.89	.9194623
70+	138298.9	157266.3	.5546197	.5646361	78088.53	88798.24	.6684263
	6655763.	8126260			5622834.	6863784.	

The ratio of enumerated to corrected totals is 1.183818

THE ENUMERATED AND THE CORRECTED 1969 AND 1979 FEMALE POPULATIONS

	ENUMERATED POP.		CORR.	CORRECTED POP.	
age,x	5N1(x)	5N3(x)	FACTORSei	5N1*(x)	5N3*(x)
0	1046380	1498880	1.172616	1227002.	1757611.
5	893359	1312614.	1.058352	945487.9	1389207.
10	663808	1079660	1.062465	705273.0	1147101.
15	544847	936122.1	.9562960	521035.0	895209.8
20	450096	723404.2	.9079707	408674.0	656829.8
25	411245	570771.6	.8527755	350699.7	486740.0
30	299241	435191.6	.9322979	278981.7	405728.2
35	264819	343106.3	.9212398	243961.8	316083.2
40	201936	288624.2	.9476126	191357.1	273503.9
45	163852	234066.3	.9348177	153171.7	218809.3
50	139072	201436.8	.8643243	120203.3	174106.8
55	102235	141869.5	.9398816	96088.79	133340.5
60	94508	115489.5	.8589798	81180.47	99203.13
65	63307	87757.89	.9034268	57193.24	79282.83
70+	121619	157266.3	.6457465	78535.05	101554.2
	5460324	8126260		5458845.	8134311.

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM.

						SUM.	
age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	5r(x)	5Cx/5Co
0	1227002.	1757611.	1468534.	.2205504	.0359382		1
5	945487.9	1389207.	1146071.	.1721215	.0384787	.0384787	.7804180
10	705273.0	1147101.	899455.2	.1350838	.0486409	.0871196	.6124849
15	521035.0	895209.8	682960.9	.1025698	.0541241	.1412436	.4650629
20	408674.0	656829.8	518101.6	.0778106	.0474507	.1886944	.3528018
25	350699.7	486740.0	413158.0	.0620497	.0327800	.2214744	.2813404
30	278981.7	405728.2	336438.3	.0505277	.0374537	.2589281	.2290980
35	243961.8	316083.2	277690.9	.0417047	.0258994	.2848275	.1890939
40	191357.1	273503.9	228772.6	.0343580	.0357175	.3205449	.1557830
45	153171.7	218809.3	183072.1	.0274945	.0356641	.3562090	.1246632
50	120203.3	174106.8	144665.9	.0217265	.0370484	.3932574	.0985104
55	96088.79	133340.5	113192.4	.0169997	.0327633	.4260208	.0770785
60	81180.47	99203.13	89740.49	.0134776	.0200495	.4460703	.0611089
65	57193.24	79282.83	67338.26	.0101131	.0326586	.4787288	.0458541
70+	78535.05	101554.2	89306.00	.0134123	.0257047		.0608130
	5458845.	8134311.	6658498.				

Assume e(70) = 7.612
source: Mudaki,1986

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM.

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.93347	1.091462	-
5	.9399924	10.93347	1	-
10	.9172365	9.993482	.9140262	13.77485
15	.9004784	9.076246	.8301337	13.78290
20	.8805942	8.175767	.7477739	13.76614
25	.8581959	7.295173	.6672328	13.74927
30	.8329732	6.436977	.5887403	13.72793
35	.8055118	5.604004	.5125547	13.69847
40	.7741302	4.798492	.4388808	13.65440
45	.7405148	4.024362	.3680771	13.60180
50	.7018174	3.283847	.3003480	13.53333
55	.6538417	2.582030	.2361582	13.44407
60	.5915405	1.928188	.1763564	13.31994
65	.5063898	1.336648	.1222528	13.12254
70+		.8302579	.0759372	

Tx/T5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS - NORTH MODEL FEMALES.

age,x	LEVEL 11	LEVEL 12	LEVEL 13	LEVEL 14	LEVEL 15
0	1.07944	1.07666	1.07415	1.07181	1.06962
5	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90781	.91028	.91243	.91449	.91648
15	.81877	.82329	.82719	.83095	.83461
20	.7321	.73838	.74379	.74899	.7541
25	.64799	.65575	.66243	.66884	.67516
30	.56676	.57569	.58339	.59074	.59805
35	.48876	.49853	.50696	.51497	.52297
40	.41432	.42456	.43341	.44177	.45018
45	.34371	.35405	.36301	.37143	.37995
50	.27709	.28719	.29598	.30417	.31254
55	.21485	.2244	.23273	.24045	.2484
60	.15789	.16655	.17412	.18111	.18838
65	.10765	.11504	.12152	.1275	.13379
70+					

source: Office of Population Research, Princeton University.

ASSUME k2/k1 = 1.05: FEMALES

age,x	5N1(x)	5N3(x)	5N3'(x)	5N2(x)	SURVIVAL RATIOS LEVEL 14	LEVEL 15	*LEVEL*
	FEMALE POPULATIONS						
0	1046380	1423936	1356130.	1191229.	.93907	.94852	.9400305
5	893359	1246983	1187603.	1030027.	.97519	.97879	.9755559
10	663808	1025677	976835.2	805252.2	.9811	.98345	.9813389
15	544847	889316	846967.6	679314.2	.97812	.98056	.9783680
20	450096	687234	654508.6	542763.0	.97432	.97704	.9745965
25	411245	542233	516412.4	460838.4	.97042	.97358	.9707412
30	299241	413432	393744.8	343255.8	.9661	.96972	.9664679
35	264819	325951	310429.5	286718.7	.96118	.96501	.9615693
40	201936	274193	261136.2	229636.2	.95619	.95998	.9565752
45	163852	222363	211774.3	186278.4	.94737	.95131	.9477705
50	139072	191365	182252.4	159204.9	.93104	.93576	.9315197
55	102235	134776	128358.1	114554.3	.90313	.90929	.9037561
60	94508	109715	104490.5	99373.97	.85614	.86418	.8569572
65	63307	83370	79400	70898.35	.78471	.79498	.7857538
70+	121619	149403	142288.6	131548.4	.5537253	.5625247	.5546197
	5460324	7719947	7352330.	6330893.			

LEVEL - Mortality level 14.10164- Females: North model (Mudaki,1986)

OBTAINING CORRECTION FACTORS FOR THE 1969 AND 1974 FEMALE POPULATIONS

age,x	5N1(x)	5N2(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1969	1974	FINAL CORRECTION FACTORS
0	1046380	1191229.	.9400305	1	1046380	1191229.	.9644339
5	893359	1030027.	.9755559	.9549547	853117.3	983629.1	.9209907
10	663808	805252.2	.9813389	1.033544	686074.9	832263.7	.9967850
15	544847	679314.2	.9783680	.9911053	540000.8	673271.9	.9558556
20	450096	542763.0	.9745965	.9733889	438118.4	528319.5	.9387692
25	411245	460838.4	.9707412	.9265476	381038.1	426988.7	.8935939
30	299241	343255.8	.9664679	1.077591	322459.3	369889.3	1.039265
35	264819	286718.7	.9615693	1.086942	287842.9	311646.6	1.048284
40	201936	229636.2	.9565752	1.205301	243393.7	276780.9	1.162434
45	163852	186278.4	.9477705	1.249873	204794.3	232824.4	1.205420
50	139072	159204.9	.9315197	1.219171	169552.5	194098.0	1.175810
55	102235	114554.3	.9037561	1.378748	140956.3	157941.5	1.329711
60	94508	99373.97	.8569572	1.281926	121152.3	127390.1	1.236333
65	63307	70898.35	.7857538	1.464383	92705.68	103822.3	1.412300
70+	121619	131548.4	.5546197	1.136478	138217.3	149501.9	1.096058
	5460324	6330893.			5665804.	6559597.	

The ratio of enumerated to corrected totals is .9644339

OBTAINING CORRECTION FACTORS FOR THE 1974 AND 1979 FEMALE POPULATIONS

age,x	5N2(x)	5N3(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1974	1979	FINAL CORRECTION FACTORS
0	1191229.	1356130.	.9400305	1	1191229.	1356130.	.9830380
5	1030027.	1187603.	.9755559	.9429008	971213.3	1119792.	.9269073
10	805252.2	976835.2	.9813389	.9699414	781047.4	947472.9	.9534892
15	679314.2	846967.6	.9783680	.9049604	614752.4	766472.1	.8896105
20	542763.0	654508.6	.9745965	.9189400	498766.6	601454.1	.9033529
25	460838.4	516412.4	.9707412	.9412946	433784.7	486096.2	.9253284
30	343255.8	393744.8	.9664679	1.069456	367097.0	421092.7	1.051316
35	286718.7	310429.5	.9615693	1.142892	327688.6	354787.5	1.123506
40	229636.2	261136.2	.9565752	1.206632	277086.4	315095.3	1.186165
45	186278.4	211774.3	.9477705	1.251587	233143.7	265054.0	1.230358
50	159204.9	182252.4	.9315197	1.212421	193023.4	220966.7	1.191856
55	114554.3	128358.1	.9037561	1.400809	160468.7	179805.2	1.377048
60	99373.97	104490.5	.8569572	1.387921	137923.2	145024.6	1.364379
65	70898.35	79400	.7857538	1.488593	105538.8	118194.3	1.463344
70+	131548.4	142288.6	.5546197	1.196141	157350.5	170197.2	1.175852
	6330893.	7352330.			6450114.	7467634.	

The ratio of enumerated to corrected totals is .9830380

THE ENUMERATED AND THE CORRECTED 1969 AND 1979 FEMALE POPULATIONS

age,x	ENUMERATED POP. 5N1(x)	5N3(x)	CORR. FACTORSei	CORRECTED POP. 5N1*(x)	5N3*(x)
0	1046380	1356130.	.9737360	1018898.	1320512.
5	893359	1187603.	.9239490	825418.2	1097284.
10	663808	976835.2	.9751371	647303.8	952548.3
15	544847	846967.6	.9227330	502748.3	781525.0
20	450096	654508.6	.9210611	414565.9	602842.4
25	411245	516412.4	.9094612	374011.4	469657.0
30	299241	393744.8	1.045290	312793.8	411577.6
35	264819	310429.5	1.085895	287565.6	337093.9
40	201936	261136.2	1.174299	237133.3	306652.1
45	163852	211774.3	1.217889	199553.6	257917.6
50	139072	182252.4	1.183833	164638.0	215756.4
55	102235	128358.1	1.353380	138362.8	173717.2
60	94508	104490.5	1.300356	122894.1	135874.8
65	63307	79400	1.437822	91024.21	114163.1
70+	121619	142288.6	1.135955	138153.7	161633.4
	5460324	7352330.		5475064.	7338755.

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1018898.	1320512.	1159943.	.1831439	.0259298		1
5	825418.2	1097284.	951692.5	.1502632	.0284704	.0284704	.8204651
10	647303.8	952548.3	785231.3	.1239806	.0386325	.0671029	.6769570
15	502748.3	781525.0	626825.6	.0989698	.0441157	.1112186	.5403937
20	414565.9	602842.4	499917.9	.0789323	.0374424	.1486610	.4309850
25	374011.4	469657.0	419114.6	.0661742	.0227716	.1714326	.3613236
30	312793.8	411577.6	358802.1	.0566514	.0274454	.1988780	.3093274
35	287565.6	337093.9	311346.5	.0491587	.0158910	.2147690	.2684154
40	237133.3	306652.1	269661.7	.0425770	.0257091	.2404782	.2324785
45	199553.6	257917.6	226866.4	.0358201	.0256557	.2661339	.1955842
50	164638.0	215756.4	188472.0	.0297579	.0270401	.2931740	.1624839
55	138362.8	173717.2	155035.5	.0244786	.0227550	.3159290	.1336579
60	122894.1	135874.8	129221.6	.0204029	.0100411	.3259701	.1114034
65	91024.21	114163.1	101939.2	.0160952	.0226502	.3486203	.0878830
70+	138153.7	161633.4	149433.1	.0235941	.0156964		.1288280
	5475064.	7338755.	6333503.				

Assume e(70) = 7.612
source: Mudaki,1986

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.95392	1.091292	-
5	.9399924	10.95392	1	-
10	.9172365	10.01392	.9141866	13.85273
15	.9004783	9.096687	.8304507	13.86720
20	.8805942	8.196209	.7482446	13.85666
25	.8581959	7.315614	.6678538	13.84615
30	.8329732	6.457419	.5895078	13.83235
35	.8055118	5.624445	.5134644	13.81203
40	.7741302	4.818933	.4399279	13.77966
45	.7405148	4.044803	.3692564	13.74185
50	.7018174	3.304289	.3016536	13.69275
55	.6538417	2.602471	.2375836	13.62871
60	.5915405	1.948629	.1778934	13.53983
65	.5063898	1.357089	.1238908	13.39645
70+		.8506991	.0776616	

Tx/T5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS - NORTH MODEL FEMALES.

age,x	LEVEL 11	LEVEL 12	LEVEL 13	LEVEL 14	LEVEL 15
0	1.07944	1.07666	1.07415	1.07181	1.06962
5	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90781	.91028	.91243	.91449	.91648
15	.81877	.82329	.82719	.83095	.83461
20	.7321	.73838	.74379	.74899	.7541
25	.64799	.65575	.66243	.66884	.67516
30	.56676	.57569	.58339	.59074	.59805
35	.48876	.49853	.50696	.51497	.52297
40	.41432	.42456	.43341	.44177	.45018
45	.34371	.35405	.36301	.37143	.37995
50	.27709	.28719	.29598	.30417	.31254
55	.21485	.2244	.23273	.24045	.2484
60	.15789	.16655	.17412	.18111	.18838
65	.10765	.11504	.12152	.1275	.13379
70+					

source: Office of Population Research,Princeton University.

Let 5N1(x) - 1969 male population
5N2(x) - 1974 male population (estimated as geometric mean)
5N3(x) - 1979 male population
5N3'(x) - 1979 male population (adjusted for coverage)

ASSUME k2/k1 = 0.95: MALES

	MALE POPULATIONS				SURVIVAL RATIOS		
age,x	5N1(x)	5N3(x)	5N3'(x)	5N2(x)	LEVEL 14	LEVEL 15	*LEVEL*
0	1058102	1424954	1499952.	1259802.	.9347	.94381	.9378862
5	916599	1249662	1315434.	1098055.	.97392	.97724	.9750812
10	714707	1053099	1108525.	890095.9	.97958	.98166	.9803075
15	560152	855884	900930.5	710392.9	.97264	.97507	.9734899
20	428915	642723	676550.5	538686.1	.96704	.96997	.9680648
25	349594	515512	542644.2	435551.6	.96515	.96826	.9662377
30	280948	406221	427601.1	346603.0	.96174	.96513	.9629257
35	252136	290825	306131.6	277825.1	.95539	.95927	.9567470
40	193936	262091	275885.3	231309.5	.94617	.95061	.9477229
45	172508	219365	230910.5	199584.4	.93213	.93704	.9338473
50	132466	183285	192931.6	159865.2	.91193	.91761	.9139166
55	114669	141067	148491.6	130489.0	.88078	.88756	.8831513
60	102466	107932	113612.6	107895.5	.83102	.83936	.8339369
65	74611	100112	105381.1	88671.22	.75634	.767	.7600683
70+	131472	154453	162582.1	146201.9	.5289292	.5383947	.5322397
	5483281	7607185	8007563.	6621029.			

LEVEL -Mortality level 14.34975- Males: North model (Mudaki,1986)

: OBTAINING CORRECTION FACTORS FOR THE 1974 AND 1979 MALE POPULATIONS

age,x	5N1(x)	5N2(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED 1969	POP. 1974	FINAL CORRECTION FACTORS
0	1058102	1259802.	.9378862	1	1058102	1259802.	1.130307
5	916599	1098055.	.9750812	.9037608	828386.3	992379.3	1.021527
10	714707	890095.9	.9803075	.9074796	648582.0	807743.9	1.025731
15	560152	710392.9	.9734899	.8950115	501342.5	635809.8	1.011638
20	428915	538686.1	.9680648	.9060042	388598.8	488051.8	1.024063
25	349594	435551.6	.9662377	.8637067	301946.7	376188.8	.9762539
30	280948	346603.0	.9629257	.8417476	236487.3	291752.3	.9514334
35	252136	277825.1	.9567470	.8196512	206663.6	227719.7	.9264577
40	193936	231309.5	.9477229	.8548061	165777.7	197724.8	.9661935
45	172508	199584.4	.9338473	.7871925	135797.0	157111.3	.8897693
50	132466	159865.2	.9139166	.7932538	105079.2	126813.7	.8966205
55	114669	130489.0	.8831513	.7359515	84390.83	96033.58	.8318513
60	102466	107895.5	.8339369	.6907599	70779.41	74529.87	.7807710
65	74611	88671.22	.7600683	.6656676	49666.13	59025.56	.7524089
70+	131472	146201.9	.5322397	.4952250	65108.22	72402.83	.5597564
	5483281	6621029.			4846708.	5863089.	

The ratio of enumerated to corrected totals is 1.130307

OBTAINING CORRECTION FACTORS FOR THE 1974 AND 1979

MALE POPULATIONS

age,x	5N2(x)	5N3'(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED 1974	POP. 1979	FINAL CORRECTION FACTORS
0	1259802.	1499952.	.9378862	1	1259802.	1499952.	1.147232
5	1098055.	1315434.	.9750812	.8982218	986297.1	1181551.	1.030469
10	890095.9	1108525.	.9803075	.8675668	772217.7	961719.7	.9953008
15	710392.9	900930.5	.9734899	.8402543	596910.7	757010.8	.9639670
20	538686.1	676550.5	.9680648	.8588960	462675.3	581086.5	.9853533
25	435551.6	542644.2	.9662377	.8254020	359505.1	447899.6	.9469280
30	346603.0	427601.1	.9629257	.8123634	281567.6	347367.4	.9319696
35	277825.1	306131.6	.9567470	.8856606	246058.7	271128.7	1.016059
40	231309.5	275885.3	.9477229	.8533112	197379.0	235416.0	.9789462
45	199584.4	230910.5	.9338473	.8100998	161683.2	187060.6	.9293728
50	159865.2	192931.6	.9139166	.7825959	125109.8	150987.5	.8978194
55	130489.0	148491.6	.8831513	.7700096	100477.8	114339.9	.8833800
60	107895.5	113612.6	.8339369	.7810495	84271.71	88737.09	.8960453
65	88671.22	105381.1	.7600683	.6668873	59133.71	70277.29	.7650747
70+	146201.9	162582.1	.5322397	.5302219	77519.45	86204.59	.6082878
	6621029.	8007563.			5770609.	6980738.	

The ratio of enumerated to corrected totals is 1.147232

THE ENUMERATED AND THE CORRECTED 1969 AND 1979 MALE POPULATIONS

age,x	ENUMERATED POP. 5N1(x)	5N3(x)	CORR. FACTORSei	CORRECTED POP. 5N1*(x)	5N3*(x)
0	1058102	1499952.	1.138770	1204935.	1708100.
5	916599	1315434.	1.025998	940429.0	1349633.
10	714707	1108525.	1.010516	722222.7	1120182.
15	560152	900930.5	.9878025	553319.5	889941.4
20	428915	676550.5	1.004708	430934.4	679735.9
25	349594	542644.2	.9615909	336166.4	521801.8
30	280948	427601.1	.9417015	264569.2	402672.6
35	252136	306131.6	.9712581	244889.1	297332.8
40	193936	275885.3	.9725699	188616.3	268317.7
45	172508	230910.5	.9095711	156908.3	210029.5
50	132466	192931.6	.8972199	118851.1	173102.1
55	114669	148491.6	.8576157	98341.93	127348.7
60	102466	113612.6	.8384082	85908.33	95253.76
65	74611	105381.1	.7587418	56610.49	79957.01
70+	131472	162582.1	.5840221	76782.55	94951.54
	5483281	8007563.		5479484.	8018359.

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1204935.	1708100.	1434625.	.2165909	.0348956		1
5	940429.0	1349633.	1126603.	.1700876	.0361252	.0361252	.7852943
10	722222.7	1120182.	899455.9	.1357944	.0438913	.0800165	.6269625
15	553319.5	889941.4	701727.8	.1059426	.0475220	.1275385	.4891368
20	430934.4	679735.9	541222.3	.0817104	.0455748	.1731133	.3772570
25	336166.4	521801.8	418822.4	.0632313	.0439681	.2170814	.2919387
30	264569.2	402672.6	326396.6	.0492774	.0420021	.2590836	.2275136
35	244889.1	297332.8	269839.9	.0407388	.0194046	.2784882	.1880909
40	188616.3	268317.7	224964.6	.0339638	.0352457	.3137339	.1568108
45	156908.3	210029.5	181536.1	.0274072	.0291587	.3428925	.1265391
50	118851.1	173102.1	143434.2	.0216548	.0376010	.3804935	.0999803
55	98341.93	127348.7	111909.4	.0168954	.0258479	.4063414	.0780061
60	85908.33	95253.76	90460.44	.0136572	.0103264	.4166677	.0630551
65	56610.49	79957.01	67278.57	.0101573	.0345295	.4511972	.0468963
70+	76782.55	94951.54	85385.13	.0128909	.0212389		.0595174
	5479484.	8018359.	6623661.				

Assume e(70) = 7.4165

source: Mudaki,1986

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.48444	1.095379	-
5	.9378692	10.48444	1	-
10	.9145936	9.546569	.9105465	14.11483
15	.8967424	8.631975	.8233131	14.12349
20	.8728775	7.735233	.7377823	14.12211
25	.8449434	6.862355	.6545277	14.11468
30	.8163648	6.017412	.5739375	14.10113
35	.7868942	5.201047	.4960730	14.08330
40	.7520735	4.414153	.4210195	14.04988
45	.7129110	3.662079	.3492871	14.01804
50	.6655923	2.949168	.2812901	13.97210
55	.6085704	2.283576	.2178062	13.91074
60	.5384911	1.675006	.1597611	13.81754
65	.4480208	1.136514	.1084001	13.65605
70+		.6884936	.0656681	

Tx/T5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS
NORTH MODEL - MALES

age,x	LEVEL 12	LEVEL 13	LEVEL 14	LEVEL 15	LEVEL 16	LEVEL 17
0	1.08049	1.07786	1.0755	1.07324	1.07111	1.06908
5	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90604	.90828	.91031	.91237	.91438	.91634
15	.81498	.81907	.82285	.8266	.83032	.83399
20	.72619	.73188	.73714	.7424	.74763	.75283
25	.64026	.64729	.65378	.6603	.66682	.67331
30	.55767	.56574	.57318	.58067	.5882	.59574
35	.47848	.4873	.49539	.50359	.51186	.52018
40	.40288	.41214	.42059	.4292	.43794	.44677
45	.33126	.34063	.34913	.35784	.36675	.3758
50	.26417	.27328	.28152	.29002	.29877	.30772
55	.20235	.21083	.21849	.22646	.23473	.24326
60	.14671	.15421	.161	.16813	.1756	.18338
65	.09849	.1047	.11034	.11633	.12268	.12936
70+						

ASSUME k2/k1 = 1.05: MALES

	MALE POPULATIONS				SURVIVAL RATIOS		
age,x	5N1(x)	5N3(x)	5N3'(x)	5N2(x)	LEVEL 14	LEVEL 15	*LEVEL*
0	1058102	1424954	1357099.	1198311.	.9347	.94381	.9378862
5	916599	1249662	1190154.	1044459.	.97392	.97724	.9750812
10	714707	1053099	1002951.	846650.1	.97958	.98166	.9803075
15	560152	855884	815127.6	675718.4	.97264	.97507	.9734899
20	428915	642723	612117.1	512392.6	.96704	.96997	.9680648
25	349594	515512	490963.8	414292.2	.96515	.96826	.9662377
30	280948	406221	386877.1	329685.2	.96174	.96513	.9629257
35	252136	290825	276976.2	264264.4	.95539	.95927	.9567470
40	193936	262091	249610.5	220019.2	.94617	.95061	.9477229
45	172508	219365	208919.0	189842.6	.93213	.93704	.9338473
50	132466	183285	174557.1	152062.1	.91193	.91761	.9139166
55	114669	141067	134349.5	124119.8	.88078	.88756	.8831513
60	102466	107932	102792.4	102629.1	.83102	.83936	.8339369
65	74611	100112	95344.76	84343.16	.75634	.767	.7600683
70+	131472	154453	147098.1	139065.7	.5289292	.5383947	.5322397
	5483281	7607185	7244938.	6297854.			

LEVEL -Mortality level 14.34975- Males: North model (Mudaki,1986)

OBTAINING CORRECTION FACTORS FOR THE 1969 AND 1974 MALE POPULATIONS

age,x	5N1(x)	5N2(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1969	CORRECTED POP. 1974	FINAL CORRECTION FACTORS
0	1058102	1198311.	.9378862	1	1058102	1198311.	.9385532
5	916599	1044459.	.9750812	.9501373	870894.9	992379.3	.8917544
10	714707	846650.1	.9803075	1.003004	716853.8	849193.2	.9413723
15	560152	675718.4	.9734899	1.039985	582549.8	702737.1	.9760814
20	428915	512392.6	.9680648	1.106781	474714.9	567106.3	1.038773
25	349594	414292.2	.9662377	1.109253	387788.1	459554.7	1.041093
30	280948	329685.2	.9629257	1.136525	319304.4	374695.5	1.066689
35	252136	264264.4	.9567470	1.163480	293355.3	307466.4	1.091988
40	193936	220019.2	.9477229	1.275647	247393.8	280666.8	1.197262
45	172508	189842.6	.9338473	1.235027	213052.1	234460.8	1.159139

50	132466	152062.1	.9139166	1.308400	173318.6	198958.1	1.228003
55	114669	124119.8	.8831513	1.276176	146337.8	158398.7	1.197759
60	102466	102629.1	.8339369	1.259277	129033.1	129238.4	1.181899
65	74611	84343.16	.7600683	1.275805	95189.12	107605.5	1.197411
70+	131472	139065.7	.5322397	1.047171	137673.7	145625.7	.9828259
	5483281	6297854.			5845561.	6706397.	

The ratio of enumerated to corrected totals is .9385532

OBTAINING CORRECTION FACTORS FOR 1974 AND 1979 MALE POPULATIONS

age,x	5N2(x)	5N3'(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1974	1979	FINAL CORRECTION FACTORS
0	1198311.	1357099.	.9378862	1	1198311.	1357099.	.9526081
5	1044459.	1190154.	.9750812	.9443140	986297.1	1123879.	.8995612
10	846650.1	1002951.	.9803075	.9588896	811844.0	961719.7	.9134461
15	675718.4	815127.6	.9734899	.9763585	659743.4	795856.8	.9300870
20	512392.6	612117.1	.9680648	1.049233	537619.3	642253.5	.9995079
25	414292.2	490963.8	.9662377	1.060058	439173.9	520450.3	1.009820
30	329685.2	386877.1	.9629257	1.096850	361615.4	424346.4	1.044869
35	264264.4	276976.2	.9567470	1.257179	332227.7	348208.8	1.197599
40	220019.2	249610.5	.9477229	1.273416	280175.9	317857.9	1.213066
45	189842.6	208919.0	.9338473	1.270967	241283.6	265529.1	1.210733
50	152062.1	174557.1	.9139166	1.290821	196285.0	225322.0	1.229647
55	124119.8	134349.5	.8831513	1.335234	165729.0	179388.1	1.271955
60	102629.1	102792.4	.8339369	1.423878	146131.3	146363.8	1.356398
65	84343.16	95344.76	.7600683	1.278143	107802.6	121864.2	1.217569
70+	139065.7	147098.1	.5322397	1.121174	155916.8	164922.5	1.068039
	6297854.	7244938.			6620156.	7595062.	

The ratio of enumerated to corrected totals is .9526081

THE ENUMERATED AND THE CORRECTED 1969 AND 1979 MALE POPULATIONS

age,x	ENUMERATED POP. 5N1(x)	5N3(x)	CORR. FACTORSei	CORRECTED POP. 5N1*(x)	5N3*(x)
0	1058102	1357099.	.9455806	1000521.	1283247.
5	916599	1190154.	.8956578	820959.0	1065971.
10	714707	1002951.	.9274092	662825.8	930146.4
15	560152	815127.6	.9530842	533872.0	776885.3

20	428915	612117.1	1.019140	437124.5	623833.2
25	349594	490963.8	1.025456	358493.4	503462.0
30	280948	386877.1	1.055779	296619.0	408456.7
35	252136	276976.2	1.144794	288643.7	317080.6
40	193936	249610.5	1.205164	233724.7	300821.6
45	172508	208919.0	1.184936	204410.9	247555.7
50	132466	174557.1	1.228825	162777.5	214500.2
55	114669	134349.5	1.234857	141599.8	165902.4
60	102466	102792.4	1.269148	130044.5	130458.8
65	74611	95344.76	1.207490	90092.06	115127.9
70+	131472	147098.1	1.025432	134815.7	150839.2
	5483281	7244938.		5496524.	7234287.

. DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM.

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1000521.	1283247.	1133100.	.1798467	.0248873		1
5	820959.0	1065971.	935477.7	.1484800	.0261168	.0261168	.8255917
10	662825.8	930146.4	785191.1	.1246263	.0338830	.0599998	.6929585
15	533872.0	776885.3	644016.5	.1022190	.0375137	.0975134	.5683671
20	437124.5	623833.2	522200.0	.0828841	.0355665	.1330799	.4608597
25	358493.4	503462.0	424838.6	.0674308	.0339598	.1670397	.3749349
30	296619.0	408456.7	348074.7	.0552468	.0319938	.1990335	.3071881
35	288643.7	317080.6	302528.2	.0480176	.0093963	.2084298	.2669917
40	233724.7	300821.6	265159.3	.0420864	.0252373	.2336671	.2340123
45	204410.9	247555.7	224951.3	.0357045	.0191503	.2528174	.1985274
50	162777.5	214500.2	186857.7	.0296582	.0275926	.2804100	.1649085
55	141599.8	165902.4	153270.2	.0243272	.0158395	.2962496	.1352663
60	130044.5	130458.8	130251.5	.0206736	.0003180	.2965676	.1149515
65	90092.06	115127.9	101843.5	.0161647	.0245211	.3210887	.0898805
70+	134815.7	150839.2	142602.5	.0226340	.0112306		.1258517
	5496524.	7234287.	6300363.				

assume e(70) = 7.4165
source: Mudaki,1986

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.50101	1.095229	-

5	.9378692	10.50101	1	-
10	.9145936	9.563143	.9106877	14.18336
15	.8967424	8.648549	.8235920	14.19786
20	.8728775	7.751807	.7381962	14.20079
25	.8449434	6.878929	.6550730	14.19831
30	.8163648	6.033986	.5746099	14.19091
35	.7868942	5.217621	.4968684	14.18029
40	.7520735	4.430727	.4219333	14.15602
45	.7129110	3.678653	.3503142	14.13596
50	.6655923	2.965742	.2824244	14.10640
55	.6085704	2.300150	.2190408	14.06911
60	.5384911	1.691580	.1610873	14.01224
65	.4480208	1.153088	.1098074	13.90556
70+		.7050677	.0671428	

Tx/T5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS
NORTH MODEL - MALES

age,x	LEVEL 12	LEVEL 13	LEVEL 14	LEVEL 15	LEVEL 16	LEVEL 17
0	1.08049	1.07786	1.0755	1.07324	1.07111	1.06908
5	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90604	.90828	.91031	.91237	.91438	.91634
15	.81498	.81907	.82285	.8266	.83032	.83399
20	.72619	.73188	.73714	.7424	.74763	.75283
25	.64026	.64729	.65378	.6603	.66682	.67331
30	.55767	.56574	.57318	.58067	.5882	.59574
35	.47848	.4873	.49539	.50359	.51186	.52018
40	.40288	.41214	.42059	.4292	.43794	.44677
45	.33126	.34063	.34913	.35784	.36675	.3758
50	.26417	.27328	.28152	.29002	.29877	.30772
55	.20235	.21083	.21849	.22646	.23473	.24326
60	.14671	.15421	.161	.16813	.1756	.18338
65	.09849	.1047	.11034	.11633	.12268	.12936
70+						

APPENDIX I

THE EFFECT OF CHANGES IN MORTALITY LEVEL

Let 5N1(x) - 1969 female population
5N2(x) - 1974 female population (estimated as geometric mean)
5N3(x) - 1979 female population

	FEMALE POPULATIONS			SURVIVAL RATIOS		
age,x	5N1(x)	5N3(x)	5N2(x)	LEVEL 14	LEVEL 15	*LEVEL*
0	1046380	1423936	1220647.	.93907	.94852	.9400305
5	893359	1246983	1055464.	.97519	.97879	.9755559
10	663808	1025677	825137.9	.9811	.98345	.9813389
15	544847	889316	696089.9	.97812	.98056	.9783680
20	450096	687234	556166.6	.97432	.97704	.9745965
25	411245	542233	472218.8	.97042	.97358	.9707412
30	299241	413432	351732.6	.9661	.96972	.9664679
35	264819	325951	293799.3	.96118	.96501	.9615693
40	201936	274193	235307.1	.95619	.95998	.9565752
45	163852	222363	190878.6	.94737	.95131	.9477705
50	139072	191365	163136.5	.93104	.93576	.9315197
55	102235	134776	117383.2	.90313	.90929	.9037561
60	94508	109715	101828.0	.85614	.86418	.8569572
65	63307	83370	72649.19	.78471	.79498	.7857538
70+	121619	149403	134797.0	.5537253	.5625247	.5546197
	5460324	7719947	6487235.			

ASSUME MORTALITY LEVEL IS 14: FEMALES - NORTH MODEL

OBTAINING CORRECTION FACTORS FOR THE 1969 AND 1974 FEMALE POPULATIONS

age,x	5N1(x)	5N2(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED 1969	POP. 1974	FINAL CORRECTION FACTORS
0	1046380	1220647.	.93907	1	1046380	1220647.	1.062341
5	893359	1055464.	.97519	.9309881	831706.6	982624.1	.9890268
10	663808	825137.9	.9811	.9829532	652492.2	811071.9	1.044231
15	544847	696089.9	.97812	.9196514	501069.3	640160.1	.9769834
20	450096	556166.6	.97432	.8812214	396634.2	490105.9	.9361576
25	411245	472218.8	.97042	.8183678	336549.7	386448.7	.8693857
30	299241	351732.6	.9661	.9285308	277854.5	326594.5	.9864163
35	264819	293799.3	.96118	.9136687	241956.8	268435.2	.9706277
40	201936	235307.1	.95619	.9883427	199582.0	232564.1	1.049957
45	163852	190878.6	.94737	.9997891	163817.4	190838.3	1.062117
50	139072	163136.5	.93104	.9513245	132302.6	155195.7	1.010631
55	102235	117383.2	.90313	1.049375	107282.8	123179.0	1.114794
60	94508	101828.0	.85614	.9515097	89925.27	96890.34	1.010828
65	63307	72649.19	.78471	1.059731	67088.41	76988.62	1.125796
70+	121619	134797.0	.5537253	.7804625	94919.07	105204.0	.8291173
	5460324	6487235.			5139561.	6106947.	

The ratio of enumerated to corrected totals is 1.062341

OBTAINING CORRECTION FACTORS FOR THE 1974 AND 1979 FEMALE POPULATIONS

age,x	5N2(x)	5N3(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED 1974	POP. 1979	FINAL CORRECTION FACTORS
0	1220647.	1423936	.93907	1	1220647.	1423936	1.082833
5	1055464.	1246983	.97519	.9192368	970221.0	1146273.	.9953799
10	825137.9	1025677	.9811	.9224637	761159.8	946149.8	.9988741
15	696089.9	889316	.97812	.8397171	584518.6	746773.9	.9092734
20	556166.6	687234	.97432	.8319282	462690.7	571729.3	.9008393
25	472218.8	542233	.97042	.8313931	392599.5	450808.8	.9002599
30	351732.6	413432	.9661	.9215212	324129.0	380986.4	.9978536
35	293799.3	325951	.96118	.9606998	282252.9	313141.1	1.040277
40	235307.1	274193	.95619	.9894339	232820.8	271295.9	1.071392
45	190878.6	222363	.94737	1.001160	191100.0	222621.0	1.084089
50	163136.5	191365	.93104	.9460580	154336.6	181042.4	1.024423
55	117383.2	134776	.90313	1.066166	125150.0	143693.5	1.154479
60	101828.0	109715	.85614	1.030184	104901.6	113026.7	1.115518
65	72649.19	83370	.78471	1.077252	78261.48	89810.49	1.166484
70+	134797.0	149403	.5537253	.8214358	110727.1	122725.0	.8894778
	6487235.	7719947			5995516.	7124013.	

The ratio of enumerated to corrected totals is 1.082833

THE ENUMERATED AND THE CORRECTED 1969 AND 1979 FEMALE POPULATIONS

age,x	ENUMERATED POP. 5N1(x)	5N3(x)	CORR. FACTORSei	CORRECTED POP. 5N1*(x)	5N3*(x)
0	1046380	1423936	1.072587	1122334.	1527295.
5	893359	1246983	.9922033	886393.8	1237261.
10	663808	1025677	1.021553	678114.9	1047783.
15	544847	889316	.9431284	513860.7	838739.2
20	450096	687234	.9184985	413412.5	631223.4
25	411245	542233	.8848228	363878.9	479780.1
30	299241	413432	.9921350	296887.5	410180.3
35	264819	325951	1.005453	266263.0	327728.3
40	201936	274193	1.060674	214188.3	290829.5
45	163852	222363	1.073103	175830.1	238618.4
50	139072	191365	1.017527	141509.5	194719.0
55	102235	134776	1.134637	115999.6	152921.8
60	94508	109715	1.063173	100478.3	116646.0
65	63307	83370	1.146140	72558.68	95553.69
70+	121619	149403	.8592976	104506.9	128381.6
	5460324	7719947		5466216.	7717660.

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1122334.	1527295.	1309250.	.2017365	.0308088		1
5	886393.8	1237261.	1047235.	.1613637	.0333494	.0333494	.7998738
10	678114.9	1047783.	842921.9	.1298821	.0435115	.0768609	.6438206
15	513860.7	838739.2	656502.2	.1011575	.0489948	.1258557	.5014339
20	413412.5	631223.4	510838.2	.0787128	.0423214	.1681771	.3901763
25	363878.9	479780.1	417830.0	.0643816	.0276507	.1958277	.3191370
30	296887.5	410180.3	348966.2	.0537706	.0323244	.2281521	.2665391
35	266263.0	327728.3	295401.3	.0455171	.0207700	.2489221	.2256264
40	214188.3	290829.5	249584.2	.0384573	.0305881	.2795103	.1906315
45	175830.1	238618.4	204832.4	.0315617	.0305348	.3100451	.1564502
50	141509.5	194719.0	165995.8	.0255775	.0319191	.3419641	.1267869
55	115999.6	152921.8	133187.3	.0205222	.0276340	.3695981	.1017280
60	100478.3	116646.0	108260.8	.0166814	.0149202	.3845183	.0826892
65	72558.68	95553.69	83266.14	.0128301	.0275293	.4120476	.0635984
70+	104506.9	128381.6	115830.8	.0178478	.0205754		.0884711
	5466216.	7717660.	6489901.				

assume e(70) = 7.612

source: Mudaki,1986

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.90648	1.091689	-
5	.9390320	10.90648	1	-
10	.9159556	9.967448	.9139015	13.71430
15	.8990020	9.051493	.8299188	13.72574
20	.8789276	8.152491	.7474905	13.71164
25	.8563288	7.273563	.6669029	13.69780
30	.8308859	6.417234	.5883873	13.67990
35	.8031874	5.586348	.5122045	13.65475
40	.7715839	4.783161	.4385614	13.61619
45	.7377818	4.011577	.3678159	13.57078
50	.6989317	3.273795	.3001697	13.51157
55	.6508180	2.574864	.2360857	13.43467
60	.5883970	1.924046	.1764131	13.32805
65	.5032185	1.335649	.1224638	13.15782
70+		.8324301	.0763244	

Tx/T5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS: NORTH MODEL -- FEMALES

age,x	LEVEL 11	LEVEL 12	LEVEL 13	LEVEL 14	LEVEL 15
0	1.07944	1.07666	1.07415	1.07181	1.06962
5	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90781	.91028	.91243	.91449	.91648
15	.81877	.82329	.82719	.83095	.83461
20	.7321	.73838	.74379	.74899	.7541
25	.64799	.65575	.66243	.66884	.67516
30	.56676	.57569	.58339	.59074	.59805
35	.48876	.49853	.50696	.51497	.52297
40	.41432	.42456	.43341	.44177	.45018
45	.34371	.35405	.36301	.37143	.37995
50	.27709	.28719	.29598	.30417	.31254
55	.21485	.2244	.23273	.24045	.2484
60	.15789	.16655	.17412	.18111	.18838
65	.10765	.11504	.12152	.1275	.13379
70+					

Source: Office of Population Research, Princeton University.

ASSUME MORTALITY LEVEL IS 15: FEMALES - NORTH MODEL

OBTAINING CORRECTION FACTORS FOR THE 1969 AND 1974 FEMALE POPULATIONS

age,x	5N1(x)	5N2(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1969	1974	FINAL CORRECTION FACTORS
0	1046380	1220647.	.94852	1	1046380	1220647.	1.043128
5	893359	1055464.	.97879	.9403568	840076.2	992512.4	.9809125
10	663808	825137.9	.98345	.9965099	661491.3	822258.2	1.039488
15	544847	696089.9	.98056	.9345684	509196.8	650543.6	.9748745
20	450096	556166.6	.97704	.8977490	404073.2	499298.0	.9364671
25	411245	472218.8	.97358	.8360440	343818.9	394795.7	.8721009
30	299241	351732.6	.96972	.9516753	284780.3	334735.2	.9927192
35	264819	293799.3	.96501	.9399517	248917.1	276157.1	.9804900
40	201936	235307.1	.95998	1.020825	206141.4	240207.5	1.064852
45	163852	190878.6	.95131	1.036741	169872.1	197891.6	1.081454
50	139072	163136.5	.93576	.9905877	137763.0	161601.0	1.033310
55	102235	117383.2	.90929	1.098224	112277.0	128913.1	1.145589
60	94508	101828.0	.86418	1.002595	94753.29	102092.3	1.045836
65	63307	72649.19	.79498	1.127114	71354.19	81883.90	1.175724
70+	121619	134797.0	.5625247	.8545088	103924.5	115185.3	.8913621
	5460324	6487235.			5234819.	6218721.	

The ratio of enumerated to corrected totals is 1.043128

OBTAINING CORRECTION FACTORS FOR THE 1974 AND 1979 FEMALE POPULATIONS

age,x	5N2(x)	5N3(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1974	1979	FINAL CORRECTION FACTORS
0	1220647.	1423936	.94852	1	1220647.	1423936	1.063250
5	1055464.	1246983	.97879	.9284872	979984.5	1157808.	.9872136
10	825137.9	1025677	.98345	.9351862	771657.6	959199.0	.9943364
15	696089.9	889316	.98056	.8533375	593999.6	758886.7	.9073107
20	556166.6	687234	.97704	.8475312	471368.5	582452.3	.9011372
25	472218.8	542233	.97358	.8493506	401079.3	460545.9	.9030717
30	351732.6	413432	.96972	.9444910	332208.3	390482.8	1.004230
35	293799.3	325951	.96501	.9883356	290372.3	322149.0	1.050847
40	235307.1	274193	.95998	1.021952	240472.7	280212.2	1.086590
45	190878.6	222363	.95131	1.038163	198163.0	230848.9	1.103826
50	163136.5	191365	.93576	.9851039	160706.4	188514.4	1.047411
55	117383.2	134776	.90929	1.115797	130975.8	150382.6	1.186370
60	101828.0	109715	.86418	1.085494	110533.7	119095.0	1.154151
65	72649.19	83370	.79498	1.145748	83237.69	95521.04	1.218217
70+	134797.0	149403	.5625247	.8993694	121232.3	134368.5	.9562542
	6487235.	7719947			6106638.	7254402.	

The ratio of enumerated to corrected totals is 1.063250

THE ENUMERATED AND THE CORRECTED 1969 AND 1979 FEMALE POPULATIONS

	ENUMERATED POP.		CORR.	CORRECTED POP.	
age,x	5N1(x)	5N3(x)	FACTORSei	5N1*(x)	5N3*(x)
0	1046380	1423936	1.053189	1102036.	1499674.
5	893359	1246983	.9840631	879121.6	1227110.
10	663808	1025677	1.016912	675034.3	1043023.
15	544847	889316	.9410926	512751.5	836928.7
20	450096	687234	.9188022	413549.2	631432.1
25	411245	542233	.8875863	365015.4	481278.6
30	299241	413432	.9984745	298784.5	412801.3
35	264819	325951	1.015669	268968.4	331058.2
40	201936	274193	1.075721	217226.8	294955.2
45	163852	222363	1.092640	179031.2	242962.6
50	139072	191365	1.040361	144685.0	199088.6
55	102235	134776	1.165979	119203.9	157146.0
60	94508	109715	1.099993	103958.2	120685.8
65	63307	83370	1.196970	75776.60	99791.41
70+	121619	149403	.9238082	112352.6	138019.7
	5460324	7719947		5467495.	7715955.

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1102036.	1499674.	1285571.	.1980880	.0308088		1
5	879121.6	1227110.	1038643.	.1600398	.0333494	.0333494	.8079231
10	675034.3	1043023.	839092.6	.1292920	.0435115	.0768609	.6527001
15	512751.5	836928.7	655085.1	.1009391	.0489948	.1258557	.5095672
20	413549.2	631432.1	511007.1	.0787388	.0423214	.1681771	.3974941
25	365015.4	481278.6	419135.0	.0645826	.0276507	.1958277	.3260301
30	298784.5	412801.3	351196.0	.0541142	.0323244	.2281521	.2731828
35	268968.4	331058.2	298402.7	.0459795	.0207700	.2489221	.2321168
40	217226.8	294955.2	253124.8	.0390029	.0305881	.2795103	.1968967
45	179031.2	242962.6	208561.5	.0321363	.0305348	.3100451	.1622325
50	144685.0	199088.6	169720.8	.0261515	.0319191	.3419641	.1320197
55	119203.9	157146.0	136866.4	.0210891	.0276340	.3695981	.1064635
60	103958.2	120685.8	112010.2	.0172591	.0149202	.3845183	.0871287
65	75776.60	99791.41	86958.92	.0133991	.0275293	.4120476	.0676422
70+	112352.6	138019.7	124526.6	.0191877	.0205754		.0968648
	5467495.	7715955.	6489902.				

Assume e(70) = 7.612
source: Mudaki,1986

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	12.27627	1.088682	-
5	.9484816	11.27627	1	-
10	.9285884	10.32779	.9158870	14.70200
15	.9135840	9.399204	.8335381	14.70713
20	.8954121	8.485620	.7525199	14.69077
25	.8748248	7.590208	.6731131	14.67613
30	.8515965	6.715383	.5955321	14.65555
35	.8262922	5.863787	.5200110	14.63013
40	.7969425	5.037495	.4467340	14.59024
45	.7650499	4.240552	.3760597	14.54339
50	.7277782	3.475502	.3082137	14.48312
55	.6811142	2.747724	.2436730	14.40541
60	.6199876	2.066610	.1832706	14.29720
65	.5352154	1.446622	.1282890	14.12544
70+		.9114068	.0808252	

Tx/T5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS: NORTH MODEL - FEMALES

age,x	LEVEL 11	LEVEL 12	LEVEL 13	LEVEL 14	LEVEL 15
0	1.07944	1.07666	1.07415	1.07181	1.06962
5	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90781	.91028	.91243	.91449	.91648
15	.81877	.82329	.82719	.83095	.83461
20	.7321	.73838	.74379	.74899	.7541
25	.64799	.65575	.66243	.66884	.67516
30	.56676	.57569	.58339	.59074	.59805
35	.48876	.49853	.50696	.51497	.52297
40	.41432	.42456	.43341	.44177	.45018
45	.34371	.35405	.36301	.37143	.37995
50	.27709	.28719	.29598	.30417	.31254
55	.21485	.2244	.23273	.24045	.2484
60	.15789	.16655	.17412	.18111	.18838
65	.10765	.11504	.12152	.1275	.13379
70+					

Source: Office of Population Research, Princeton University.

Let 5N1(x) - 1969 male population
5N2(x) - 1974 male population (estimated as geometric mean)
5N3(x) - 1979 male population

	MALE POPULATIONS			SURVIVAL RATIOS		
age,x	5N1(x)	5N3(x)	5N2(x)	LEVEL 14	LEVEL 15	*LEVEL*
0	1058102	1424954	1227903.	.9347	.94381	.9378862
5	916599	1249662	1070252.	.97392	.97724	.9750812
10	714707	1053099	867558.2	.97958	.98166	.9803075
15	560152	855884	692405.3	.97264	.97507	.9734899
20	428915	642723	525046.2	.96704	.96997	.9680648
25	349594	515512	424523.1	.96515	.96826	.9662377
30	280948	406221	337826.8	.96174	.96513	.9629257
35	252136	290825	270790.4	.95539	.95927	.9567470
40	193936	262091	225452.6	.94617	.95061	.9477229
45	172508	219365	194530.8	.93213	.93704	.9338473
50	132466	183285	155817.3	.91193	.91761	.9139166
55	114669	141067	127185.0	.88078	.88756	.8831513
60	102466	107932	105163.5	.83102	.83936	.8339369
65	74611	100112	86426.02	.75634	.767	.7600683
70+	131472	154453	142500.0	.5289292	.5383947	.5322397
	5483281	7607185	6453380.			

ASSUME MORTALITY LEVEL IS 14: NORTH MODEL - MALES

OBTAINING CORRECTION FACTORS FOR THE 1969 AND 1974 MALE POPULATIONS

age,x	5N1(x)	5N2(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED 1969	POP. 1974	FINAL CORRECTION FACTORS
0	1058102	1227903.	.9347	1	1058102	1227903.	1.038394
5	916599	1070252.	.97392	.9240890	847019.1	989007.9	.9595682
10	714707	867558.2	.97958	.9508628	679588.3	824928.8	.9873699
15	560152	692405.3	.97264	.9614471	538556.5	665711.1	.9983606
20	428915	525046.2	.96704	.9976676	427914.6	523821.6	1.035972
25	349594	424523.1	.96515	.9747656	340772.2	413810.5	1.012190
30	280948	337826.8	.96174	.9735647	273521.0	328896.3	1.010943
35	252136	270790.4	.95539	.9714381	244934.5	263056.1	1.008735
40	193936	225452.6	.94617	1.037948	201295.4	234008.0	1.077798
45	172508	194530.8	.93213	.9790722	168897.8	190459.7	1.016662
50	132466	155817.3	.91193	1.010380	133841.0	157434.7	1.049172
55	114669	127185.0	.88078	.9596547	110042.6	122053.6	.9964993
60	102466	105163.5	.83102	.9216445	94437.23	96923.36	.9570298
65	74611	86426.02	.75634	.9080509	67750.59	78479.22	.9429143
70+	131472	142500.0	.5289292	.7023308	92336.83	100082.1	.7292958
	5483281	6453380.			5279010.	6216576.	

The ratio of enumerated to corrected totals is 1.038394

OBTAINING CORRECTION FACTORS FOR THE 1974 AND 1979 MALE POPULATIONS

age,x	5N2(x)	5N3(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED 1974	POP. 1979	FINAL CORRECTION FACTORS
0	1227903.	1424954	.9347	1	1227903.	1424954	1.053943
5	1070252.	1249662	.97392	.9184254	982946.4	1147721.	.9679680
10	867558.2	1053099	.97958	.9090419	788646.8	957311.2	.9580785
15	692405.3	855884	.97264	.9026254	624982.6	772542.6	.9513158
20	525046.2	642723	.96704	.9457933	496585.2	607883.1	.9968123
25	424523.1	515512	.96515	.9315355	395458.4	480217.7	.9817854
30	337826.8	406221	.96174	.9395789	317415.0	381676.7	.9902626
35	270790.4	290825	.95539	1.049671	284240.9	305270.7	1.106294
40	225452.6	262091	.94617	1.036132	233598.7	271561.0	1.092024
45	194530.8	219365	.93213	1.007563	196002.1	221024.1	1.061914
50	155817.3	183285	.91193	.9968049	155319.5	182699.4	1.050576
55	127185.0	141067	.88078	1.004065	127702.0	141640.5	1.058228
60	105163.5	107932	.83102	1.042113	109592.3	112477.4	1.098328
65	86426.02	100112	.75634	.9097147	78623.02	91073.36	.9587875
70+	142500.0	154453	.5289292	.7519636	107154.8	116143.0	.7925268
	6453380.	7607185			6126171.	7214196.	

The ratio of enumerated to corrected totals is 1.053943

THE ENUMERATED AND THE CORRECTED 1969 AND 1979 MALE POPULATIONS

age,x	ENUMERATED POP. 5N1(x)	5N3(x)	CORR. FACTORSei	CORRECTED POP. 5N1*(x)	5N3*(x)
0	1058102	1424954	1.046168	1106953.	1490742.
5	916599	1249662	.9637681	883388.9	1204384.
10	714707	1053099	.9727242	695212.8	1024375.
15	560152	855884	.9748382	546057.6	834348.4
20	428915	642723	1.016392	435945.8	653258.5
25	349594	515512	.9969879	348541.0	513959.2
30	280948	406221	1.000603	281117.4	406466.0
35	252136	290825	1.057515	266637.5	307551.7
40	193936	262091	1.084911	210403.4	284345.5
45	172508	219365	1.039288	179285.6	227983.5
50	132466	183285	1.049874	139072.6	192426.2
55	114669	141067	1.027363	117806.7	144927.1
60	102466	107932	1.027679	105302.1	110919.4
65	74611	100112	.9508509	70943.94	95191.59
70+	131472	154453	.7609113	100038.5	117525.0
	5483281	7607185		5486707.	7608403.

CORRECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1106953.	1490742.	1284594.	.1989784	.0297663		1
5	883388.9	1204384.	1031475.	.1597713	.0309958	.0309958	.8029579
10	695212.8	1024375.	843894.8	.1307159	.0387620	.0697578	.6569352
15	546057.6	834348.4	674983.2	.1045522	.0423927	.1121505	.5254449
20	435945.8	653258.5	533652.8	.0826607	.0404455	.1525960	.4154254
25	348541.0	513959.2	423244.4	.0655589	.0388388	.1914348	.3294773
30	281117.4	406466.0	338030.6	.0523596	.0368728	.2283076	.2631420
35	266637.5	307551.7	286364.8	.0443568	.0142753	.2425829	.2229225
40	210403.4	284345.5	244596.1	.0378870	.0301164	.2726992	.1904074
45	179285.6	227983.5	202173.6	.0313159	.0240293	.2967286	.1573833
50	139072.6	192426.2	163588.5	.0253392	.0324716	.3292002	.1273465
55	117806.7	144927.1	130665.2	.0202395	.0207185	.3499187	.1017171
60	105302.1	110919.4	108074.3	.0167403	.0051970	.3551158	.0841311
65	70943.94	95191.59	82178.26	.0127291	.0294002	.3845159	.0639722
70+	100038.5	117525.0	108429.8	.0167954	.0161096		.0844079
	5486707.	7608403.	6455945.				

assume e(70) = 7.4165
source: Mudaki,1986

CORRECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.37387	1.096396	-
5	.9346831	10.37387	1	-
10	.9104011	9.439184	.9099002	13.79814
15	.8919693	8.528783	.8221411	13.81247
20	.8674734	7.636813	.7361588	13.81346
25	.8388233	6.769340	.6525378	13.80859
30	.8095394	5.930517	.5716785	13.79819
35	.7793544	5.120977	.4936421	13.78394
40	.7438109	4.341623	.4185154	13.75448
45	.7039233	3.597812	.3468149	13.72764
50	.6559926	2.893889	.2789595	13.68926
55	.5984893	2.237896	.2157244	13.63895
60	.5281490	1.639407	.1580324	13.56294
65	.4378793	1.111258	.1071209	13.42923
70+		.6733785	.0649110	

Tx/t5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS: NORTH MODEL -.MALES

age,x	LEVEL 12	LEVEL 13	LEVEL 14	LEVEL 15	LEVEL 16	LEVEL 17
0	1.08049	1.07786	1.0755	1.07324	1.07111	1.06908
5	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90604	.90828	.91031	.91237	.91438	.91634
15	.81498	.81907	.82285	.8266	.83032	.83399
20	.72619	.73188	.73714	.7424	.74763	.75283
25	.64026	.64729	.65378	.6603	.66682	.67331
30	.55767	.56574	.57318	.58067	.5882	.59574
35	.47848	.4873	.49539	.50359	.51186	.52018
40	.40288	.41214	.42059	.4292	.43794	.44677
45	.33126	.34063	.34913	.35784	.36675	.3758
50	.26417	.27328	.28152	.29002	.29877	.30772
55	.20235	.21083	.21849	.22646	.23473	.24326
60	.14671	.15421	.161	.16813	.1756	.18338
65	.09849	.1047	.11034	.11633	.12268	.12936
70+						

Let 5N1(x) - 1969 male population
5N2(x) - 1974 male population (estimated as geometric mean)
5N3(x) - 1979 male population

age,x	MALE POPULATIONS 5N1(x)	5N3(x)	5N2(x)	SURVIVAL RATIOS LEVEL 14	LEVEL 15	*LEVEL*
0	1058102	1424954	1227903.	.9347	.94381	.9378862
5	916599	1249662	1070252.	.97392-	.97724	.9750812
10	714707	1053099	867558.2	.97958	.98166	.9803075
15	560152	855884	692405.3	.97264	.97507	.9734899
20	428915	642723	525046.2	.96704	.96997	.9680648
25	349594	515512	424523.1	.96515	.96826	.9662377
30	280948	406221	337826.8	.96174	.96513	.9629257
35	252136	290825	270790.4	.95539	.95927	.9567470
40	193936	262091	225452.6	.94617	.95061	.9477229
45	172508	219365	194530.8	.93213	.93704	.9338473
50	132466	183285	155817.3	.91193	.91761	.9139166
55	114669	141067	127185.0	.88078	.88756	.8831513
60	102466	107932	105163.5	.83102	.83936	.8339369
65	74611	100112	86426.02	.75634	.767	.7600683
70+	131472	154453	142500.0	.5289292	.5383947	.5322397
	5483281	7607185	6453380.			

ASSUME MORTALITY LEVEL IS 15: NORTH MODEL - MALES

OBTAINING CORRECTION FACTORS FOR THE 1969 AND 1974 MALE POPULATIONS

age,x	5N1(x)	5N2(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1969	1974	FINAL CORRECTION FACTORS
0	1058102	1227903.	.94381	1	1058102	1227903.	1.019846
5	916599	1070252.	.97724	.9330956	855274.5	998647.2	.9516142
10	714707	867558.2	.98166	.9634033	688551.1	835808.4	.9825235
15	560152	692405.3	.97507	.9761956	546817.9	675923.1	.9955697
20	428915	525046.2	.96997	1.015503	435564.3	533185.8	1.035657
25	349594	424523.1	.96826	.9951973	347915.0	422484.3	1.014948
30	280948	337826.8	.96513	.9971741	280154.1	336872.2	1.016964
35	252136	270790.4	.95927	.9985032	251758.6	270385.1	1.018320
40	193936	225452.6	.95061	1.071198	207743.9	241504.5	1.092458
45	172508	194530.8	.93704	1.015179	175126.4	197483.4	1.035326
50	132466	155817.3	.91761	1.053159	139507.8	164100.5	1.074061
55	114669	127185.0	.88756	1.006517	115416.3	128013.8	1.026492
60	102466	105163.5	.83936	.9740914	99811.24	102438.8	.9934236
65	74611	86426.02	.767	.9693559	72324.61	83777.57	.9885942
70+	131472	142500.0	.5383947	.7735075	101694.6	110224.8	.7888589
	5483281	6453380.			5375762.	6328753.	

The ratio of enumerated to corrected totals is 1.019846

OBTAINING CORRECTION FACTORS FOR THE 1974 AND 1979 MALE POPULATIONS

age,x	5N2(x)	5N3(x)	SURV. RATIOS	CORRECTION FACTORS	CORRECTED POP. 1974	1979	FINAL CORRECTION FACTORS
0	1227903.	1424954	.94381	1	1227903.	1424954	1.035118
5	1070252.	1249662	.97724	.9273767	992526.6	1158907.	.9599446
10	867558.2	1053099	.98166	.9210309	799047.9	969936.7	.9533759
15	692405.3	855884	.97507	.9164716	634569.8	784393.4	.9486565
20	525046.2	642723	.96997	.9627009	505462.5	618750.0	.9965092
25	424523.1	515512	.96826	.9510611	403747.5	490283.4	.9844607
30	337826.8	406221	.96513	.9623641	325112.4	390932.5	.9961607
35	270790.4	290825	.95927	1.078916	292160.1	313775.8	1.116806
40	225452.6	262091	.95061	1.069325	241082.1	280260.5	1.106878
45	194530.8	219365	.93704	1.044720	203230.2	229175.1	1.081409
50	155817.3	183285	.91761	1.039009	161895.7	190434.9	1.075498
55	127185.0	141067	.88756	1.053096	133937.9	148557.1	1.090079
60	105163.5	107932	.83936	1.101415	115828.7	118878.0	1.140095
65	86426.02	100112	.767	.9711320	83931.07	97221.97	1.005236
70+	142500.0	154453	.5383947	.8281702	118014.2	127913.4	.8572541
	6453380.	7607185			6238450.	7344374.	

The ratio of enumerated to corrected totals is 1.035118

THE ENUMERATED AND THE CORRECTED 1969 AND 1979 MALE POPULATIONS

age,x	ENUMERATED POP. 5N1(x)	5N3(x)	CORR. FACTORSei	CORRECTED POP. 5N1*(x)	5N3*(x)
0	1058102	1424954	1.027482	1087181.	1464115.
5	916599	1249662	.9557794	876066.5	1194401.
10	714707	1053099	.9679497	691800.4	1019347.
15	560152	855884	.9721131	544531.1	832016.0
20	428915	642723	1.016083	435813.2	653059.9
25	349594	515512	.9997046	349490.7	515359.7
30	280948	406221	1.006563	282791.7	408886.9
35	252136	290825	1.067563	269171.0	310474.0
40	193936	262091	1.099668	213265.2	288213.0
45	172508	219365	1.058368	182576.9	232168.8
50	132466	183285	1.074779	142371.7	196990.9
55	114669	141067	1.058286	121352.5	149289.2
60	102466	107932	1.066759	109306.6	115137.5
65	74611	100112	.9969153	74380.85	99803.18
70+	131472	154453	.8230565	108208.9	127123.5
	5483281	7607185		5488308.	7606386.

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1087181.	1464115.	1261649.	.1954244	.0297663		1
5	876066.5	1194401.	1022925.	.1584469	.0309958	.0309958	.8107838
10	691800.4	1019347.	839752.7	.1300743	.0387620	.0697578	.6655993
15	544531.1	832016.0	673096.3	.1042599	.0423927	.1121505	.5335052
20	435813.2	653059.9	533490.5	.0826355	.0404455	.1525960	.4228518
25	349490.7	515359.7	424397.7	.0657375	.0388388	.1914348	.3363833
30	282791.7	408886.9	340043.9	.0526714	.0368728	.2283076	.2695233
35	269171.0	310474.0	289085.8	.0447782	.0142753	.2425829	.2291333
40	213265.2	288213.0	247923.0	.0384023	.0301164	.2726992	.1965071
45	182576.9	232168.8	205885.1	.0318908	.0240293	.2967286	.1631873
50	142371.7	196990.9	167469.2	.0259403	.0324716	.3292002	.1327383
55	121352.5	149289.2	134598.0	.0208487	.0207185	.3499187	.1066842
60	109306.6	115137.5	112184.1	.0173769	.0051970	.3551158	.0889187
65	74380.85	99803.18	86159.42	.0133457	.0294002	.3845159	.0682911
70+	108208.9	127123.5	117285.5	.0181671	.0161096		.0929621
	5488308.	7606386.	6455945.				

assume e(70) = 7.4165
source: Mudaki,1986

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.71775	1.093303	-
5	.9437929	10.71775	1	-
10	.9224080	9.773956	.9119411	14.79181
15	.9056521	8.851548	.8258775	14.80734
20	.8829809	7.945896	.7413773	14.80557
25	.8564056	7.062915	.6589924	14.79945
30	.8291712	6.206509	.5790870	14.78865
35	.8010679	5.377338	.5017227	14.77228
40	.7676390	4.576270	.4269805	14.74222
45	.7298826	3.808631	.3553574	14.71497
50	.6837672	3.078749	.2872570	14.67494
55	.6277148	2.394981	.2234594	14.62351
60	.5582037	1.767266	.1648916	14.54580
65	.4674417	1.209063	.1128094	14.41225
70+		.7416210	.0691956	

Tx/T5 VALUES CORRESPONDING TO DIFFERENT MORTALITY LEVELS: NORTH MODEL - MALES

age,x	LEVEL 12	LEVEL 13	LEVEL 14	LEVEL 15	LEVEL 16	LEVEL 17
0	1.08049	1.07786	1.0755	1.07324	1.07111	1.06908
5	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
10	.90604	.90828	.91031	.91237	.91438	.91634
15	.81498	.81907	.82285	.8266	.83032	.83399
20	.72619	.73188	.73714	.7424	.74763	.75283
25	.64026	.64729	.65378	.6603	.66682	.67331
30	.55767	.56574	.57318	.58067	.5882	.59574
35	.47848	.4873	.49539	.50359	.51186	.52018
40	.40288	.41214	.42059	.4292	.43794	.44677
45	.33126	.34063	.34913	.35784	.36675	.3758
50	.26417	.27328	.28152	.29002	.29877	.30772
55	.20235	.21083	.21849	.22646	.23473	.24326
60	.14671	.15421	.161	.16813	.1756	.18338
65	.09849	.1047	.11034	.11633	.12268	.12936
70+						

ASSUME e(70) = 10: FEMALES

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM.

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1120261	1524475	1306832.	.2013640	.0308088		1
5	885662.4	1236239	1046370.	.1612306	.0333493	.0333493	.8006921
10	677809.6	1047311	842542.3	.1298236	.0435115	.0768608	.6447212
15	513754.4	838565.7	656366.4	.1011366	.0489948	.1258556	.5022577
20	413431.7	631252.8	510861.9	.0787165	.0423214	.1681770	.3909163
25	363999.1	479938.6	417968.0	.0644028	.0276507	.1958276	.3198330
30	297083.8	410451.6	349197.0	.0538062	.0323244	.2281520	.2672088
35	266540.5	328069.9	295709.2	.0455645	.0207700	.2489221	.2262794
40	214498.4	291250.6	249945.6	.0385130	.0305882	.2795102	.1912607
45	176155.6	239060.2	205211.6	.0316201	.0305348	.3100450	.1570298
50	141831.4	195162.0	166373.4	.0256357	.0319191	.3419641	.1273105
55	116323.3	153348.6	133559.0	.0205795	.0276340	.3695982	.1022006
60	100828.6	117052.6	108638.2	.0167396	.0149201	.3845183	.0831309
65	72881.16	95978.37	83636.21	.0128871	.0275293	.4120476	.0639992
70+	105280.7	129332.3	116688.5	.0179800	.0205755		.0892911
.	5466342.	7717488.	6489899.				

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM.

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.97134	1.091147	-
5	.9399925	10.97134	1	-
10	.9172364	10.03135	.9143229	13.91888
15	.9004784	9.114110	.8307199	13.93881
20	.8805942	8.213632	.7486444	13.93354
25	.8581960	7.333038	.6683813	13.92843
30	.8329732	6.474842	.5901596	13.92104
35	.8055118	5.641868	.5142370	13.90848
40	.7741303	4.836357	.4408173	13.88604
45	.7405150	4.062226	.3702580	13.86081
50	.7018176	3.321711	.3027626	13.82815
55	.6538418	2.619894	.2387943	13.78553
60	.5915404	1.966052	.1791989	13.72659
65	.5063901	1.374511	.1252820	13.62909
70+		.8681214	.0791263	

THE IDEAL CASE, e(70) = 12.5: FEMALES

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1120262.	1524476.	1306833.	.2013641	.0308088		1
5	885661.8	1236239.	1046370.	.1612305	.0333494	.0333494	.8006914
10	677809.0	1047311.	842541.7	.1298236	.0435115	.0768609	.6447204
15	513754.2	838565.4	656366.1	.1011366	.0489948	.1258557	.5022572
20	413431.6	631252.6	510861.8	.0787165	.0423214	.1681771	.3909160
25	363999.1	479938.6	417968.0	.0644028	.0276507	.1958277	.3198328
30	297083.8	410451.6	349196.9	.0538062	.0323244	.2281521	.2672086
35	266540.5	328069.8	295709.1	.0455645	.0207700	.2489221	.2262792
40	214498.5	291250.7	249945.7	.0385130	.0305881	.2795103	.1912606
45	176155.5	239060.0	205211.4	.0316201	.0305348	.3100451	.1570296
50	141831.3	195161.9	166373.3	.0256357	.0319191	.3419641	.1273103
55	116323.3	153348.5	133559.0	.0205795	.0276340	.3695981	.1022005
60	100828.6	117052.6	108638.2	.0167396	.0149202	.3845183	.0831309
65	72881.11	95978.30	83636.14	.0128871	.0275293	.4120476	.0639991
70+	105280.8	129332.3	116688.5	.0179800	.0205754		.0892911
	5466341.	7717488.	6489898.				

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	12.00162	1.090896	-
5	.9399917	11.00162	1	-
10	.9172357	10.06163	.9145588	14.03456
15	.9004780	9.144391	.8311860	14.06448
20	.8805938	8.243913	.7493364	14.06779
25	.8581958	7.363319	.6692942	14.07186
30	.8329730	6.505123	.5912879	14.07495
35	.8055115	5.672150	.5155742	14.07552
40	.7741304	4.866639	.4423566	14.06975
45	.7405142	4.092509	.3719915	14.06590
50	.7018168	3.351994	.3046819	14.06116
55	.6538412	2.650178	.2408898	14.05532
60	.5915401	1.996336	.1814584	14.04793
65	.5063894	1.404796	.1276900	14.03020
70+		.8984068	.0816613	

ASSUME e(70) = 5: MALES

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1100020	1481405	1276548.	.1977322	.0297663		1
5	880848.8	1200921	1028509.	.1593119	.0309958	.0309958	.8056951
10	694040.2	1022647	842471.4	.1304955	.0387620	.0697578	.6599606
15	545541.4	833559.8	674345.1	.1044534	.0423927	.1121505	.5282567
20	435914.3	653211.3	533614.2	.0826547	.0404455	.1525960	.4180134
25	348885.1	514466.7	423662.3	.0656236	.0388388	.1914348	.3318812
30	281712.1	407325.8	338745.6	.0524704	.0368728	.2283075	.2653606
35	267530.9	308582.2	287324.3	.0445054	.0142753	.2425829	.2250791
40	211408.2	285703.5	245764.2	.0380679	.0301164	.2726992	.1925225
45	180437.5	229448.3	203472.5	.0315171	.0240293	.2967286	.1593928
50	140224.0	194019.3	164942.9	.0255490	.0324716	.3292002	.1292101
55	119040.8	146445.3	132034.0	.0204515	.0207186	.3499188	.1034305
60	106691.7	112383.1	109500.4	.0169612	.0051970	.3551158	.0857785
65	72132.44	96786.30	83554.96	.0129423	.0294002	.3845160	.0654538
70+	102829.2	120803.5	111454.6	.0172639	.0161096		.0873094
	5487257.	7607708.	6455943.				

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.47463	1.095469	-
5	.9378692	10.47463	1	-
10	.9145935	9.536756	.9104627	14.07415
15	.8967424	8.622163	.8231476	14.07936
20	.8728775	7.725420	.7375367	14.07541
25	.8449433	6.852543	.6542041	14.06504
30	.8163648	6.007599	.5735384	14.04784
35	.7868941	5.191235	.4956010	14.02573
40	.7520734	4.404340	.4204771	13.98664
45	.7129110	3.652267	.3486776	13.94677
50	.6655923	2.939356	.2806168	13.89039
55	.6085704	2.273764	.2170735	13.81508
60	.5384911	1.665193	.1589740	13.70162
65	.4480210	1.126702	.1075649	13.50797
70+		.6786813	.0647929	

ASSUME e(70) = 10: MALES

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1100020	1481405	1276548.	.1977322	.0297663		1
5	880848.8	1200921	1028509.	.1593119	.0309958	.0309958	.8056951
10	694040.2	1022647	842471.4	.1304955	.0387620	.0697578	.6599606
15	545541.4	833559.8	674345.1	.1044534	.0423927	.1121505	.5282567
20	435914.3	653211.3	533614.2	.0826547	.0404455	.1525960	.4180134
25	348885.1	514466.7	423662.3	.0656236	.0388388	.1914348	.3318812
30	281712.1	407325.8	338745.6	.0524704	.0368728	.2283075	.2653606
35	267530.9	308582.2	287324.3	.0445054	.0142753	.2425829	.2250791
40	211408.2	285703.5	245764.2	.0380679	.0301164	.2726992	.1925225
45	180437.5	229448.3	203472.5	.0315171	.0240293	.2967286	.1593928
50	140224.0	194019.3	164942.9	.0255490	.0324716	.3292002	.1292101
55	119040.8	146445.3	132034.0	.0204515	.0207186	.3499188	.1034305
60	106691.7	112383.1	109500.4	.0169612	.0051970	.3551158	.0857785
65	72132.44	96786.30	83554.96	.0129423	.0294002	.3845160	.0654538
70+	102829.2	120803.5	111454.6	.0172639	.0161096		.0873094
	5487257.	7607708.	6455943.				

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.51207	1.095129	-
5	.9378692	10.51207	1	-
10	.9145935	9.574197	.9107816	14.22895
15	.8967424	8.659603	.8237775	14.24733
20	.8728775	7.762861	.7384715	14.25313
25	.8449433	6.889983	.6554357	14.25394
30	.8163648	6.045040	.5750573	14.25064
35	.7868941	5.228675	.4973975	14.24482
40	.7520734	4.441781	.4225412	14.22662
45	.7129110	3.689708	.3509974	14.21440
50	.6655923	2.976797	.2831790	14.19518
55	.6085704	2.311204	.2198620	14.17215
60	.5384911	1.702634	.1619695	14.13597
65	.4480210	1.164143	.1107435	14.06736
70+		.7161218	.0681238	

THE IDEAL CASE, e(70) = 12.0: MALES

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5N1(x)	5N2(x)	5N'(x)	5C(x)	5r(x)	SUM. 5r(x)	5Cx/5Co
0	1100020.	1481405.	1276548.	.1977323	.0297663		1
5	880848.0	1200920.	1028508.	.1593118	.0309958	.0309958	.8056945
10	694039.8	1022647.	842471.0	.1304955	.0387620	.0697578	.6599603
15	545541.0	833559.1	674344.6	.1044533	.0423927	.1121505	.5282564
20	435914.0	653211.0	533613.9	.0826547	.0404455	.1525960	.4180132
25	348885.0	514466.5	423662.2	.0656236	.0388388	.1914348	.3318812
30	281711.9	407325.5	338745.4	.0524703	.0368728	.2283076	.2653605
35	267530.9	308582.2	287324.3	.0445054	.0142753	.2425829	.2250792
40	211408.3	285703.6	245764.3	.0380679	.0301164	.2726992	.1925226
45	180437.5	229448.3	203472.6	.0315171	.0240293	.2967286	.1593928
50	140224.0	194019.3	164942.9	.0255490	.0324716	.3292002	.1292101
55	119040.8	146445.2	132033.9	.0204515	.0207185	.3499187	.1034304
60	106691.7	112383.2	109500.5	.0169612	.0051970	.3551158	.0857786
65	72132.46	96786.33	83554.99	.0129423	.0294002	.3845159	.0654539
70+	102829.2	120803.6	111454.7	.0172639	.0161096		.0873094
	5487254.	7607705.	6455941.				

DETECTING AGE MISREPORTING IN DATA ADJUSTED BY THE DSM

age,x	5Lx/5Lo	Tx/5Lo	Tx/T5	ESTIMATED LEVEL
0	1	11.52761	1.094988	-
5	.9378687	10.52761	1	-
10	.9145933	9.589745	.9109135	14.29294
15	.8967420	8.675152	.8240378	14.31675
20	.8728772	7.778410	.7388578	14.32658
25	.8449434	6.905533	.6559447	14.33201
30	.8163644	6.060589	.5756850	14.33444
35	.7868944	5.244225	.4981399	14.33536
40	.7520738	4.457331	.4233942	14.32569
45	.7129112	3.705257	.3519560	14.32445
50	.6655924	2.992345	.2842378	14.31974
55	.6085701	2.326753	.2210143	14.31672
60	.5384913	1.718183	.1632073	14.30957
65	.4480211	1.179692	.1120569	14.28663
70+		.7316706	.0695001	